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ITEM 8 ALLANS CREEK FLOOD STUDY (2019)

The Allans Creek Flood Study (2019) went on public exhibition from 29 July 2019 through to 26 August 2019 and is now finalised. It is recommended Council adopt the Allans Creek Flood Study (2019) which will inform land use planning and planning certificates.

This catchment encompasses various suburbs including Mount Keira, Figtree, Mount Kembla, Kembla Heights, Cordeaux Heights, Unanderra and Port Kembla. It incorporates five main tributaries, namely, Byarong Creek, American Creek, Charcoal Creel, Allans Creek and the Unanderra Industrial Area Drains. The study improves the accuracy and reliability of flood levels and flood behaviour in the Allans Creek Catchment.

The reports and flood models for the Allans Creek Flood Study (2019) 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.

RECOMMENDATION

- 1 That the Allans Creek Flood study (2019) be adopted
- 2 That the Floodplain Risk Management Study & Plan for Allans Creek commence as a priority
- 3 Persons who made submissions be thanked and advised of Council's decision

REPORT AUTHORISATIONS

Report of: Mike Dowd, Manager Infrastructure Strategy + Planning

Authorised by: Andrew Carfield, Director Infrastructure + Works

ATTACHMENTS

- 1 Allans Creek Flood Study 2019 Community Engagement Report
- 2 Allans Creek Flood Study 2019 Executive Summary
- 3 Key Themes raised during public exhibition and Council's response

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 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.



Allans Creek Flood Study

In 2017, Advisian was commissioned by Wollongong City Council (WCC) to review the Allans Creek Flood Study (2006) 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 1 to this report provides an executive summary of the final report recommended for adoption by Council.

PROPOSAL

The Allans Creek Flood Study (2019) 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 26 June 2019, 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 29 July 2019 through to 26 August 2019. Two community drop-in sessions were attended by 74 community members; the first on Wednesday, 7 August 2019 from 4:00 pm - 5:30 pm at the Figtree Community Centre, and the second on Saturday, 10 August 2019 from 10:30 am - 12 noon at the Berkeley Community Centre.

Mailed out a letter to over 7,700 residents and property owners in flood affected areas (all properties within the extent of the probable maximum flood) to advise of the public exhibition process and seek feedback on the document.

Notices of the public exhibition were published in the local newspaper on 31 July and 7 August 2019. Hard copies of the Flood Study and Frequently Asked Questions were placed at the Unanderra and Wollongong Libraries and PDFs were available through Council's "Have Your Say" page. 200 people viewed the Website's project page. 125 people downloaded the documents from the Website. There were a total of 26 submissions throughout the exhibition period.

Comments from the submissions and at drop in sessions related to:

- Australian Rainfall and Runoff
- Flood modelling
- Mapping
- Observations of flooding
- Creek maintenance
- Flood mitigation
- Flood Risk to individual properties
- Perceived causes of flooding
- 1998 Floods
- Planning / Development
- Insurance premiums

Persons who made a submission were thanked and advised of this matter being reported to Council for adoption.

A community engagement report is provided in attachment 2 and outlines in more detail the process and outcomes of the consultation.

Attachment 3 provides responses to all key themes raised during the consultation.



The comments provided can be addressed through on-going education on floodplain management, or considered as part of the future review of the floodplain risk management study and plan for the catchment. Some submissions were very technical in nature and were considered by the consultants, council's flood engineers and flood experts from the NSW Government Department of Planning, Industry and Environment and resulted in additional information and clarifications being provided in the final report.

On 17 October 2019, a presentation was provided to the Central Floodplain Risk Management Committee summarising the outcomes of the exhibition process and how submissions have been addressed. The Committee, by majority, recommended that the Allans Creek Flood study 2019 report be adopted by Council.

The Northview Estate Flooding Residents Action Group (NEFRAG) representatives on the Committee did not support adoption of the plan by Council as the Flood Study does not apply the new National guidelines for flood estimation (AR&R 2016/19). This is consistent with the submission provided by NEFRAG during the exhibition period. Council has committed to implement AR&R 2016/19 as part of the review of the Floodplain Risk Management Study and Plans, with Allans Creek catchment being the first catchment to be reviewed, commencing in early 2020.

PLANNING AND POLICY IMPACT

This report contributes to the delivery of Our Wollongong 2028 goal "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 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

FINANCIAL IMPLICATIONS

The Allans Creek Flood Study (2019) cost \$146,430 excluding GST. The next stage in the flood planning process for this catchment, being the Floodplain Risk Management Study & Plan, will be funded from existing budget allocations and an application has already been made to the State Government for grant funding. It is expected that the Floodplain Risk Management Study & Plan will commence in early 2020.

CONCLUSION

The Allans Creek Flood Study (2019) 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 Allans Creek Catchment. The reports and flood models for the Allans Creek Flood Study (2019) 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.





ALLANS CREEK FLOOD STUDY

ENGAGEMENT REPORT

SEPTEMBER 2019 Z19/203884





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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

Council is responsible for planning and managing flood prone lands in our area and has updated the Allans Creek Flood Study as part of this commitment. A report on the draft Flood Study was prepared with information on how it was updated and what the results are. The updated Study explains the way flooding happens in the <u>Allans Creek catchment</u>. The study will form a basis for the ongoing management of flood risk in the catchment.

Council's engagement team worked collaboratively with a technical consultant to share the updated Study with the community and key stakeholders. During the public exhibition period, 29 July to 26 August 2019, Council sent letters to more than 7,700 residents and property owners in the catchment area inviting them to learn more about the review. Emails with this information were sent to community, education, Register of Interest (flood), business, government and emergency services' stakeholders. The information was also available at Council's Customer Service Centre. Copies of the draft report, a Frequently Asked Questions sheet and Feedback Form were made available at Unanderra and Wollongong Libraries, as well as information sessions at Figtree Community Hall on 7 August 2019 and Berkeley Community Centre on 10 August 2019. They were also included on the project webpage. Notices of the exhibition were published in the Advertiser on 31 July and 7 August 2019. A media release was distributed on 29 July 2019. The community were invited to provide feedback via Council's website, Customer Service Centre and at the community information sessions.

There were 25 submissions. Some comments were provided at the drop-in information sessions which were attended by a total of 74 community members.

Feedback themes relating to the flood study focused on flood estimation methodology, flood modelling and mapping. Concerns were expressed that Council is not using the most current available data. It was noted that the developers of Cobblers Run took Council to court about using the ARR1987 and were successful, with the new guidelines subsequently being used for that development. Questions were raised about why the new guidelines could not also be used for the rest of Northview Estate. Some detailed technical analyses of the Study were provided, with suggested changes. Comments related to the modelling of calibration events, blockage, hydrologic and hydraulic modelling, estimates, validity, verification, data, catchment delineation, grid size, percentage impervious values, Manning's values and definitions. There was some uncertainty about whether the modelling replicates real events. A comment was made that the mapping confirmed observed flood levels. Some suggested that the resolution of the maps needed to be improved. A method was stepped out as to how to improve this in a way that reduces loss of quality. It was also suggested to remove most maps that are based on "risk management" blockages.

Other feedback themes related to observations of flooding, creek maintenance, flood mitigation, flood risk to individual properties, perceived causes of flooding, 1998 floods, planning/development and insurance premiums.



Background

Wollongong City 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 Allans Creek Flood Study is one of 10 studies to undergo review. This catchment is located in Mount Keira, West Wollongong, Figtree, Mount Kembla, Unanderra, Farmborough Heights and Berkeley.

Figure 1 Allans Creek catchment map



The Allans Creek Catchment Flood Study and Floodplain Risk Management Study and Plan were completed by Council in 2006, with addendums to the Flood Study in 2008 and 2009. These studies identified the risk within the Allans Creek 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. We have improved information, such as recent data from land and waterway surveying. We've included an extended network of drainage pits and pipes and used more improved and detailed modelling techniques. We've also extended the mapping to capture additional flood-prone areas and waterways that were not previously mapped. Data was collected and used to update the computer models used to simulate the flooding in the catchment, and to update flood maps which provide a visual illustration of the flood risk in the catchment.



At the Central Floodplain Risk Management Committee meeting on 26 June 2019, the public exhibition of the draft Allans Creek 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 2019.

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 Allans Creek catchment.



Methods

Our Stakeholders



Our Methods

Table 1: Details of Communication and Engagement Methods

Methods	Details of Methods
Presentation	Information about the proposal was presented at the Floodplain Risk Management Committee (Central) meeting on 26 June 2019
The Advertiser	Details of the public exhibition, information sessions and Engagement HQ webpage were included in Council's Community Update pages on 31 July and 7 August
Media release	A media release was made available for media outlets
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 with registered interest in 'Flood'
Info packs	Frequently asked question sheets and hardcopy feedback forms were made available at Corrimal Library and Customer Service. Hardcopies of the draft report were also made available at Wollongong and Unanderra Libraries.
Letter	A letter about the public exhibition, information sessions and how to submit feedback (via phone, email, in person or post) 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, published on the project webpage and distributed at the information sessions.



Engagement HQ Website	 The project webpage hosted background info and supporting documents: Frequently Asked Questions with information on the Study and flood risk management News Feed for updates on project progress Document Library with the Report Flood modelling video Flooding in Wollongong video Online survey tool to capture participant's feedback
Video	The Flooding in Wollongong video was used on the Engagement HQ webpage and a flood modelling video was screened at information sessions and on the Engagement HQ webpage
Engagement HQ Website	An online survey tool was used to capture participant's feedback. The page also hosted background info and supporting documents.
Feedback Form	A hard copy feedback form was made available at libraries and engagement activities.
Community Information Sessions	Two drop-in sessions were held to provide the community with information on the work undertaken to date and findings of the Report. The Report, flood modelling maps, flood modelling video and images of flood mitigation work taking place in the catchment were displayed along with the FAQ and feedback forms. Floodplain management engineers working on the Study were on hand to answer questions.



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 Meeting	7
Drop-in Community Information Session at Figtree Community Hall	59
Drop-in Community Information Session at Berkeley Community Centre	15
Online Participation • Aware – Total number of users who viewed the project page • Informed – Total number of users who clicked a hyperlink, e.g. to download a document • Engaged – Total number of users who actively contributed to the project, e.g. submitted feedback via the online form	200 125 3

Figure 2 Community Information Session at Figtree Community Hall





Submission Results

There were 25 submissions, including 6 group submissions from Figtree Gardens Caravan Park Residents' Committee, Neighbourhood Forum 5, Rienco Consulting, Maddan Investments, Northview Estate Figtree Resident Action Group and Cardno. Discussions from drop-in sessions are also presented in this section.

Feedback themes relating to the flood study focused on flood estimation methodology, flood modelling and mapping.

Australian Rainfall and Runoff (ARR)

Concerns were expressed that Council is not using the most current available data. It was noted that the developers of Cobblers Run took Council to court about using the ARR1987 and were successful, with the new guidelines subsequently being used for that development. Questions were raised about why the new guidelines could not also be used for the rest of Northview Estate.

Expedite steps to prove up the ARR2016-19 methodology in Wollongong.

The study should not be formally released until current methodology is used for design flood estimation.

Council's engineers have said there are concerns with the new ARR2019 method and it needs to be adjusted for local characteristics unique to Wollongong. Is Wollongong so different that it can run its own race.

Use of the lower ARR2019 design rainfall for the region inevitably would have led to more scientifically correct and even lower flood levels in the Northview Estate.

Flood modelling

Technical comments were provided on modelling calibration events, blockage, hydrologic and hydraulic modelling, estimates, validity, verification, data, catchment delineation, grid size, percentage impervious values, Mannings values and definitions. There was some uncertainty about whether the modelling replicates real events. A comment was made that the mapping confirmed observed flood levels.

To alleviate confusion surrounding how the modelling has been assembled and its outputs, we recommend a Compendium of Data is published with the adopted Study which documents more of the underlying data that supports the modelling.

The modelling should include consideration of blockage, calibrated against real world events. It is difficult to see whether this has been done or not.

Clarify the hydrologic modelling's validity and superiority over conventional WBNM formulations

Mapping shows American Creek at my location to be increasing in width in the various flood conditions considered. They show increased depth and velocity. This is confirmed by my observations over the years.



Land surveys are required at two key locations where calibration of the model needs additional information to be reliable; these are immediately upstream of the Princes Highway bridge over Byarong Creek and at Figtree Grove Shopping Centre.

For calibration and verification modelling, a more forensic approach to understanding the "apparent blockage" values and harnessing them in cases where their physical significance cannot be reconciled with historical observations.

The definition of floodway includes a criteria that is too low and should be revised to exclude H1 hazard areas

Maps

Some felt the resolution of the maps needed to be improved. A suggestion was made to plot to PDF from GIS software and retain cadastre/contours/velocities as vector data instead of raster data to reduce loss of quality. It was also suggested to remove most maps that are based on "risk management" blockages.

The current maps have a poor resolution and are of little use for examining results at a street or property level.

Other feedback themes were:

Observations of flooding

Experiences of significant flood events in the catchment were recounted.

It went 12 ins up my wife's knee. My son was outside 16 ins in the carport. Within 10 minutes it was gone.

March 2019 - a car drove in floodwaters in Hurt Pde [Unanderra]. SES tried to get them out. Our backyard was underwater.

The area around Figtree Westfield shopping centre was so flooded on The Avenue at the Bowling Club that many cars had been washed over the fence in the front car park. Three houses opposite the Bowling Club were ¾ under water.

I have photographs of the big flood in 1959, 1998 and 1999



Creek Maintenance

Requests were made for creek maintenance on private land, Council land or where the landowner was not identified.

I would like the Council to remove trees that were washed down the creek up against the bridge. The creek needs to be cleared further up so the coral trees won't fall into creek and block the bridge.

Islands of vegetation have been allowed to grow in the middle of the creek, trees have fallen into the creek and in one spot fallen trees have formed a dam.

The banks are eroding toward properties on Leigh Crescent. The waterway needs to be maintained & improved.

The owners of the entry culvert/causeway land at Figtree Gardens Caravan Park have not done any vegetation clearing either side for a number of years. I understand Council can "encourage" them to maintain the area affected and also as it's a public road help with said maintenance to a degree.

Flood mitigation

There was a high level of interest in the next stage of the flood risk management process, i.e. what Council might do to reduce the impact of floods.

How many more studies are Council going to do? And when will we see something being done?

According to the current Wollongong flood map, the M1 is predicted to hold back floodwaters over a length of 1.5km. The American Creek M1 culverts are the most sensitive location along this length. What can Council do to improve this position?

The Forum requests that in the Flood Risk
Management Study priority is given to the
implementation of flood mitigating infrastructure
affecting the Figtree Grove Shopping Centre and the
nearby residential areas that are otherwise suitable
for redevelopment at higher densities.

There were many bright graphs/pictures and we could all see light and dark blue which was the flood water etc -But what is Council going to do?

A range of potential options for mitigating flood impacts was suggested.

Target the 'low hanging fruit' in terms of the suite of flood mitigation management measures e.g. a well-designed debris trap at the M1 culvert

Open the culvert on Gladstone Avenue at least another metre higher and possibly make the spans wider



Flood risk to individual properties

There was uncertainty about what the outcomes of the Study mean for flood risk to individual properties.

We still do not know if we are at risk of a flood according to your studies What should I expect in significant rain events if your proposed plans are adopted?

Perceived causes of flooding

A range of reasons for what people perceived to be the cause of flooding was presented.

Potential flooding is mainly caused by blockage of the M1 Culvert Water is being diverted towards properties by a bridge constructed in 1979 and is eroding a creek bank less than 1 metre from the main sewerage line

[Comments in 1999 letter to the Illawarra Mercury] Byarong Creek gets choked with straight willows. These catch the debris and break free of the mud and flow downstream and block the culvert forming a huge damn.

1998 floods

Experiences of the 1998 flood were shared, including those that occurred in other catchments.

The High Tide was in, the water could not flow back into the ocean. The now MI had been built and the walls on either side of this highway are about 4 to 5 meters high. The water from the creek built up and water accumulated and pushed onto the MI wall and therefore Preston Avenue flooded.

Corrimal Westfield Shopping Centre lower section was totally flooded and all merchandise and equipment etc was ruined. Fairy Meadow Fraternity Club was flooded. Bulli Pass had collapsed. Thirroul Escarpment (Sylvan Way) became a waterfall, creek flooded, water just ran down the mountain.

Planning / development

There was a concern that the Flood Study would add to the cost of making new developments compliant.

Many have been told by Council that they would not get planning permission for their build in Cobblers Run unless they built 1.0m above the ground. This adds significant cost to an average family home.



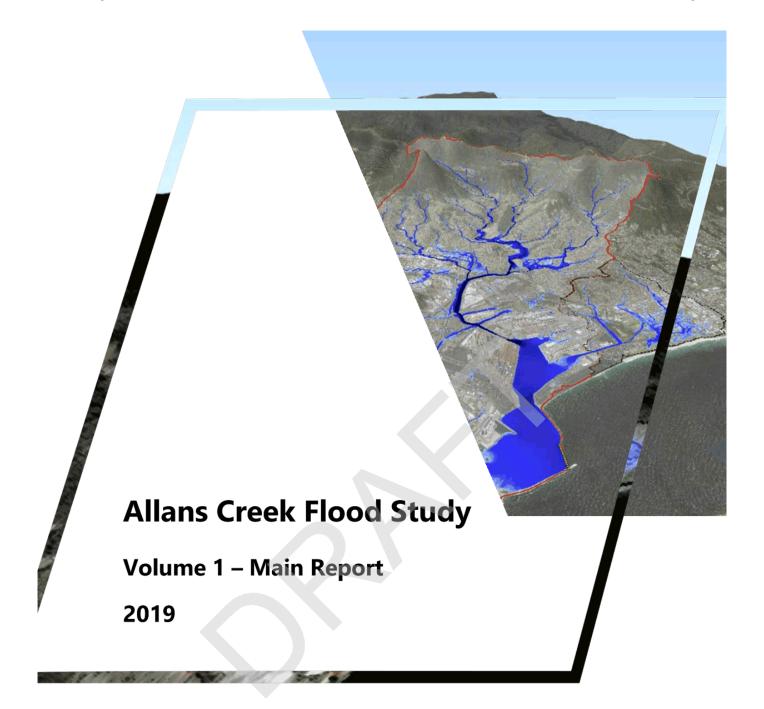
Insurance premiums

Concerns were raised about the impact of the flood study on home insurance premiums.

The modelling results in the 'flood affected' label being unnecessarily applied to hundreds of homes in Figtree which now require flood insurance when clearly they are not flood prone. This adds further annual costs of flood insurance.

People that have lived here for more than 30 years have never seen flood waters on the backyards from rising creek water and yet due to Councils classification it is very costly to have any flood insurance





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Revision B

October 2019

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Cover Photo: Three-dimensional render of major flowpaths in the Allans Creek & Wollongong City catchments (*Source: Advisian*)

Project: Allans Creek Flood Study Draft Flood Study Report

Rev	Description	Author	Review	Advisian Approval	Date
0	Draft Report for Internal Review	LC	CRT		18/7/2019
		L Collins	C Thomas		
Α	Draft Report issued for Public	LC	CRT		00/7/0040
	Exhibition	L Collins	C Thomas		26/7/2019
В	Final Draft Report	LC			
		L Collins			





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Executive Summary

Introduction

The Allans Creek catchment is located within the Wollongong City Council Local Government Area (LGA) in the Illawarra Region of New South Wales. The catchment drains from the Illawarra Escarpment to Port Kembla Harbour, covering an area of approximately 45 km². The study area includes additional areas which drain directly to Port Kembla Harbour totalling about 5 km².

The catchment encompasses various suburbs including Mount Keira, Figtree, Mount Kembla, Kembla Heights, Cordeaux Heights, Unanderra and Port Kembla, and incorporates five main tributaries, namely Byarong Creek, American Creek, Charcoal Creek, Allans Creek and the Unanderra Industrial Area Drains. A number of major transport links also pass through the catchment including the Princes Motorway (M1), Princes Highway 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 floods in August 1998 and October 1999.

Previous floodplain risk management activities completed in the study area by Wollongong City Council (Council) have included the *Allans Creek Flood Study* (*Lawson and Treloar 2006a*), *Allans Creek Floodplain Risk Management Study and Plan (Lawson and Treloar 2006b*), and the implementation of flood risk management measures including 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 Allans Creek catchment in response to a range of 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 Allans Creek 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 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 Allans Creek catchment including the assessment of potential floodplain risk management measures.





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.

Summary 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 indicative of a 'flashy' catchment where flooding generally occurs in response to relatively short durations of intense rainfall and flood levels quickly rise and fall over the course of just 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 where Allans Creek discharges to Port Kembla upstream to the area where Byarong and American Creeks pass beneath the M1 Motorway. 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 longer.

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. Such areas include Byarong and American Creeks in the vicinity of the Princess Highway and M1 Motorway.

During the 1% AEP flood event, areas of high flood hazard that may pose a significant threat to life and property (e.g. ≥ H4 Hazard) are generally constrained to defined water courses, open channels and flood flow paths. However, there are various exceptions including (but not limited to) properties adjacent to Byarong Creek at Koloona Avenue, Arrow Avenue and Preston Street; properties near a low-point in Phillips Crescent, Mangerton, and; parts of Figtree Gardens Caravan Park and O'Donnell Drive adjacent to American Creek. 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.





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.

Potential Impacts of Climate Change

To assess the potential impacts of climate change on flooding in the Allans Creek catchment 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. This owes to the steep flood gradient in
 Allans Creek approaching Port Kembla, and the relatively high surrounding ground elevations.
- 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, with localised increases of more than 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 small and limited to the lower reaches of Allans Creek.

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 and PMF peak flood levels upstream of many structures relative to the 'design' blockage factors, though the magnitude of increase is often less than 0.1 m. Localised differences in 1% AEP peak flood levels of up to 0.85 m were however observed. The magnitude of flood level difference is generally lower for the PMF event than the 1% AEP event.





2016 Blockage Policy vs 2002 Blockage Policy

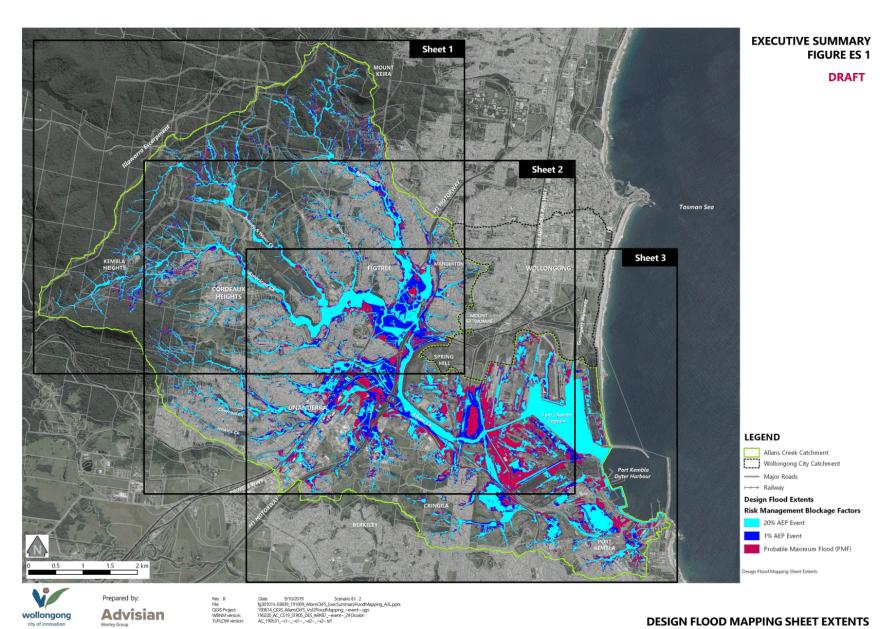
To determine the degree of any changes in peak flood levels that are attributable to the adoption of Council's *Revised Conduit Blockage Policy* (2016) a comparison between the following scenarios was made for the 1% AEP and PMF events using the new TUFLOW hydraulic model:

- 2016 policy 'risk management' blockage factors
- 2002 policy blockage factors as described in Chapter 3 of Allans Creek Flood Study Addendum 1 (Cardno Lawson Treloar 2008) and Chapter 7 of Allans Creek Flood Study (Lawson and Treloar 2006a).

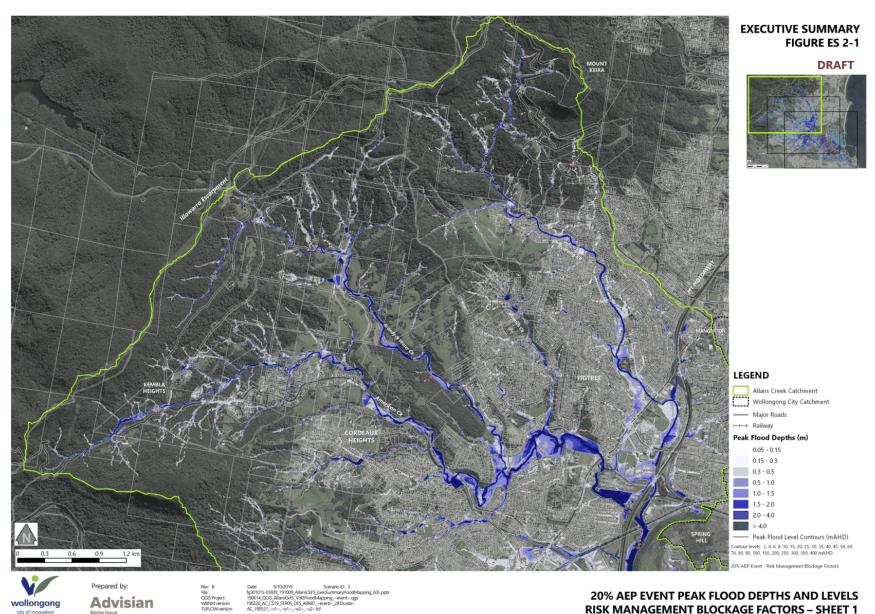
The revised 2016 blockage policy 'risk management' factors were found to result in a decrease in peak flood levels upstream of many structures relative to the 2002 Blockage Policy. No increases in peak flood level were indicated by the model results.





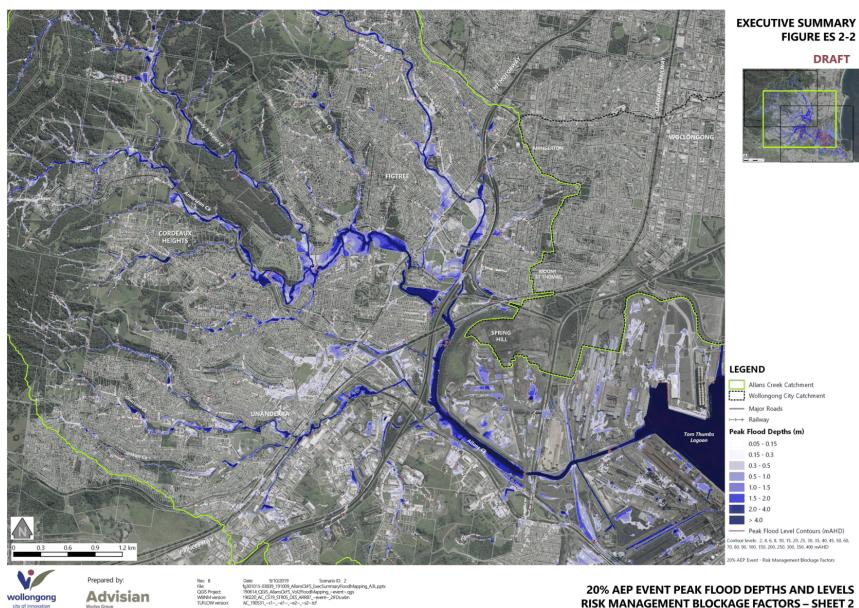


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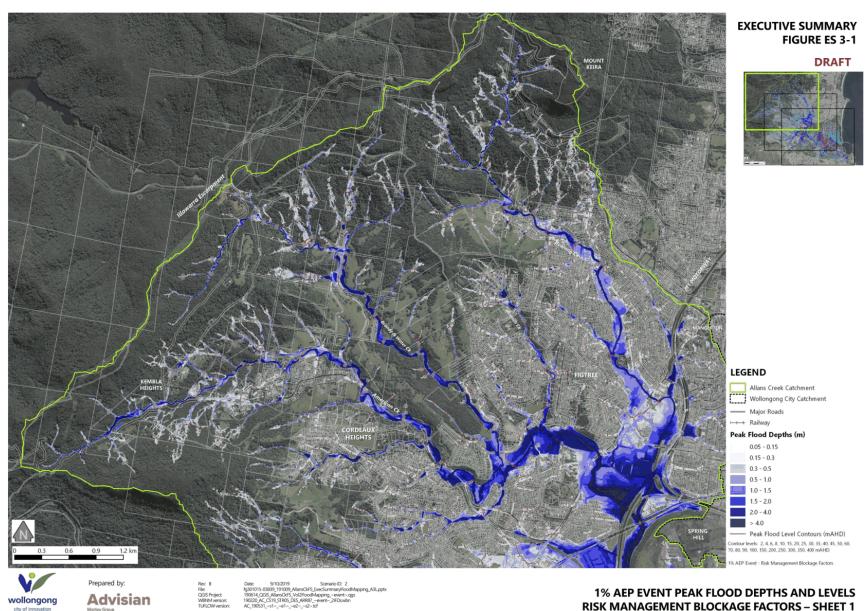






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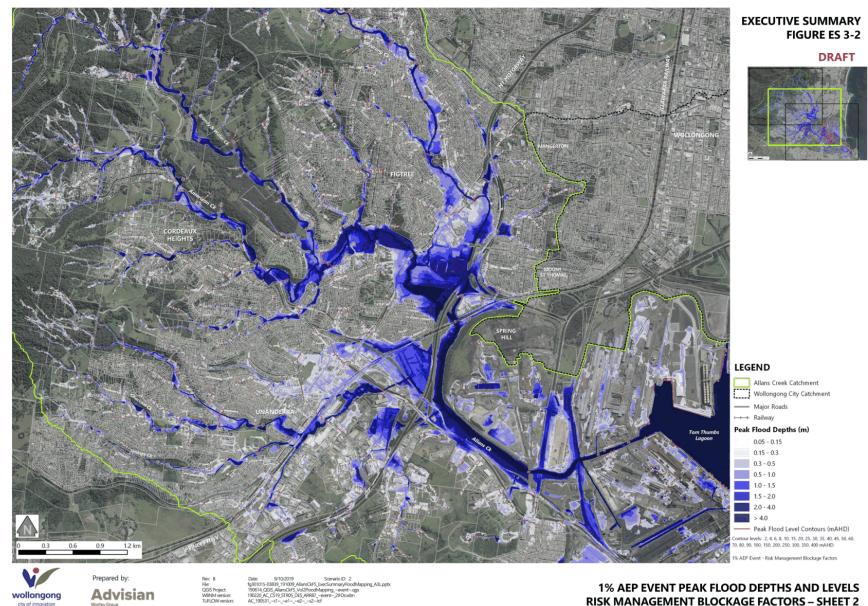




1% AEP EVENT PEAK FLOOD DEPTHS AND LEVELS **RISK MANAGEMENT BLOCKAGE FACTORS – SHEET 1**

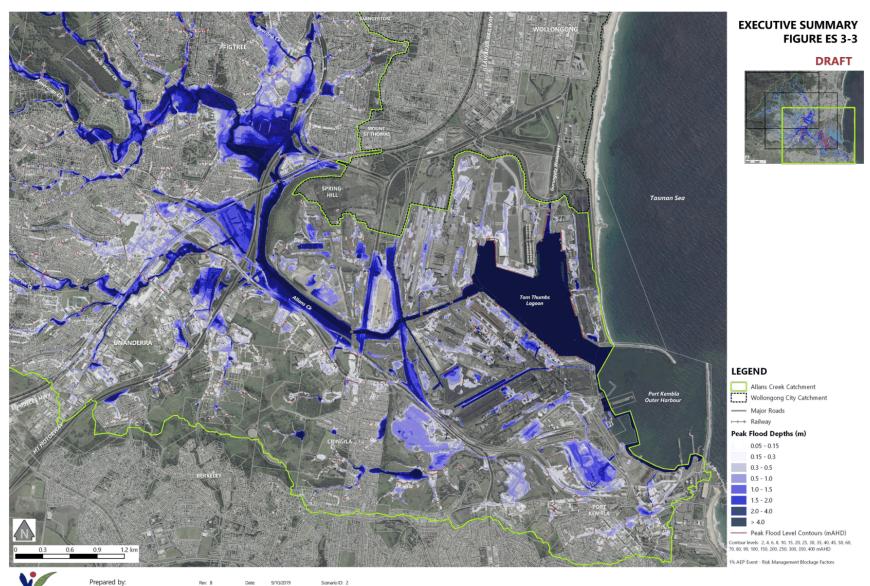
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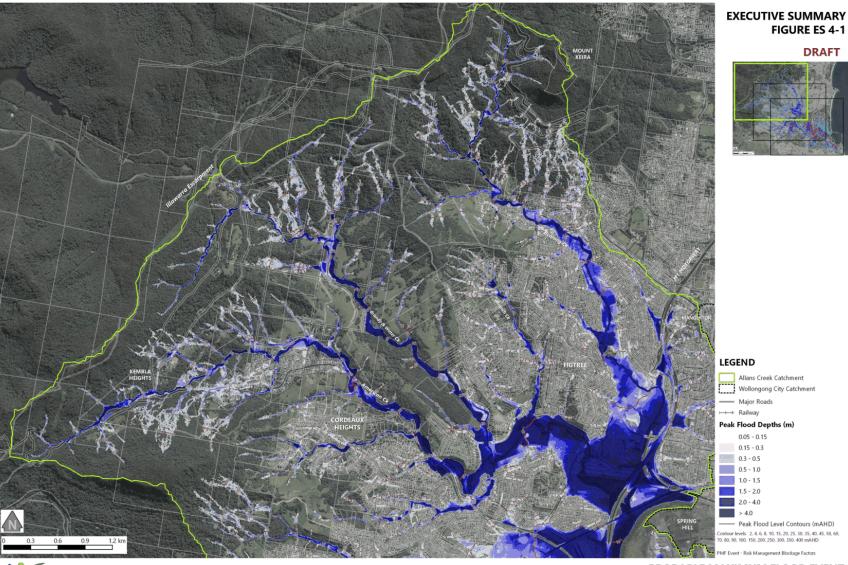


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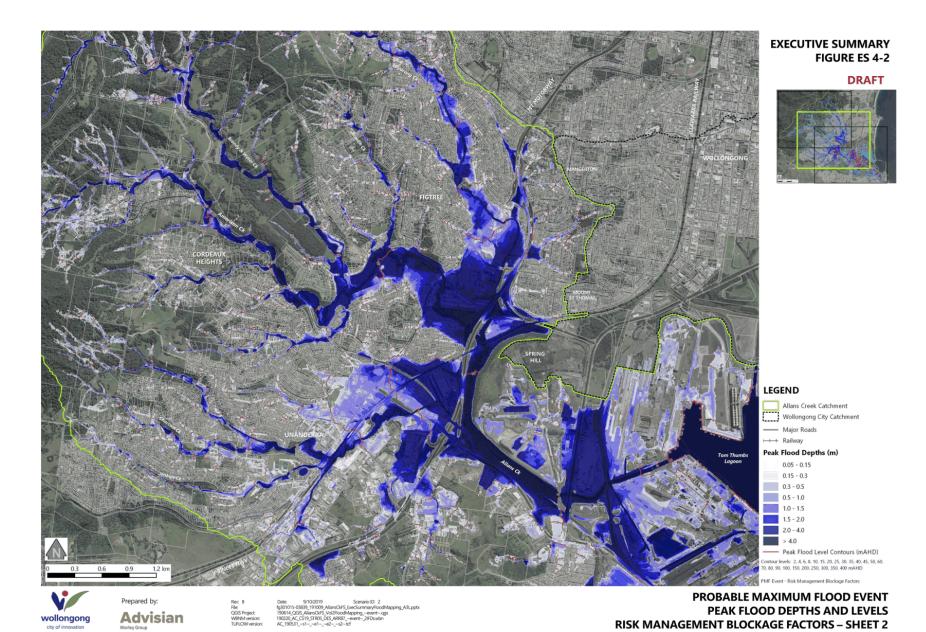


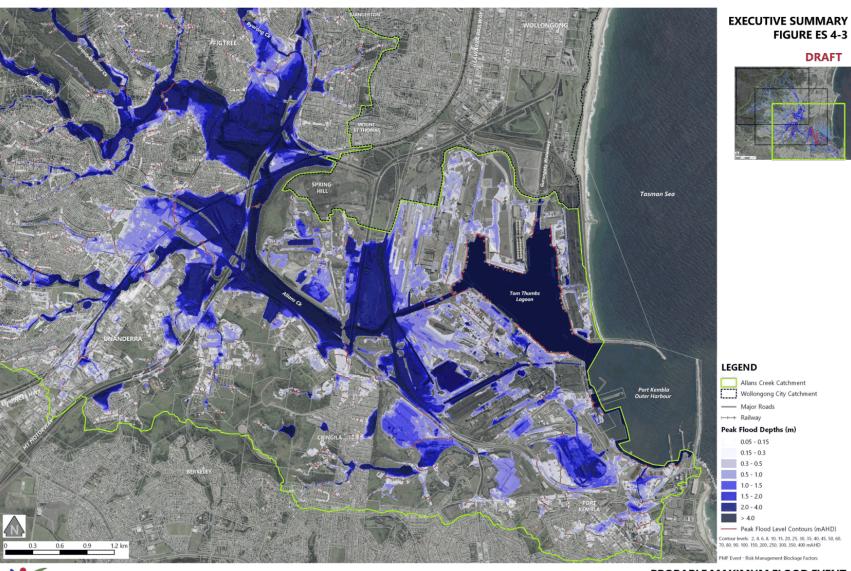
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PROBABLE MAXIMUM FLOOD EVENT
PEAK FLOOD DEPTHS AND LEVELS
RISK MANAGEMENT BLOCKAGE FACTORS – SHEET 1





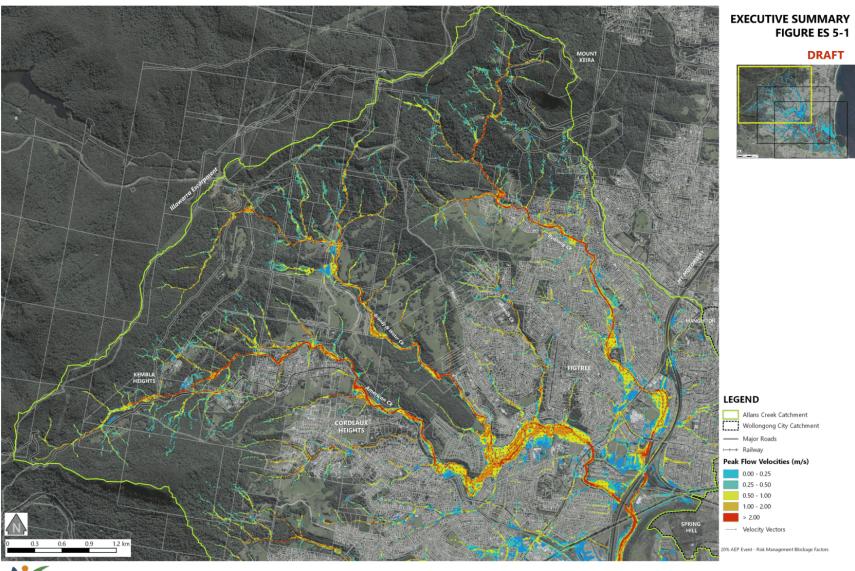




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PROBABLE MAXIMUM FLOOD EVENT **PEAK FLOOD DEPTHS AND LEVELS RISK MANAGEMENT BLOCKAGE FACTORS - SHEET 3**





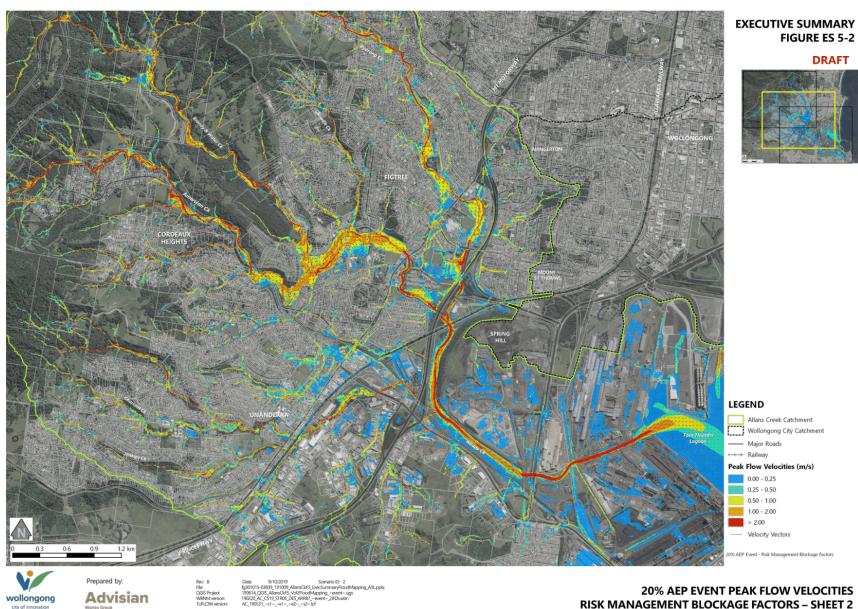




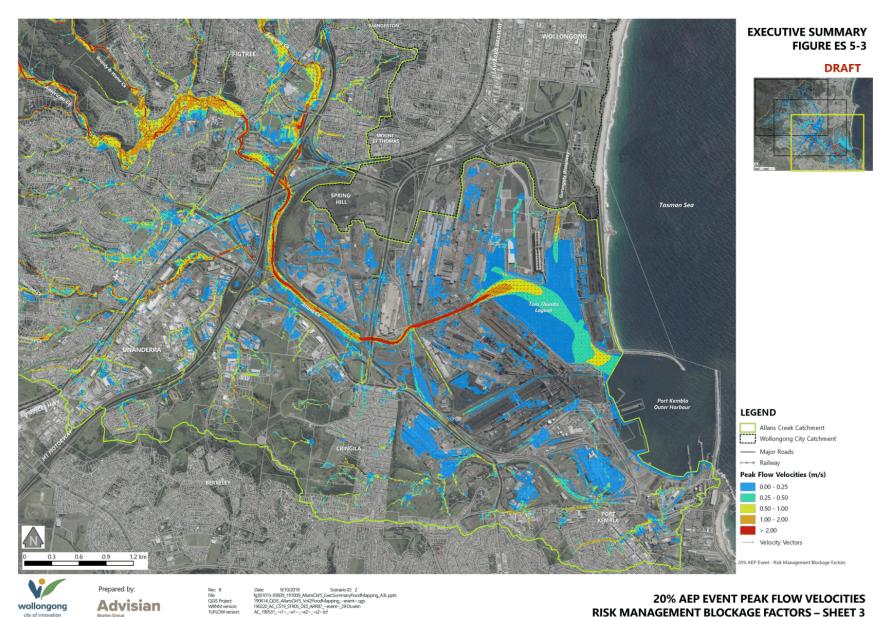
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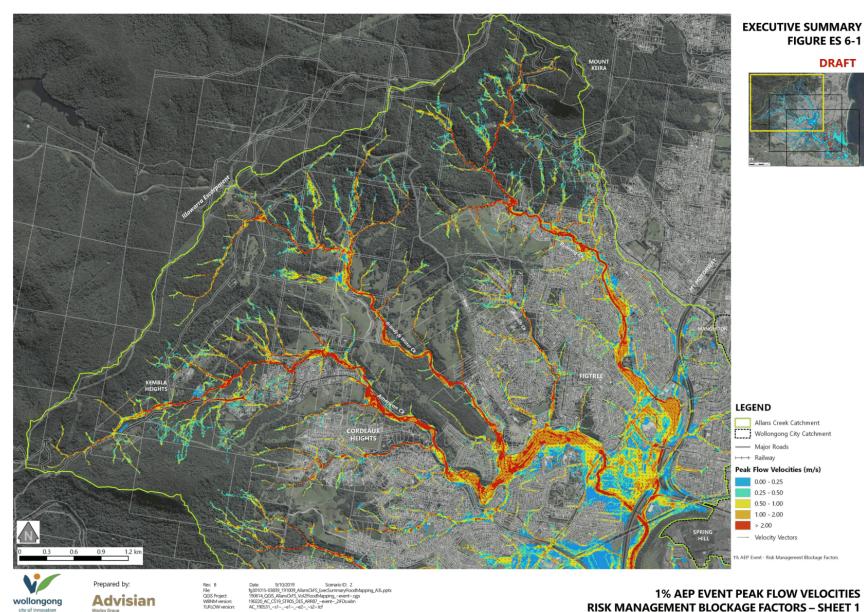




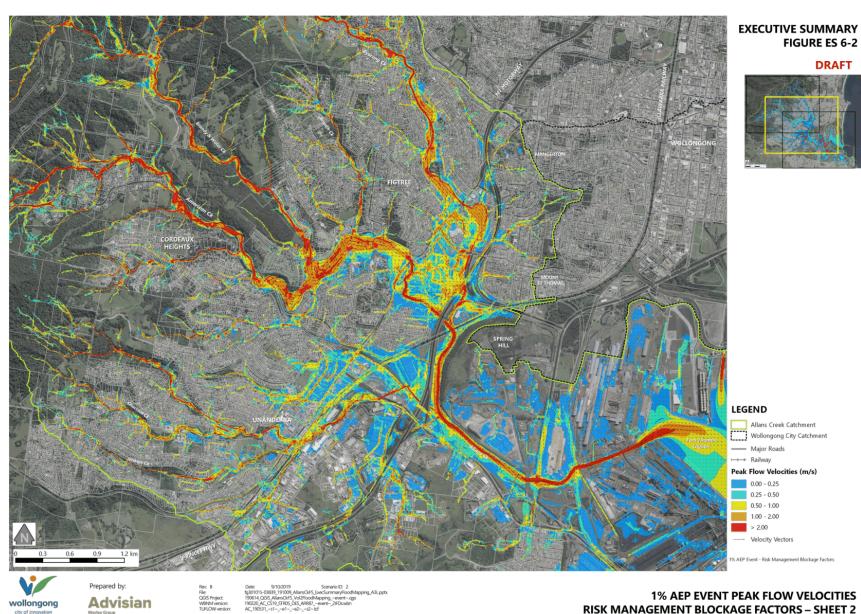




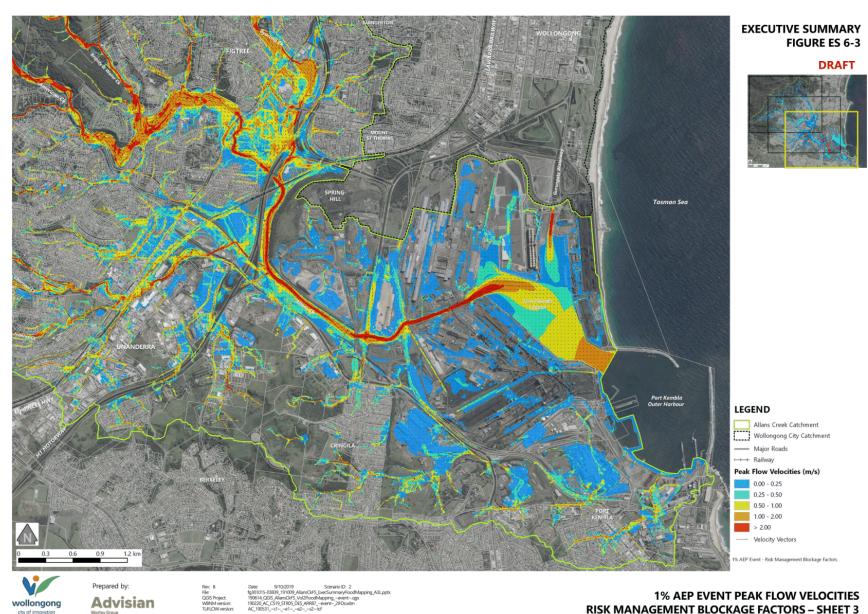




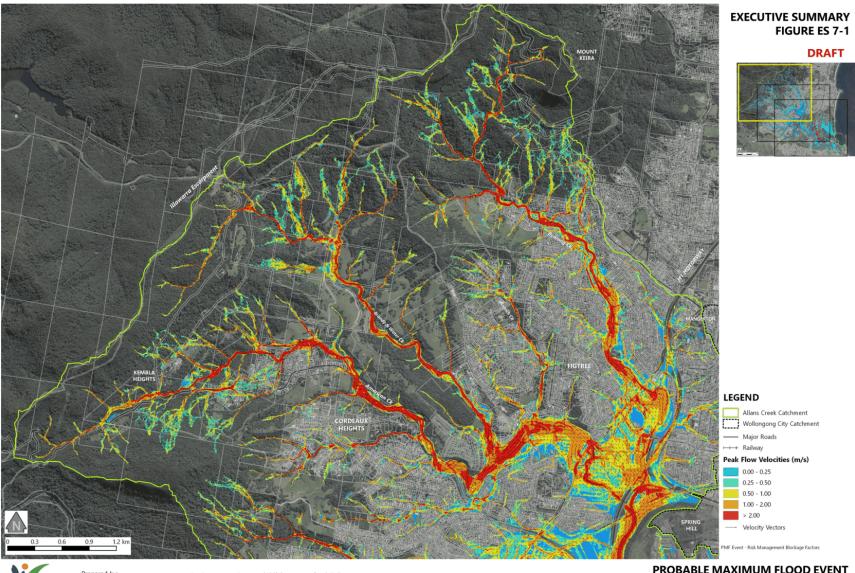












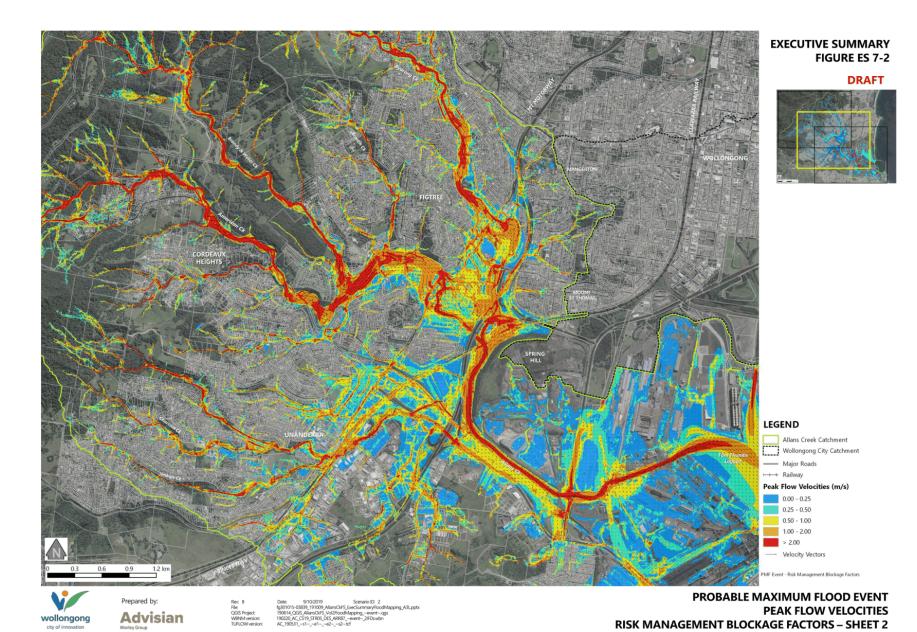




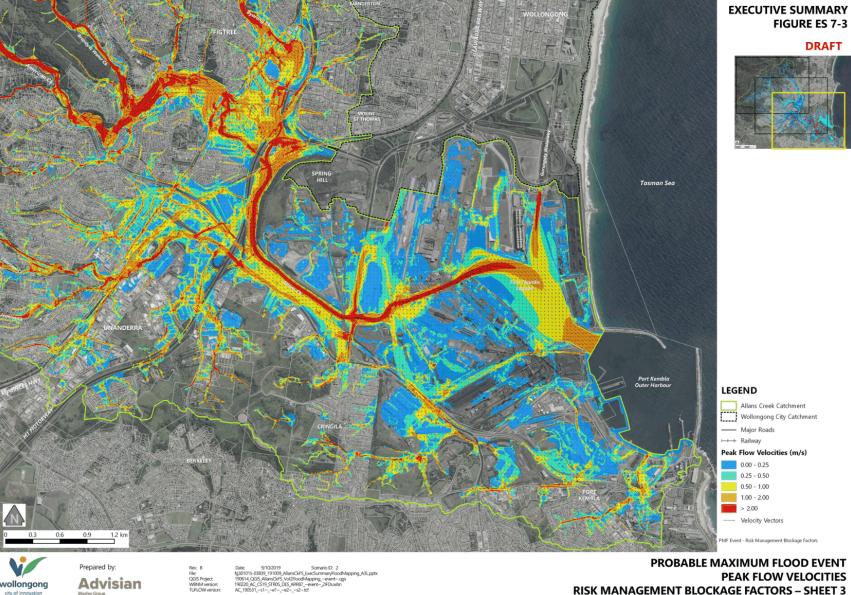
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RISK MANAGEMENT BLOCKAGE FACTORS – SHEET 1



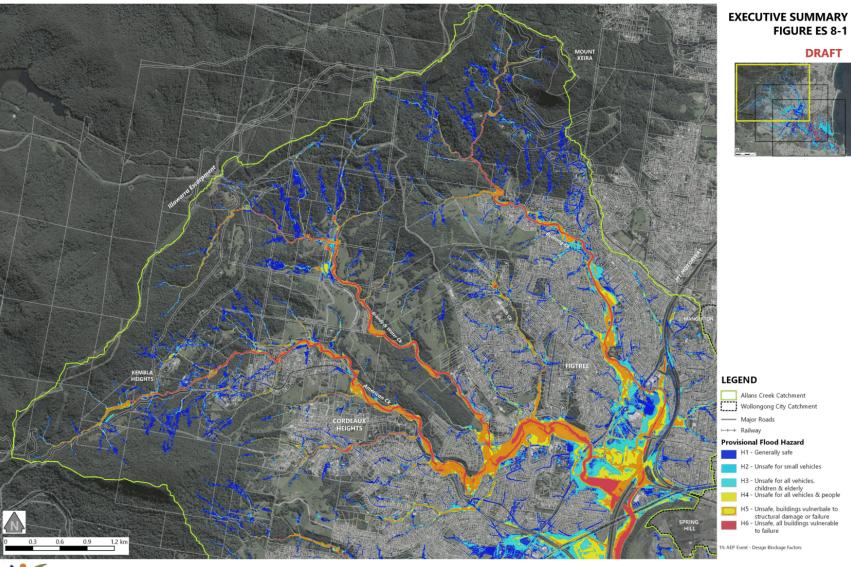


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PROBABLE MAXIMUM FLOOD EVENT **PEAK FLOW VELOCITIES RISK MANAGEMENT BLOCKAGE FACTORS – SHEET 3**









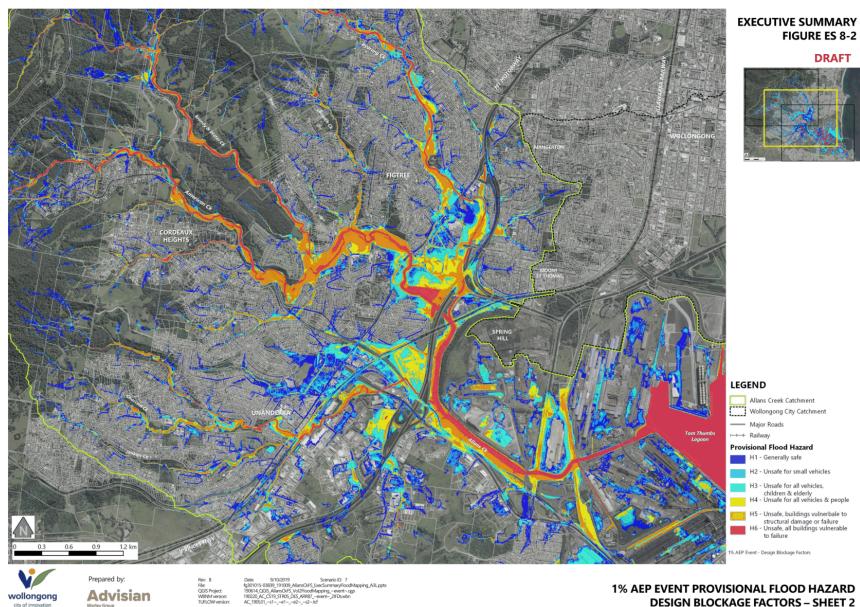
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1% AEP EVENT PROVISIONAL FLOOD HAZARD DESIGN BLOCKAGE FACTORS – SHEET 1

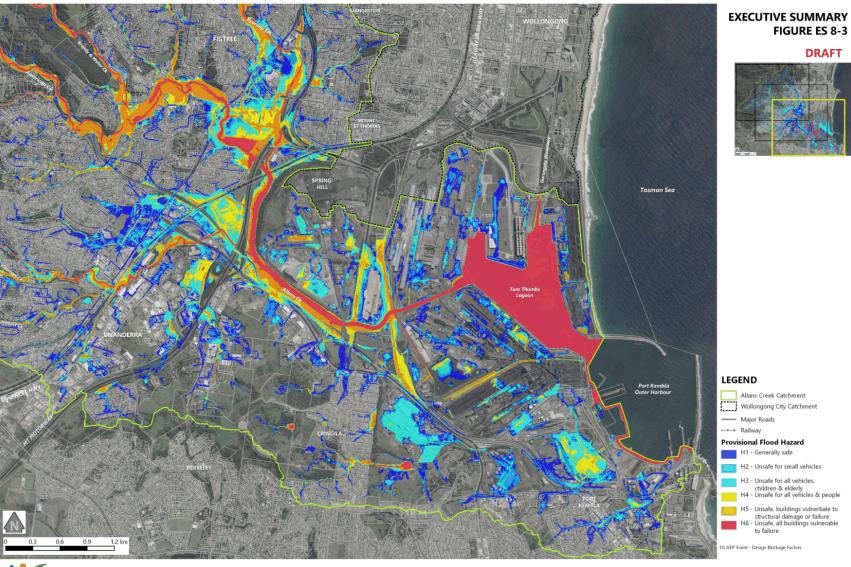
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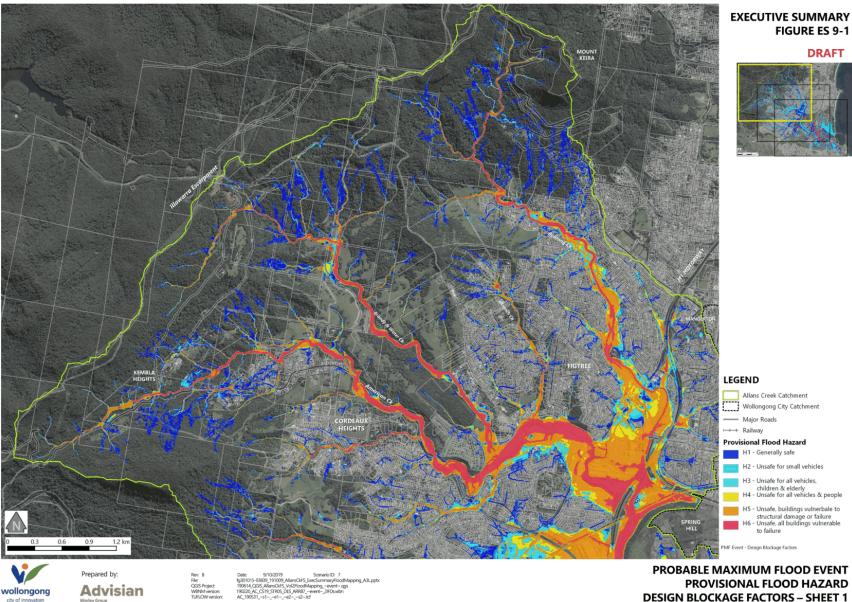
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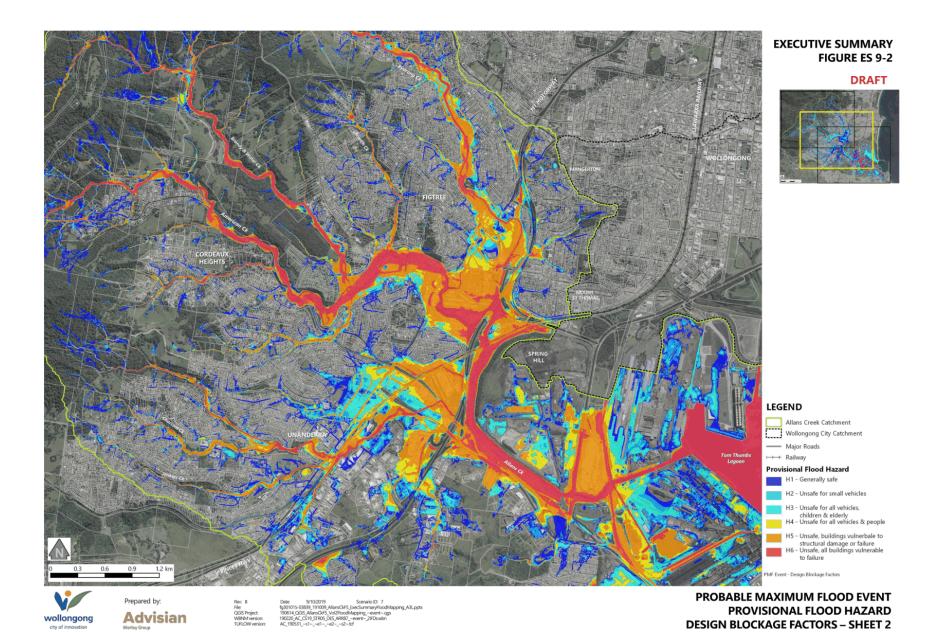
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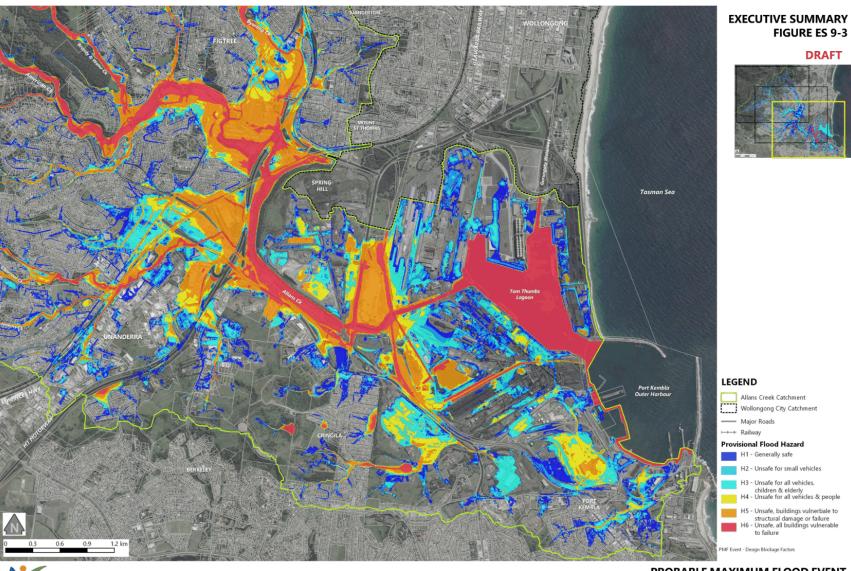


PROBABLE MAXIMUM FLOOD EVENT PROVISIONAL FLOOD HAZARD **DESIGN BLOCKAGE FACTORS - SHEET 1**













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PROBABLE MAXIMUM FLOOD EVENT PROVISIONAL FLOOD HAZARD DESIGN BLOCKAGE FACTORS – SHEET 3



Item 8 - Attachment 3 - Key Themes raised during public exhibition and Council's response

Allans Creek Flood Study 2019

Comments from the submissions and at drop in sessions related to:

Key themes	Council's response
Adoption of Australian	In accordance with the NSW Government, Floodplain Risk Management
Rainfall and Runoff	Guide, Incorporating 2016 Australian Rainfall and Runoff in studies, and in
(ARR) 2016/2019	accordance with Book 1, Chapter 1 of ARR2019, Council is currently
methodology	finalising procedures and data that are more appropriate for our region so
	that ARR2019 can be implemented. The ARR 2019 methodology will be
	considered in the future review of the floodplain risk management study
	and plan for which Council has allocated resources this financial year and
	has applied for funding under the NSW Flood Program. Until then, we will
	continue to use ARR1987.
Flood modelling	The 2019 flood study has developed a detailed and catchment wide flood
validity	model with all catchment topography, streams, hydraulic structures and stormwater drainage represented. To confirm the models' ability to
	simulate actual flood behaviour the hydraulic model was calibrated to a
	series of surveyed historical flood levels and the Byarong Creek gauge
	record. No previous model of the study area has undergone calibration to
	water level gauge data to indicate that the timing or magnitude of flood
	hydrographs is appropriate. This study has been carried out by
	experienced flood engineers who have undertaken numerous catchment
	wide flood studies in accordance with the NSW Floodplain Development
	Manual. The study was subject to a rigorous technical review process
	involving Council and NSW Government, DPIE, technical staff.
Decalution of the mane	The resolution of the flood manning was selected in order to sever the
Resolution of the maps	The resolution of the flood mapping was selected in order to cover the large study area with a practical number of 'tiles'. Increasing the number
	of flood maps and tiles does not necessarily increase their value and,
	rather, can negatively impact the community's desire or ability to digest
	the information presented. Owing to the large catchment size mapped
	and relatively narrow waterways which exhibit a high level of spatial
	variation in flood result parameters, it can be difficult to determine specific values at an individual property from the flood mapping.
	However, it is not the purpose of the 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 by local consultants, they provide finer scale
	resolution.
Observation (C)	
Observation of flooding	Council acknowledged and recorded information provided on observed
	historical flood behaviour. This was used to confirm the model
Poguest for areals	calibration/verification results.
Request for creek	Where maintenance was requested for sections of creek on Council's
maintenance	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 on their responsibilities
Flood mitigation works	in person or by letter. Council has undertaken/is currently undertaking various flood mitigation
in the catchment	projects in the catchment including debris control structures, creek
in the catchinent	projects in the catchinent including debris control structures, creek

Council's response

Item 8 - Attachment 3 - Key Themes raised during public exhibition and

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	restoration works along Council – owned portions of creeks, creek bed and bank stabilisation and voluntary purchase of severely flood affected properties. Council's website includes information on mitigation works in the catchment.
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 is committed to undertake the review of floodplain risk management study and plan and has applied for financial assistance from the State Government for this project.
Flood risk to individual properties	The purpose of a flood study is to describe existing flood behaviour. Options to reduce flooding on individual properties will be considered as part of the future review of the floodplain risk management study and plan.
Perceived causes of flooding	The draft flood study takes into consideration factors which may affect flooding such as the alignment and capacity of the existing drainage system (much of which is verified by detailed survey) and the level of vegetation within the waterways. The study also incorporates the developments that have occurred since the completion of the 2006 flood study.
1998 floods	The 1998 floods that caused significant disruption and damage in the catchment were not as big as a 1% AEP flood. This explains why residents in some areas mapped as flood affected may not have experienced flooding will be affected by the 1% AEP and larger flood events. A 1% AEP is extreme. There is a 1% chance of a flood of this size occurring at a particular location in any given year.
Impacts of flood study on Planning/development	The draft flood study has been prepared in accordance with the NSW Government's Floodplain Development Manual and incorporates the NSW Flood Prone Policy. The study was overseen by the Central Area Floodplain Risk Management Committee.
	The NSW Government's Floodplain Development Manual provides a framework to ensure the sustainable use of floodplain environment and incorporates the NSW Flood Prone Policy. Under the Policy, the management of flood liable land remains the responsibility of Local Government. Council's policies are consistent with the framework and ensure minimal damages and less flood risk to newly developed properties.
Impact of the flood study on home insurance premiums	Fact sheets on insurance were provided to residents. People were advised that the standard definition of 'flood 'for insurance purpose may or may not apply to their properties and 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 properties.