February 2020 Flood

Hawkesbury-Nepean Valley

30 June 2020

Presentation to Legislative Council Select Committee

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Matters raised for discussion

Discuss the February 2020 flood:

- Compare the event to the models and forecasts underpinning the current flood assessments
- What were the impacts of the flood – upstream and downstream?
- How early warnings and evacuation systems worked?

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February 2020 flood – presentation to Select Committee

1. **About floods**
   - Likelihood and consequence
   - In the Hawkesbury-Nepean
   - Current conditions
2. **February 2020 rainfall event**
   - The rainfall event
   - Inflows to storages
   - Upstream impacts
   - Water quality management
3. **February 2020 flood**
   - In context
   - The flood event
   - Downstream flooding
   - Emergency warnings and response
   - Had Warragamba Dam been full

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In summary …

- February 2020 event was a small flood with around a 1 in 5 chance per year
- There have been 55 similar sized floods since records began
- Warragamba Dam was around 43% full at the beginning of the rainfall event and captured all inflows
- Warragamba Dam didn't fill and spill during the February 2020 event – or since
- There were no upstream impacts in the dam catchment from the dam storage or operations
- Most downstream impact in low lying areas: bridges closed, around 65 properties affected, less than 200 people ordered to evacuate
- Had the dam been full: flood levels downstream around three metres higher, 1000 properties affected, and 2,500 to 3000 people ordered to evacuate
- Bureau of Meteorology predicts a higher likelihood of La Nina conditions with increased chance of above average rainfall and potential flooding – noting Warragamba Dam storage is at ~82%

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About floods

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About floods – likelihood or chance of a flood

- **Floods are naturally occurring probabilistic events**
- **Smaller floods occur relatively frequently - large floods occur infrequently**
- **Flood frequency is described as a chance of happening in any given year:**
  - 1 in 100 (1%) chance per year, or 1% Annual Exceedance Probability (AEP)
  - does not mean can only occur once every one hundred years
- **PMF – probable maximum flood**
  - theoretical estimate of the upper bound of possible flooding
  - defines the limit of flood prone land
  - while term is 'probable' – PMF is highly improbable
  - has less than a 0.001 % chance of happening in any year.

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About floods – consequences of flooding

The Bureau of Meteorology uses a three-tiered consequence classification:

Minor flooding

- Causes inconvenience. Low-lying areas next to water courses are inundated.
- Minor roads may be closed and low-level bridges submerged.
- Removal of stock and equipment may be required.

Moderate flooding

- Main traffic routes may be affected. Some buildings may be affected above the floor level.
- Evacuation of flood affected areas may be required. In rural areas removal of stock is required.

Major flooding

- Extensive rural areas and/or urban areas can be inundated and evacuation may re required.
- Many buildings may be affected above the floor level.
- Properties and towns are likely to be isolated and major rail and traffic routes closed.
- Utility services would be impacted.

Social cost of flooding:

- Consequences of flooding go beyond impacts to property, assets and utilities.
- A 2016 study by Deloitte Access Economics showed that the social costs to people impacted by major flooding can equal or exceed the direct damages.

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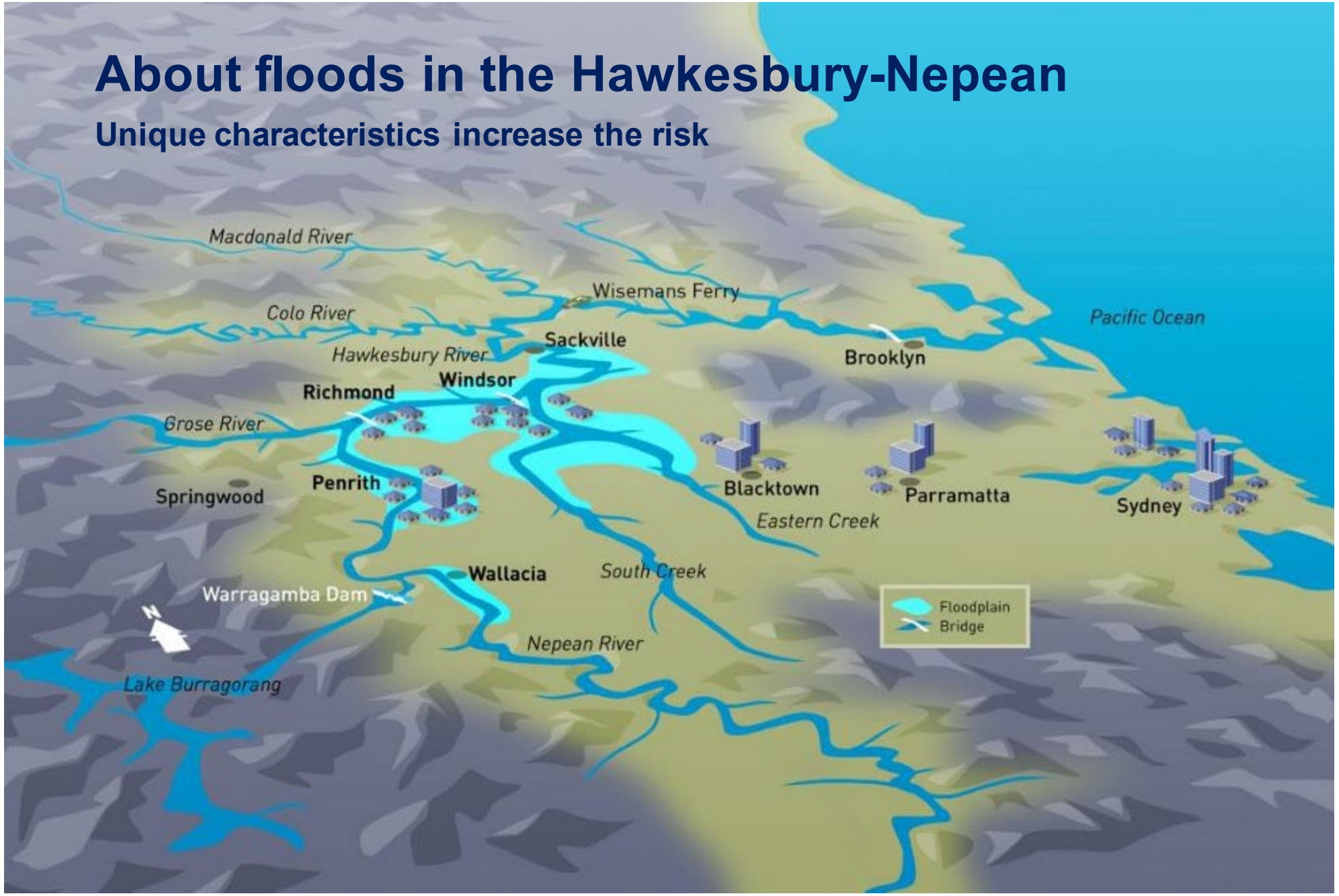
About floods in the Hawkesbury-Nepean

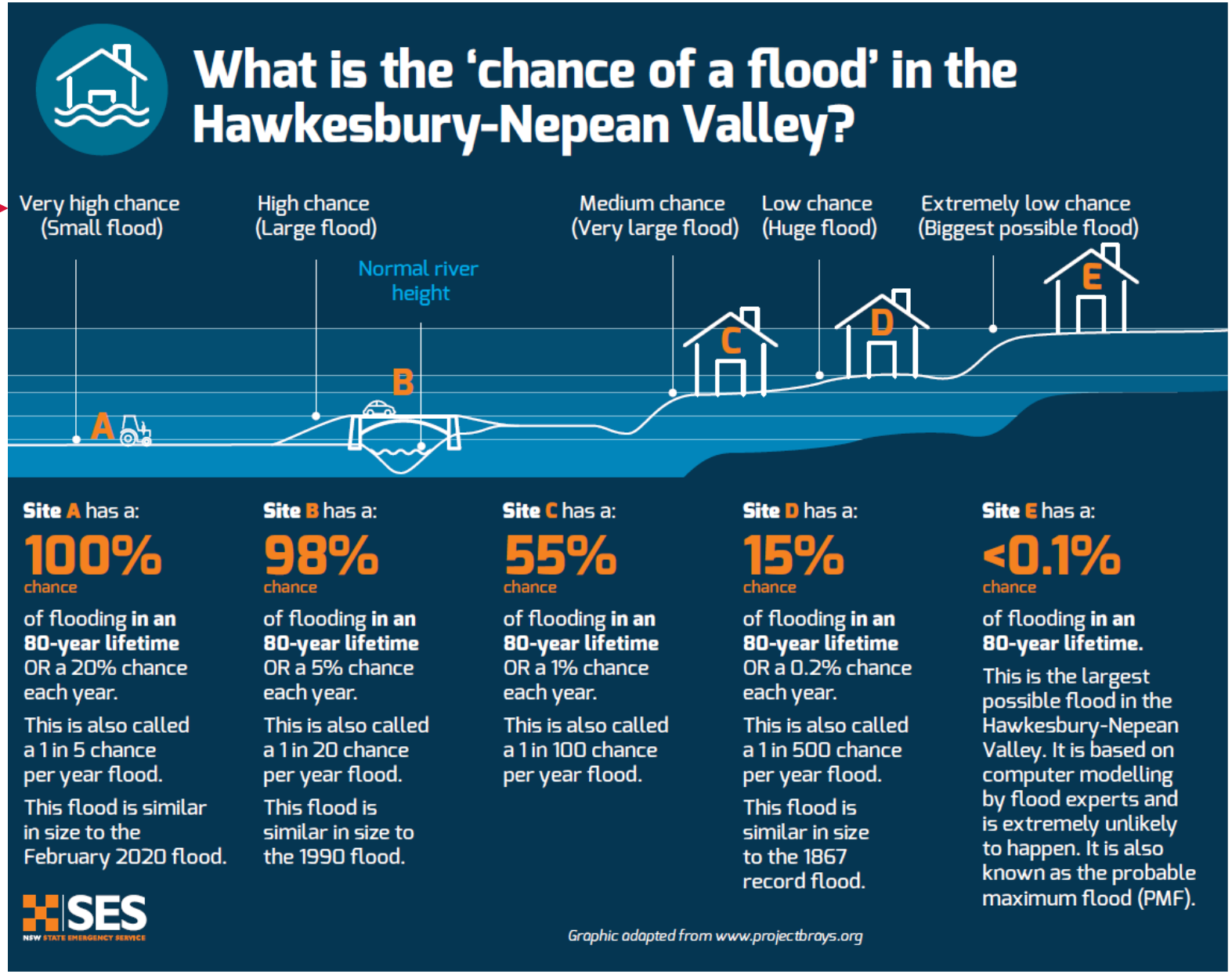
Unique characteristics increase the risk



Source: Infrastructure NSW

About floods in the Hawkesbury-Nepean – what is the chance?

February 2020 flood



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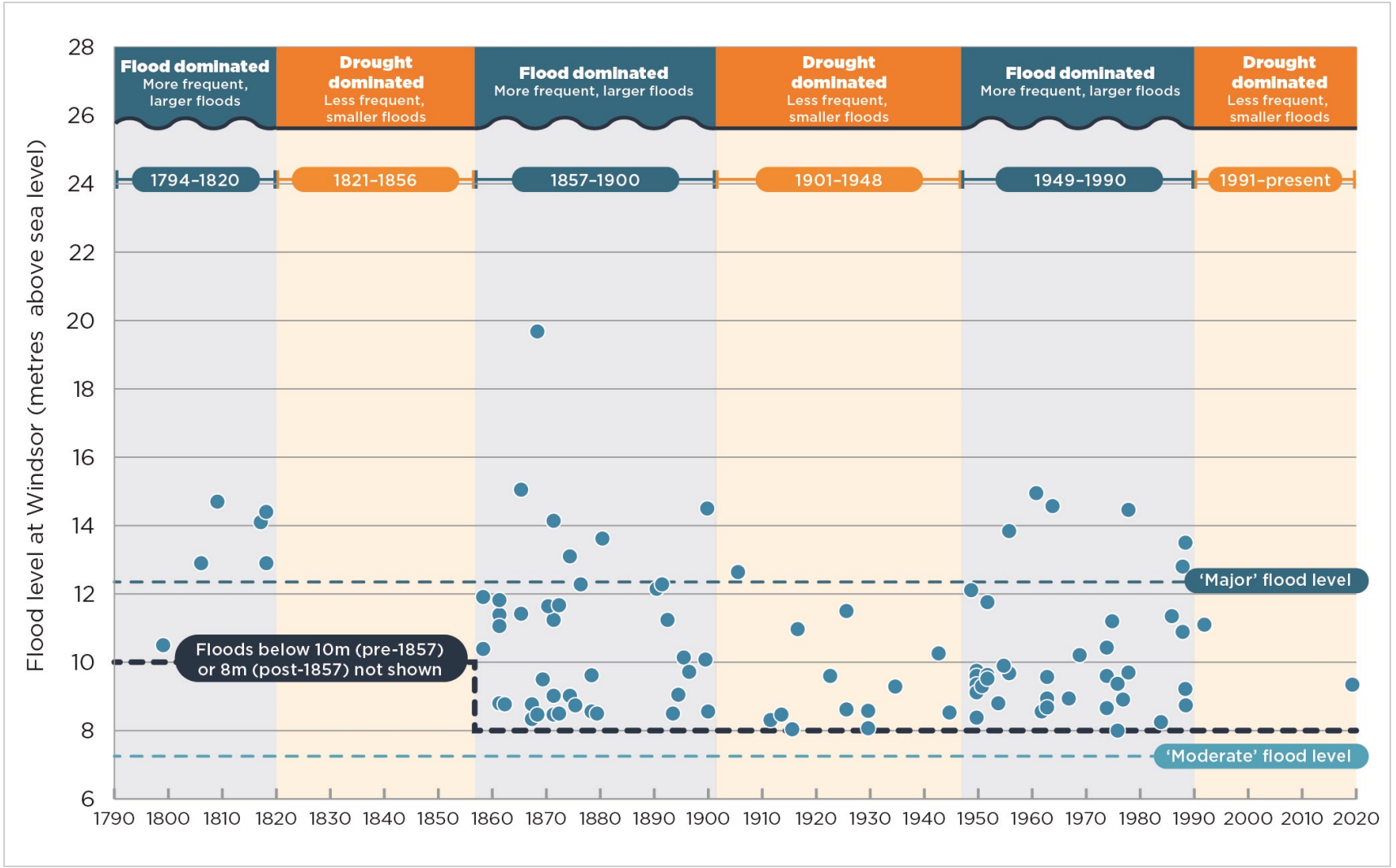
About floods in the Hawkesbury-Nepean – cyclic and unpredictable

- **Scientists observed longer-term wet and dry cycles:**
  - flood dominated regimes - FDR
  - drought dominated regimes - DDR
- **Cycles last 30 to 50 years**
  - higher number and largest flood events in FDR
- **Hawkesbury-Nepean in a DDR since early 1990s**
- **Uncertainty of climate change effects on cycles**



Source: Infrastructure NSW

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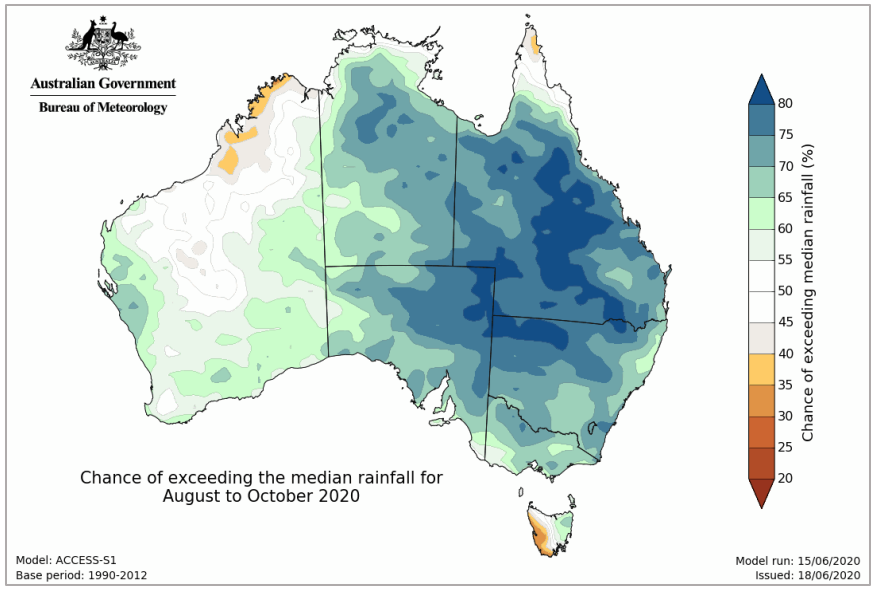
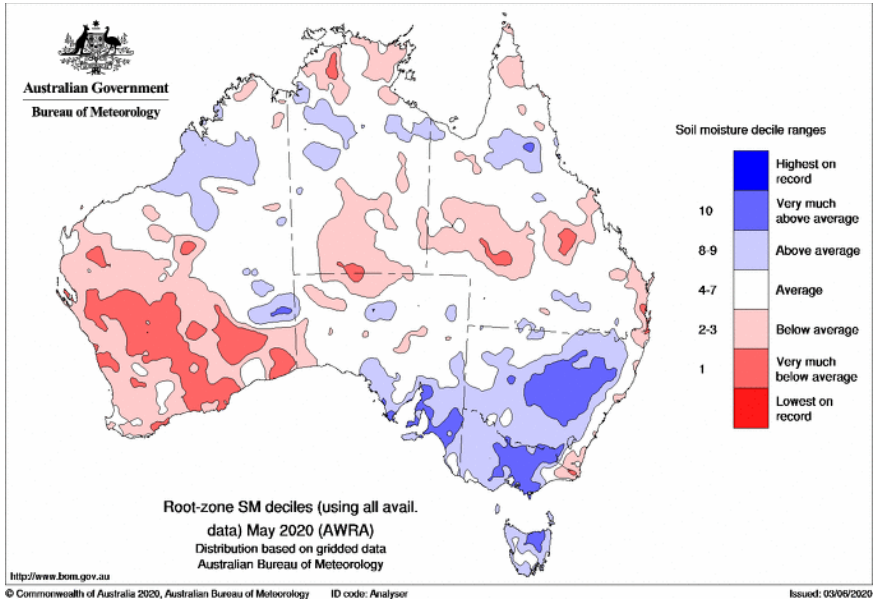
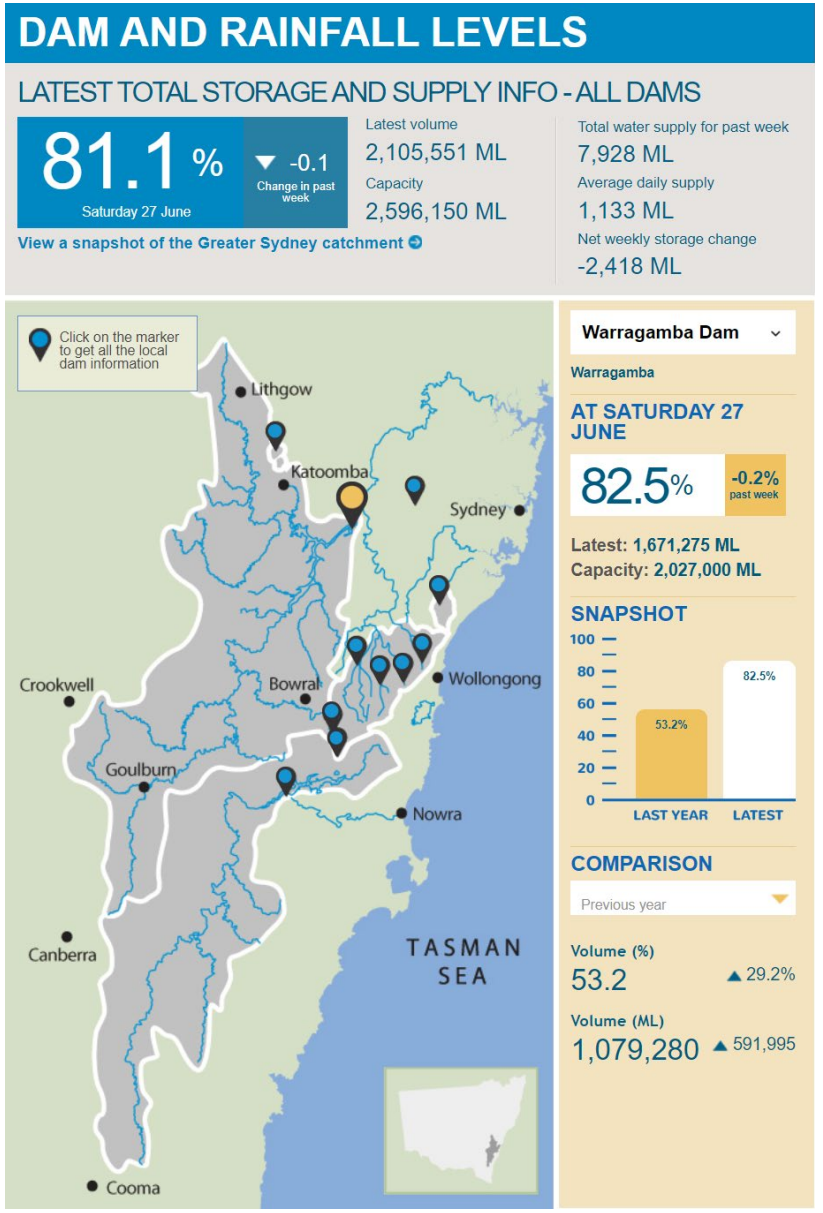
About floods – rainfall forecasts, soil moisture, dam levels







Source: WaterNSW

February 2020 rainfall event

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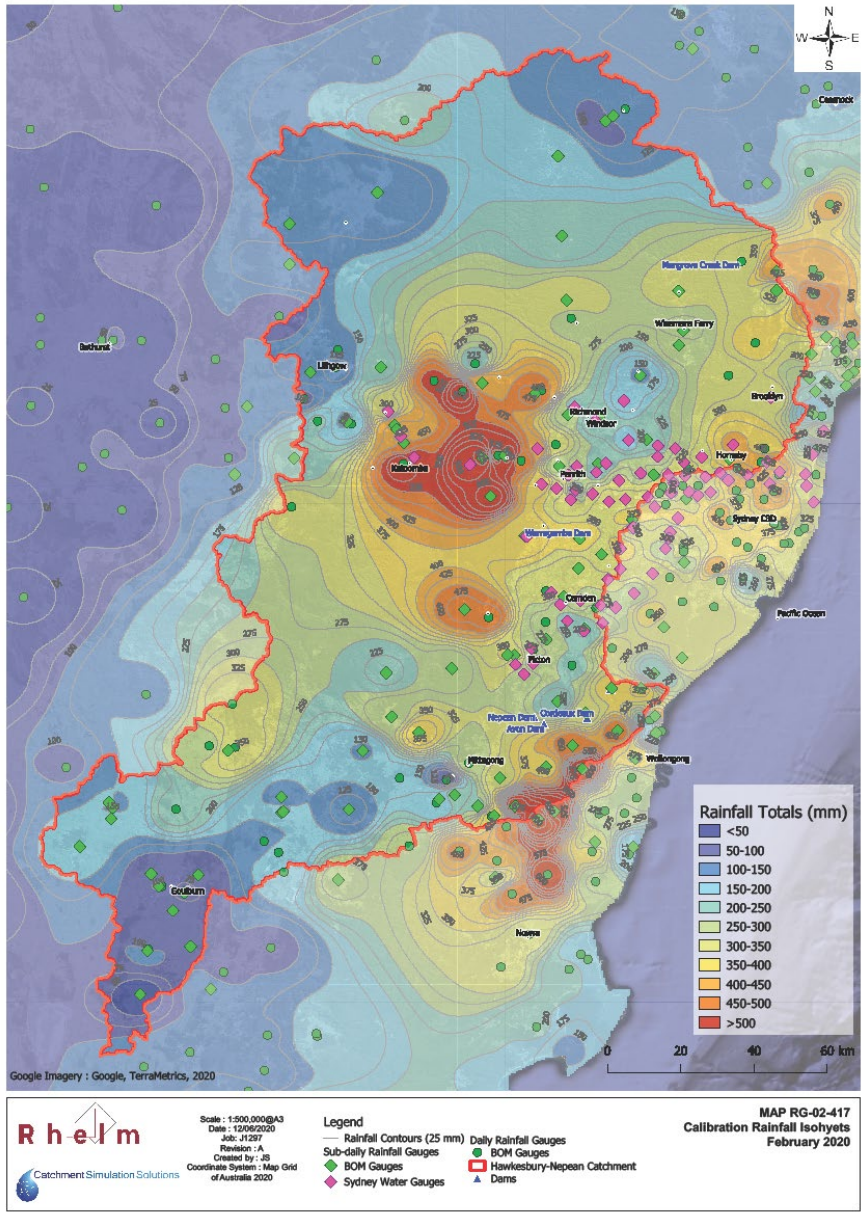
February 2020 – the rainfall event



- **Prior to February 2020 - much of NSW in prolonged and severe drought**
  - soil moisture levels low across NSW
  - much of the Hawkesbury-Nepean catchments had been impacted by 2019-2020 bushfires

- **Early February 2020 - a trough with embedded low-pressure circulations hovered off the NSW coast**
  - not an East Coast Low - which cause most Hawkesbury-Nepean floods
  - event extended from 6 to 13 February
  - generated significant rainfall over the Hawkesbury-Nepean catchments – some locations recorded more than 500mm
  - most intense rainfall over 12 hours on 9 February
  - with follow up rainfall, February 2020 was wettest month since June 2016

February 2020 rainfall event – inflows to storages

- **Warragamba Dam less than 43% capacity or 18.8m below full storage at start of event**
  - dam captured all catchment inflows, and in one 24 hour period rose by around 18%
  - storage increased by 32% over the event reaching more than 75% by 13 February
  - storage rose to 83% in following weeks.
- **Significant inflows to other catchment dams**
  - all Sydney's dams low at start of event
  - Nepean and Tallowa dams filled and spilled
  - most other storages increased to at least 70%
  - increase in storages broadly equivalent to two years water supply to greater Sydney.

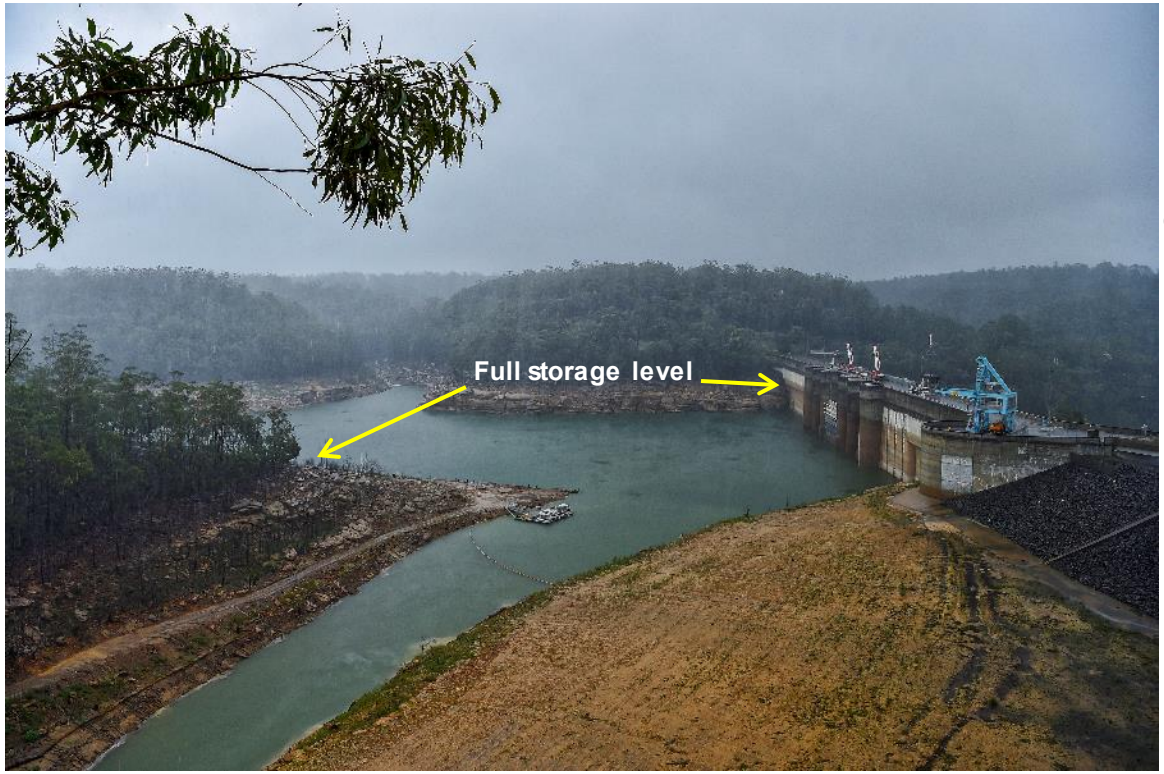


Photo: Adam Hollingworth Source: Infrastructure NSW

Warragamba Dam at ~43% storage – morning of 9 February 2020

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February 2020 rainfall event – upstream impacts

Warragamba Dam didn't fill during rainfall event – or since

- No upstream impacts in the dam catchment from dam storage or operations
- Impacts from: upstream tributary flows, overland and local catchment flooding, erosion – not from the dam
- Bushfires followed by heavy rainfall and runoff damaged catchment access roads, walking trails
- Event caused damage across local Council road networks
- Velocity and volume of flows contributed to impacts

FEBRUARY 12 2020 - 3:30PM

Burragorang Road to be closed for "a long time"

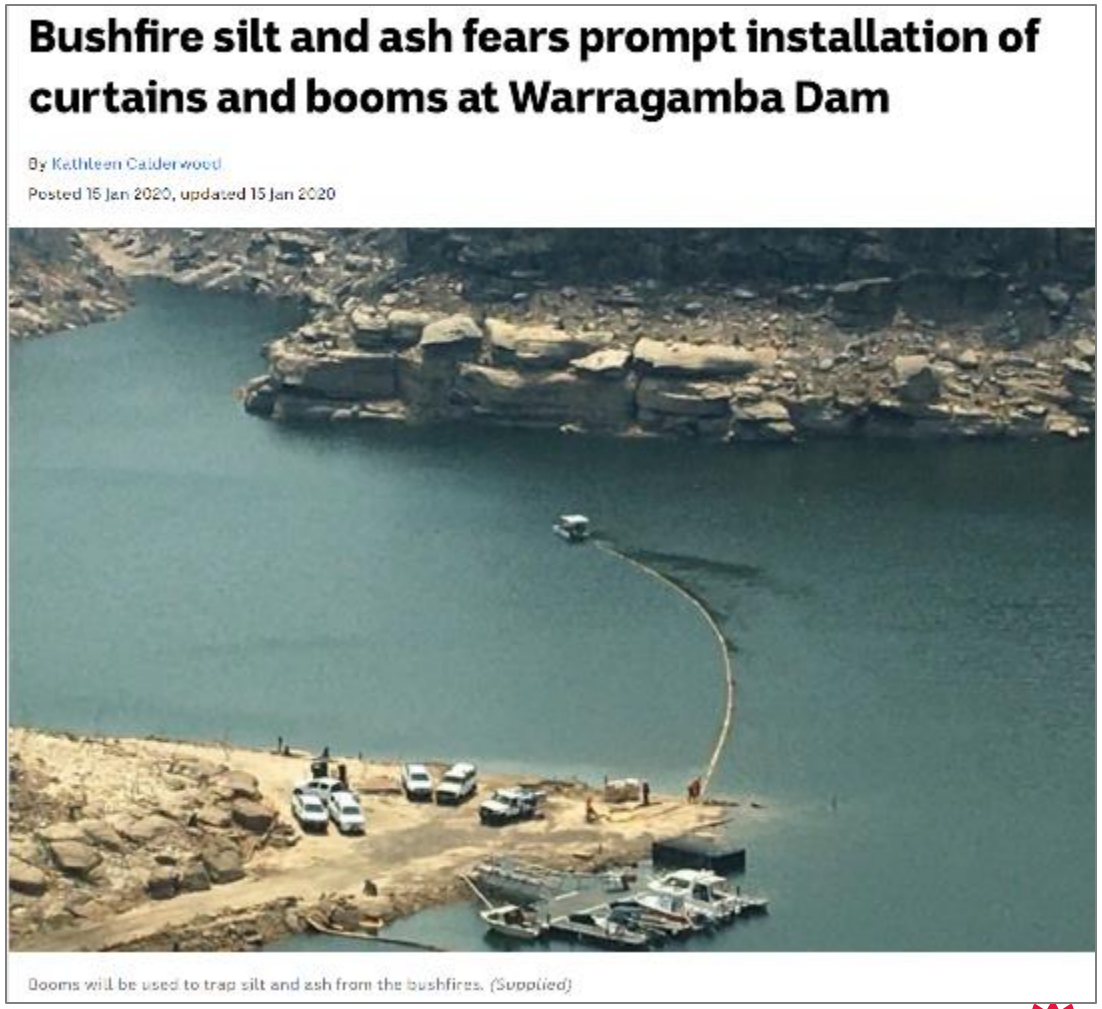
Picture: Wollondilly Council

Burragorang Road at Back Creek, Belimbla Park sustained major damage during the rainfall event

Extract from the Wollondilly Advertiser

February 2020 rainfall event – water quality management

- **Around 30% of Warragamba Dam catchment and 90% of the Special Areas closest to the storage were impacted by 2019-20 bushfires.**
  - Bushfires also impacted some water monitoring instrumentation
  - Floating curtain booms installed in Lake Burragorang in January 2020 to minimise ash and debris transport towards the supply off-take at the wall.
  - While rainfall washed debris and ash into the lake, the supply of water drawn from deep in the dam did not impact the quality of supply for treatment.
- **Water supply network operated with no disruption to raw water supply or quality.**



Bushfire silt and ash fears prompt installation of curtains and booms at Warragamba Dam

By Kathleen Calderwood

Posted 15 Jan 2020, updated 15 Jan 2020

Booms will be used to trap silt and ash from the bushfires. (Supplied)

Extract from ABC online news item - 15 June 2020

February 2020 flood

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February 2020 flood - historical context

- **February 2020 flood:**
  - first **Moderate** flood since 1992
  - likelihood of approx. 1 in 5 (20%) chance per year - or almost a 100% chance of happening at least once in an 80-year lifetime
  - peaked at 9.3 (AHD) metres at Windsor
- **By comparison:**
  - last major flood in 1990 had around 1 in 20 (5%) chance per year and rose more than four metres higher at Windsor
  - largest flood in living memory (1961) had ~1 in 40 chance per year - peaked more than five metres higher at Windsor (15 metres AHD)
  - largest flood on record (1867) had approx. 1 in 500 (0.2%) chance and peaked more than 10 metres higher at Windsor (19.7 metres AHD).

Image: Courtesy ABC

1990 flood – McGraths Hill to Windsor

Photo Vic Gillespie collection/Hawkesbury Library

1961 flood - South Windsor

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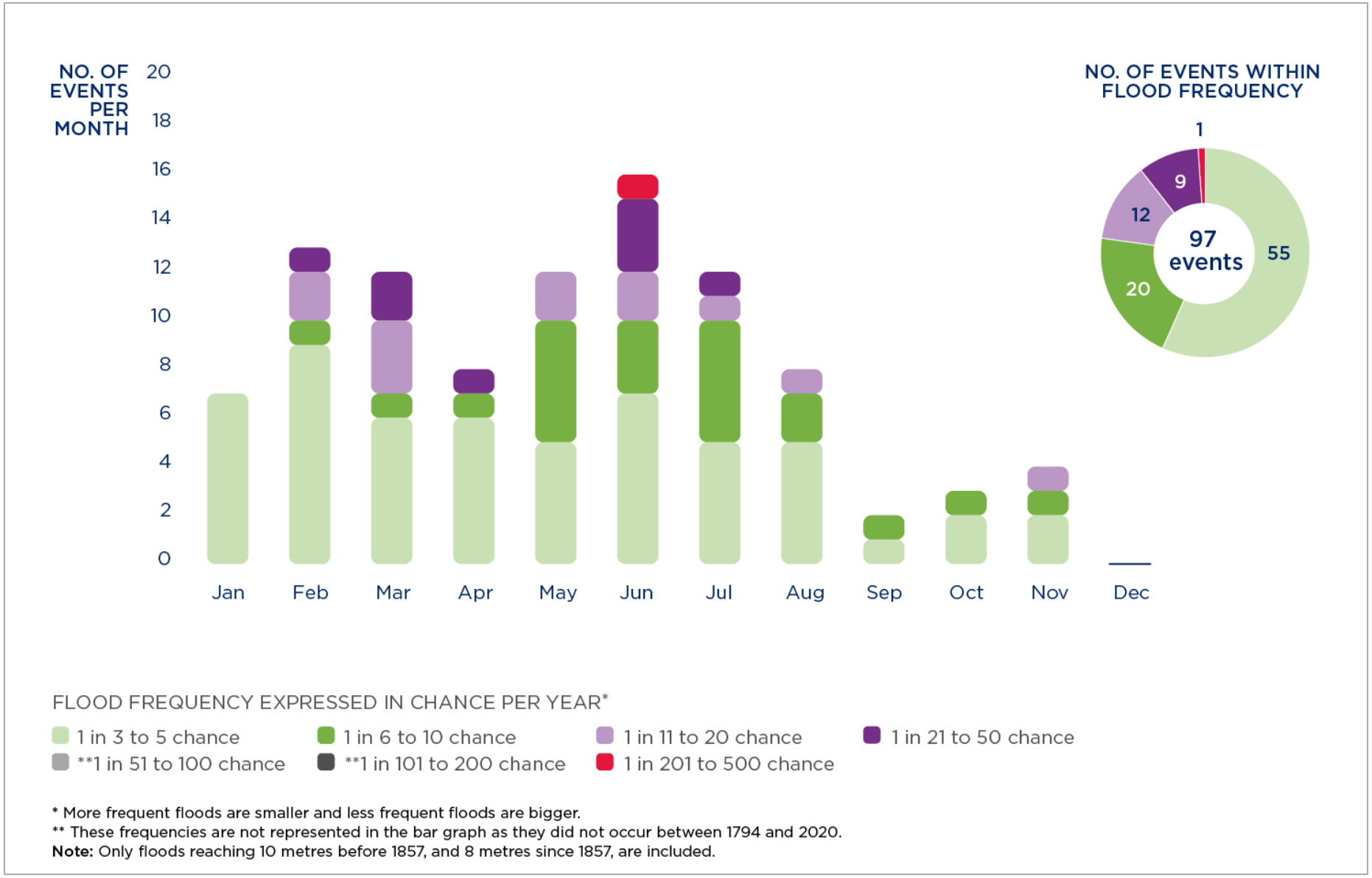
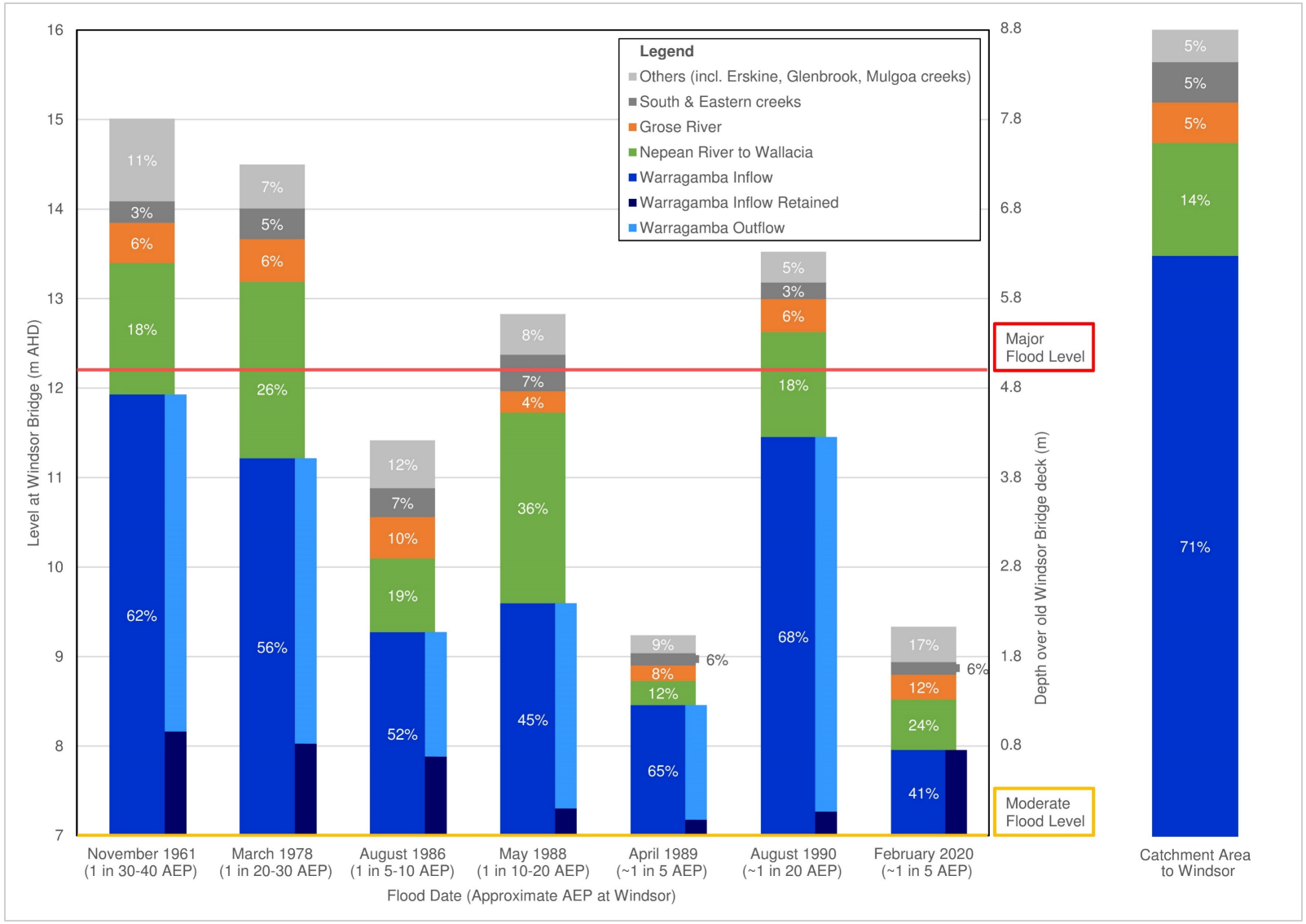
Flood seasonality and severity Windsor – 1794 to 2020



* More frequent floods are smaller and less frequent floods are bigger.
** These frequencies are not represented in the bar graph as they did not occur between 1794 and 2020.
Note: Only floods reaching 10 metres before 1857, and 8 metres since 1857, are included.

Source: Infrastructure NSW

Flooding in the Hawkesbury-Nepean – sub-catchment contributions to Windsor

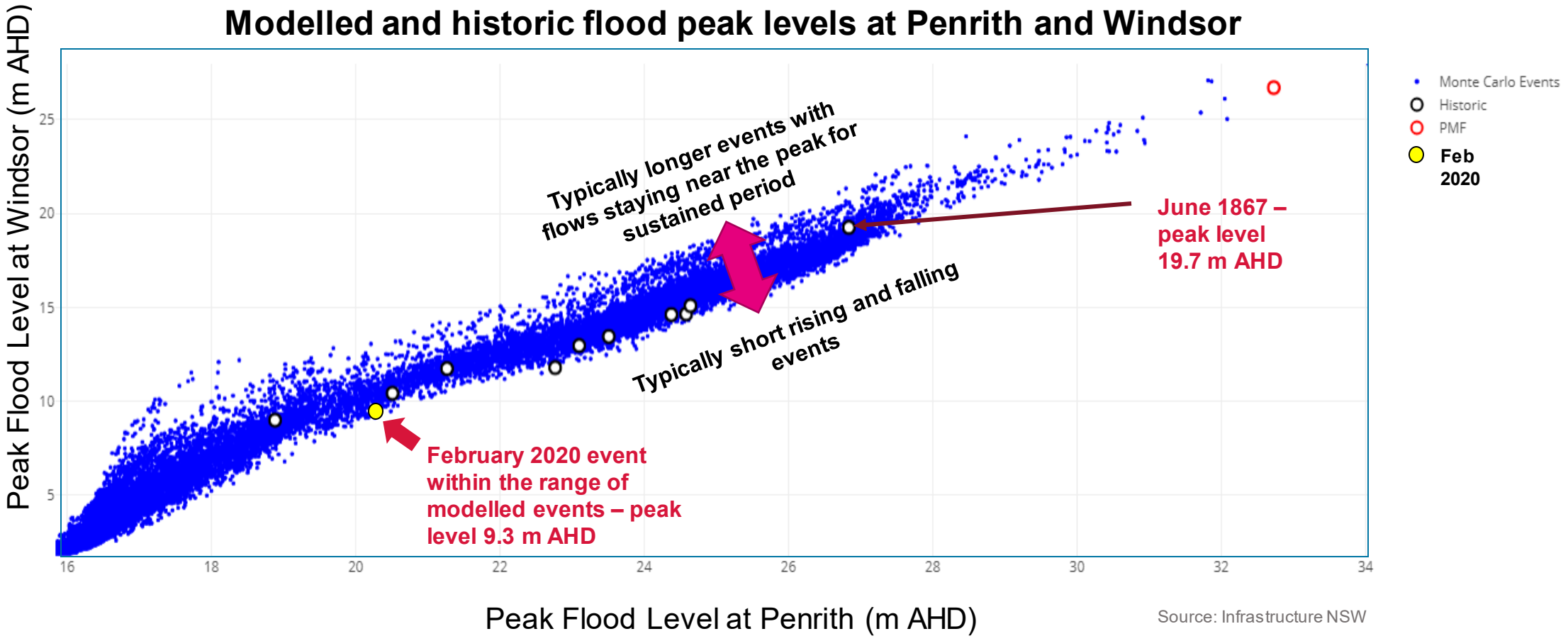


Source: Infrastructure NSW

February 2020 event:

Had Warragamba Dam been full, the 41% inflows captured by available airspace would have spilled and downstream flood levels peaked three metres higher.

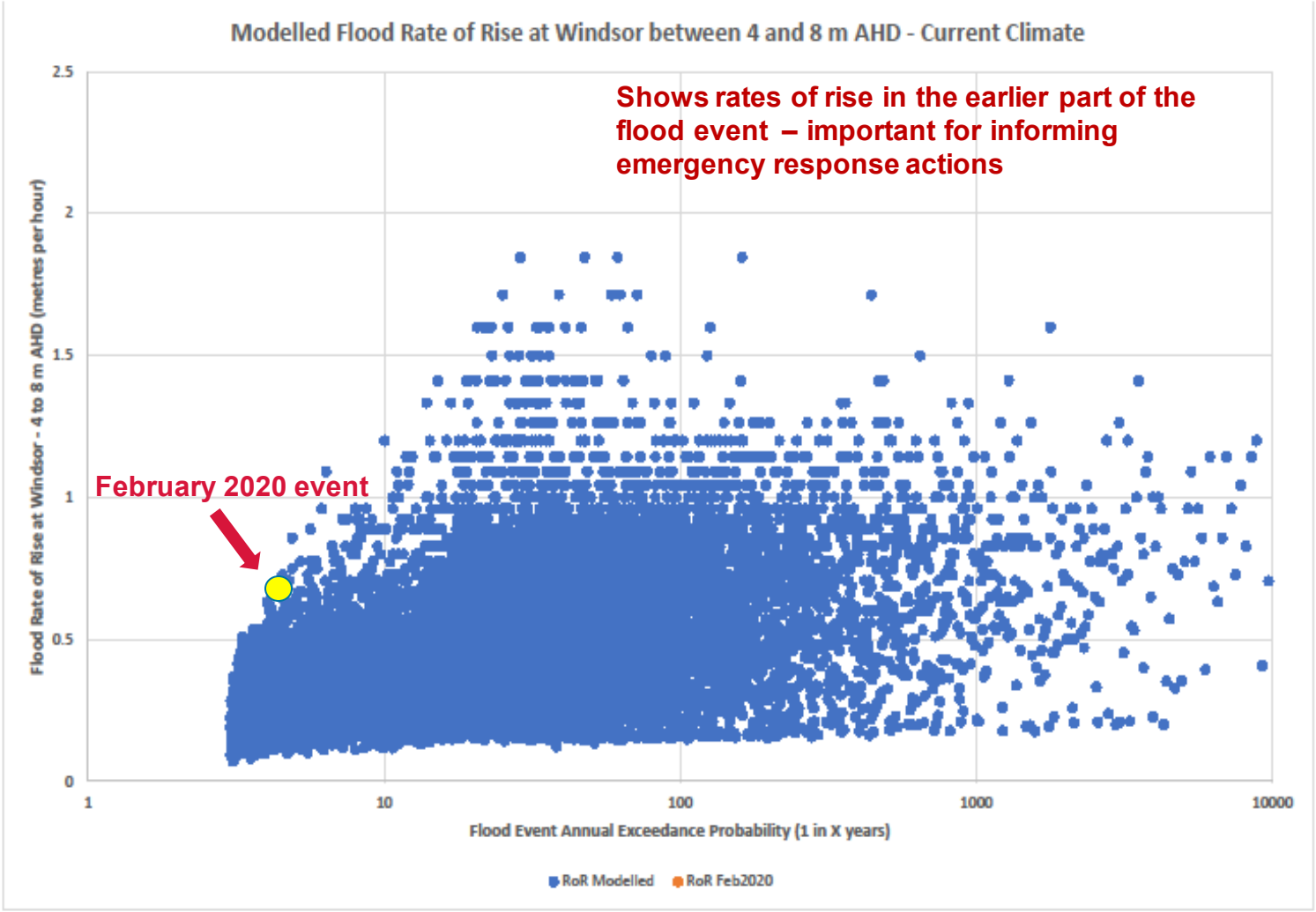
February 2020 flood – modelling context



Source: Infrastructure NSW

February 2020 flood – modelling context

- **Flood had a relatively fast rate of rise, but not beyond the rate modelled for a small event.**
  - Driven by intense rainfall in smaller downstream catchments, flood was fast to rise but fell well short of the flood planning level.
  - Fast rates of rise can occur with smaller flows when the floodwaters remain largely within banks.
  - Inflows from larger Warragamba and Nepean catchments required to cause significant flooding across the large Penrith/Emu Plains and Richmond/Windsor floodplains.

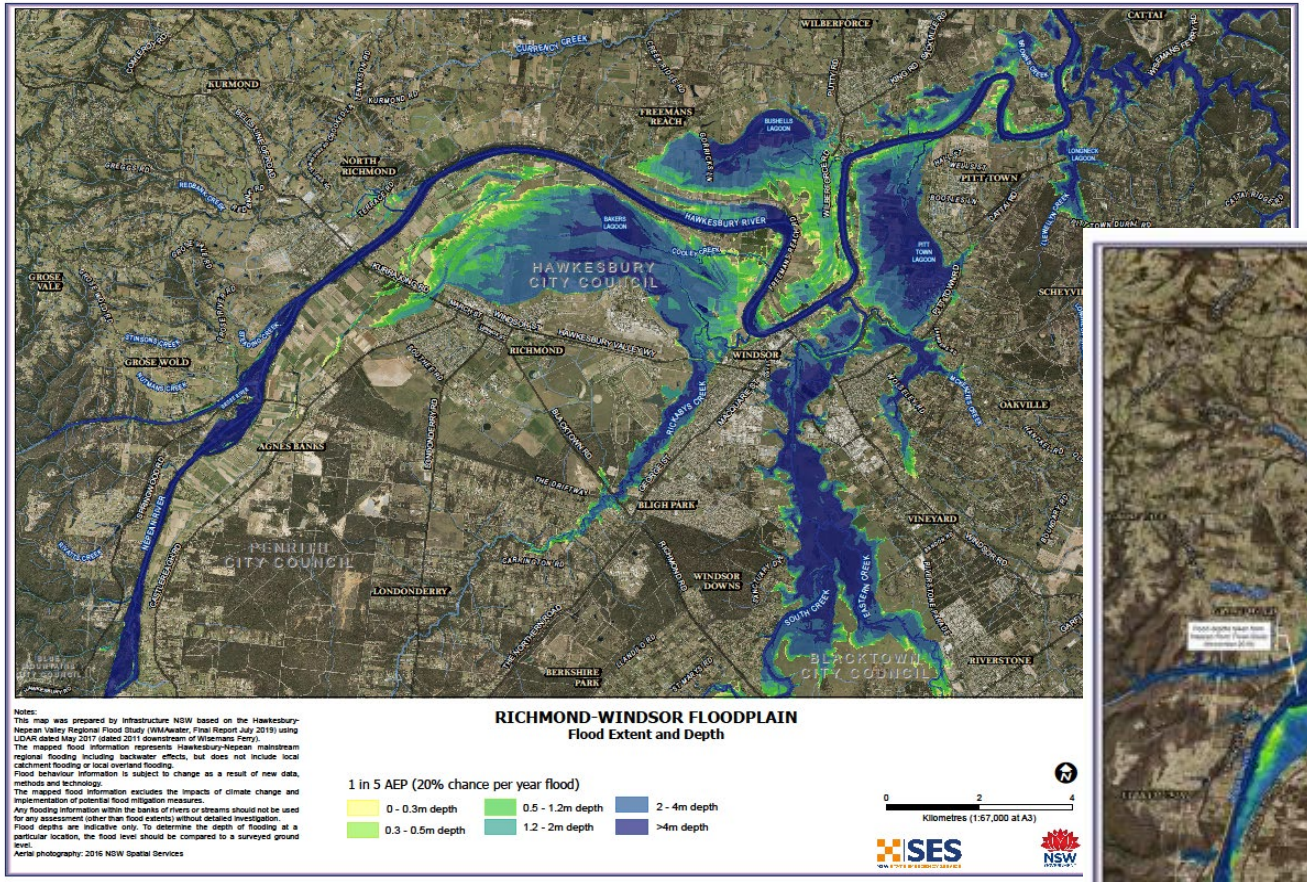


Scatter plot of more than 19,500 modelled flood events

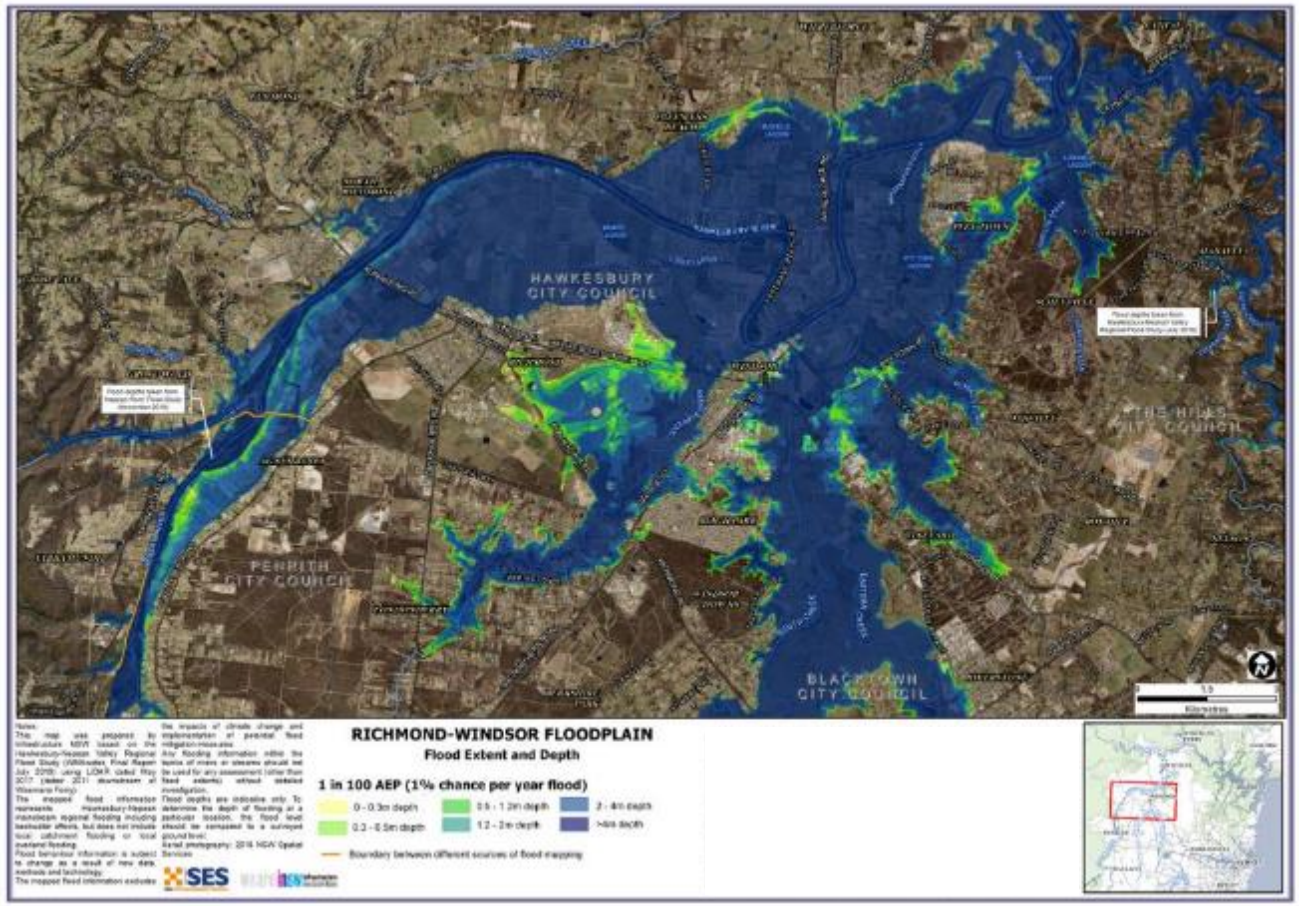
Source: Infrastructure NSW

February 2020 Flood – flood extent

1 in 5 chance per year flood - similar to February 2020



Modelled 1 in 100 chance per year flood – similar to 2011 Brisbane flood



February 2020 flood event – downstream flooding

- **Downstream flooding driven by inflows from catchments other than Warragamba**
  - Rainfall moved across the catchments north to south.
  - Typically Grose River inflows contribute about 10% of total flows to the Nepean River at their junction.
  - With all Warragamba inflows captured, peak flow on the Grose River was as much as 40% of total flows at junction of Nepean River.
  - Even with a PMF in the Grose River and minor contributions from other sub-catchments, flooding at Windsor would be below 1 in 20 chance per year level.
  - South Creek also contributed significant inflows.
  - Local catchment and overland flooding contributed to the event.

Photos: Adam Hollingw orth Source: Infrastructure NSW

Upsteam from junction with Grose - Yarramundi Bridge on Nepean River – morning of 9 February 2020

South Creek flooding at St Marys – 10 February 2020

February 2020 flood event – downstream communities

- **Perceived by many in downstream communities as a major flood event**
  - Many in community had not experienced a flood
  - Bridge closures caused significant disruption and concerns - people don't perceive bridge closures as 'Minor' impact
  - Anecdotal feedback - event was a "1 in 100 year flood" when actually much smaller (1 in 100 chance per year flood would have been eight metres higher at Windsor)
  - Rainfall and local runoff caused damage to homes and other assets - many NSW SES call outs
  - Local catchment and overland flooding contributed to road closures and community disruption
  - Misconception in community that Warragamba Dam was spilling and contributing to the flood

FEBRUARY 10 2020 - 11:42AM

Richmond, Windsor bridges flooded for first time in 28 years as Hawkesbury lashed with rain and wind

Sarah Falson Community

A A A Comments

WILD rain and wind lashed the Hawkesbury over the weekend, during which up to 90 calls were made to the local State Emergency Service (SES) unit for help with weather-related emergencies.

Sunday afternoon saw both the Windsor and Richmond bridges closed by 3pm due to rising flood waters. It was the first time in 28 years that water had submerged the decks of the two bridges. Minor flooding was also reported at Sackville and Lower Portland, and Richmond lowlands residents were evacuated to higher ground. Moderate flooding occurred along the Colo River at Putty Road.

Photo: Geoff Jones

Extract from the Hawkesbury Gazette

Downstream impacts – bridges closed on 9 &10 February 2020

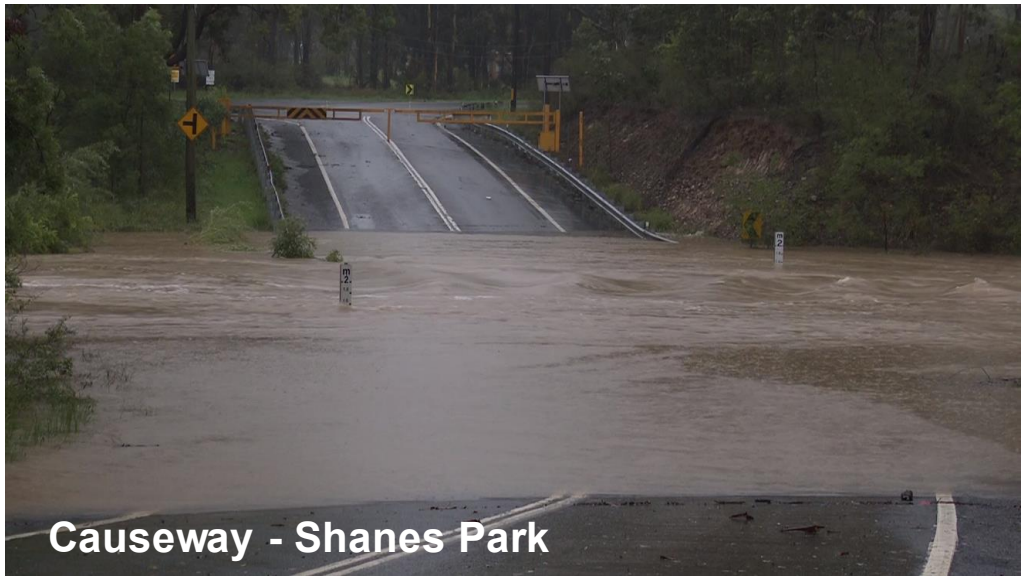
Photo: Adam Hollingw orth Source: Infrastructure NSW

Image: Top Notch Video Source: Infrastructure NSW

Image: Top Notch Video Source: Infrastructure NSW

Photo: Adam Hollingw orth Source: Infrastructure NSW

Downstream impacts – flooded roads and causeways


Causeway - Shanes Park

Pitt Town Road

Photos: Adam Hollingworth Source: Infrastructure NSW


Submerged car - Mulgrave Road


Mulgoa Road - Wallacia

Downstream impacts – low lying areas inundated

South Creek backwater

Image: Top Notch Video Source: Infrastructure NSW

Sackville Ferry

Photo: Vicky Whitehead

Near Wolseley Road, McGraths Hill.

Photo: Adam Hollingw orth Source: Infrastructure NSW

Stranded cattle – South Creek

Photo: Adam Hollingw orth Source: Infrastructure NSW

Nepean River at Penrith – largely stayed within banks

Photo: Adam Hollingw orth Source: Infrastructure NSW

Looking north – junction Hawkesbury River and South Creek

Photo: Taunton Media

Photo: Taunton Media

Looking east – Windsor to McGraths Hill

Photo: Taunton Media

Downstream impacts – when the floodwaters subsided

Image: Top Notch Video Source: Infrastructure NSW

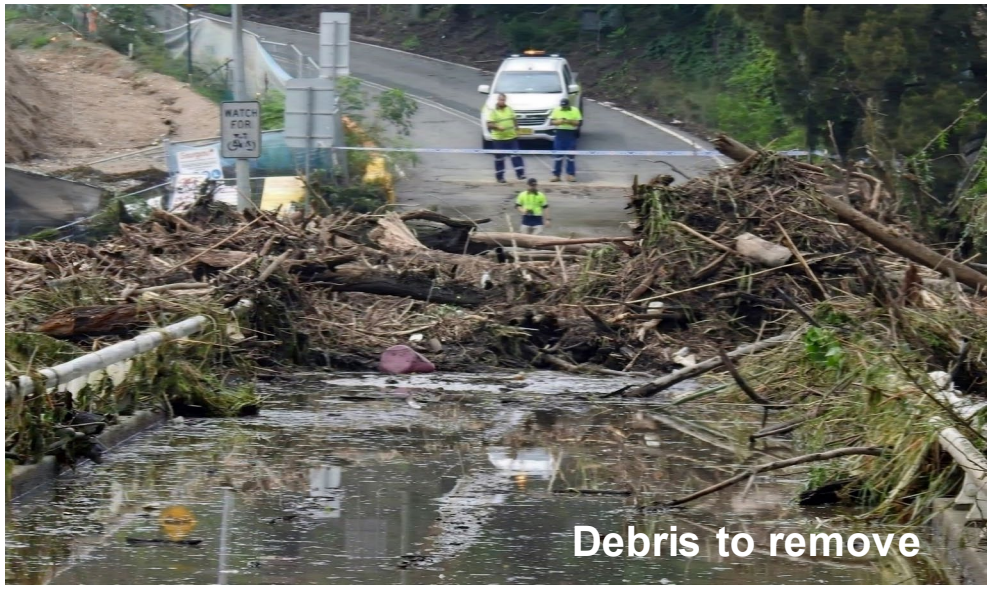


Photo: Vicky Whitehead

Photo: Adam Hollingw orth Source: Infrastructure NSW

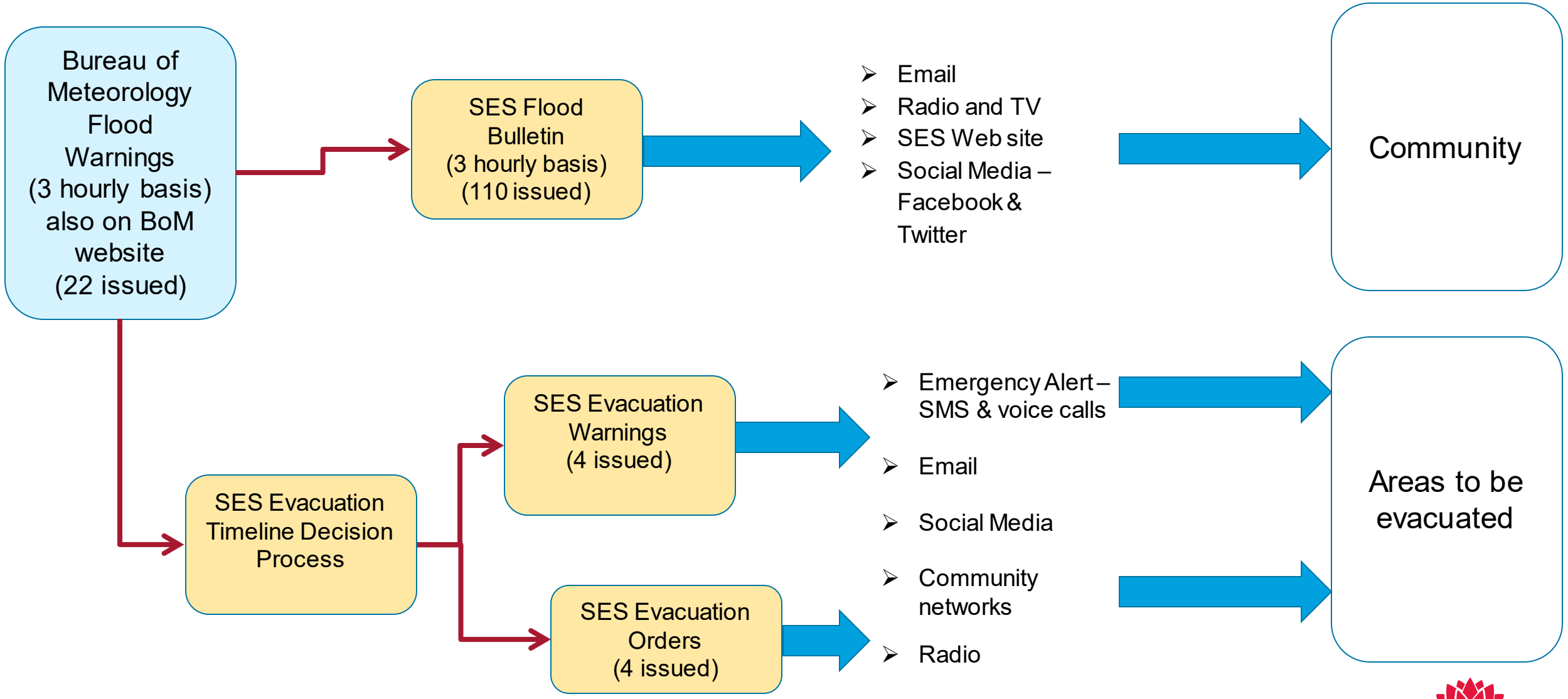
Photo: Vicky Whitehead

February 2020 flood – emergency warnings and evacuation

NSW SES rescue - elderly resident, Oxley Park (February 2020)

Image: Top Notch Video Source: Infrastructure NSW

Warning Process – Hawkesbury-Nepean



February 2020 flood – emergency response

Wallacia flood gauge area – February 2020

Flood Gauge Height	Utilities and Infrastructure	Roads and Bridges	Residential homes	Population affected	Evacuations Warnings and Orders	Comments
8.7m gauge height **Minor/Moderate** flood	Nil	Blaxlands Crossing bridge closed Roads: ➢ Greendale Rd to the south cut at Duncans Creek ➢ Mulgoa Rd to the north cut Jerrys Creek ➢ Park Rd to the east cut at Jerrys Creek	Nil	Nil	No evacuations orders issued for the Wallacia area or Bents Basin area	Nil evacuation centres activated Wallacia township became isolated due to closure of roads and Blaxlands Crossing. Last evacuation route would be via private property to Park Rd east of Jerrys Creek Bents Basin area was isolated for a short time. Access to Warragamba township and Silverdale only via Silverdale Rd to the south

Penrith flood gauge area – February 2020

Flood Gauge Height	Utilities and Infrastructure	Roads and Bridges	Residential homes	Population affected	Evacuations Warnings and Orders	Comments
Minor flood level	Nil	Victoria Bridge remained open	Nil	NIl	Nil evacuations orders	Nil evacuation centres activated

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North Richmond flood gauge area – February 2020

Flood Gauge Height	Utilities and Infrastructure	Roads and Bridges	Residential homes	Population affected	Evacuations Warnings and Orders	Comments
Peak level 11.7m 1:5 AEP **Moderate** flood	Nil	Yarramundi Bridge closed, partially isolating the Yarramundi community before North Richmond Bridge closed North Richmond Bridge closed	Very small number of residential properties isolated		Evacuations ordered for following areas: North Richmond – lowlands area along Terrace Rd	1 evac centre at North Richmond Community Hall Nil evacuees presented at this Centre

Windsor flood gauge area – February 2020

Flood Gauge Height	Utilities and Infrastructure	Roads and Bridges	Residential homes	Population affected	Evacuations	Comments
Around 3-3.5m	Nil	Sackville Ferry closed Lower Portland Ferry closed based on assessment of debris load (higher due to bushfires) and ferry cable heights Webbs Creek Ferry	Nil	Nil	Nil	
5.6-5.8m AHD	Nil	Windsor Bridge (old bridge) closed earlier due to heavy debris load New Windsor Bridge works not completed.	Nil	Nil	Nil	
Peak level 9.3m AHD 1:4 AEP **Moderate** flood	Nil	Windsor Bridge closed All Ferries closed For area west of Hawkesbury River and Webbs Creek: ➢ Only access route to Sydney via Bells Line of Road ➢ Only access route north to Putty via Putty Road	65	180 residents **Total**: **180**	Evacuations ordered for following areas: ➢ North Richmond lowlands ➢ Richmond Lowlands ➢ Pitt Town Bottoms ➢ Gronos Point A small number of boat sheds in the lower parts of Gronos Point were partly flood affected	Two evacuation centres activated: ➢ Windsor evacuation centre - 15 people presented ➢ Richmond evacuation centre Evacuees: ➢ Some residents on the higher rim of Pitt Town and Richmond Lowlands did not evacuate.

Impact assessments

- **Impact assessments at the property level**

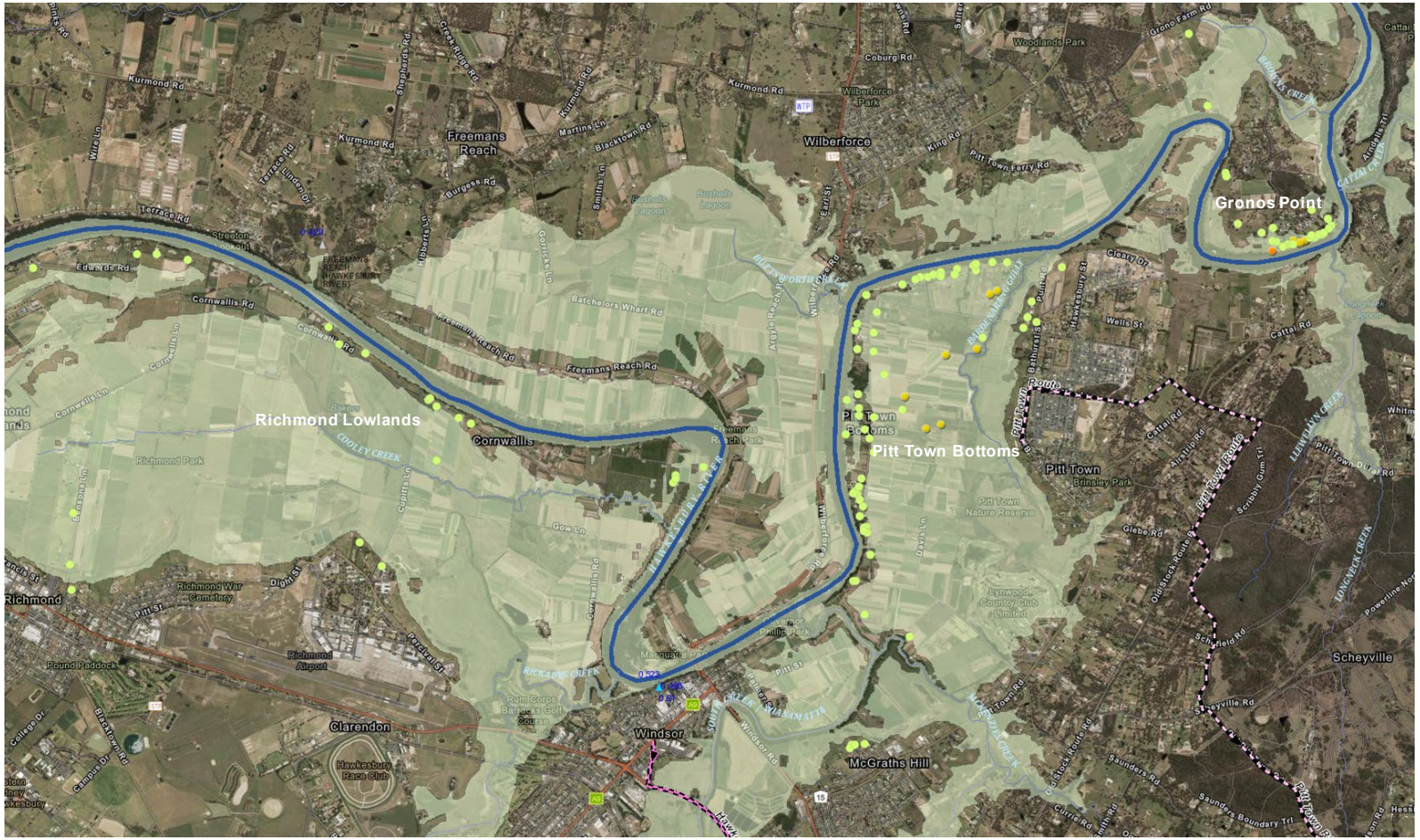
- Conducted by NSW SES, RFS and Fire & Rescue NSW teams

- North Richmond Lowlands area

- Richmond Lowlands (Cornwallis area)

- Pitt Town Bottoms

- Low lying area in Gronos Point

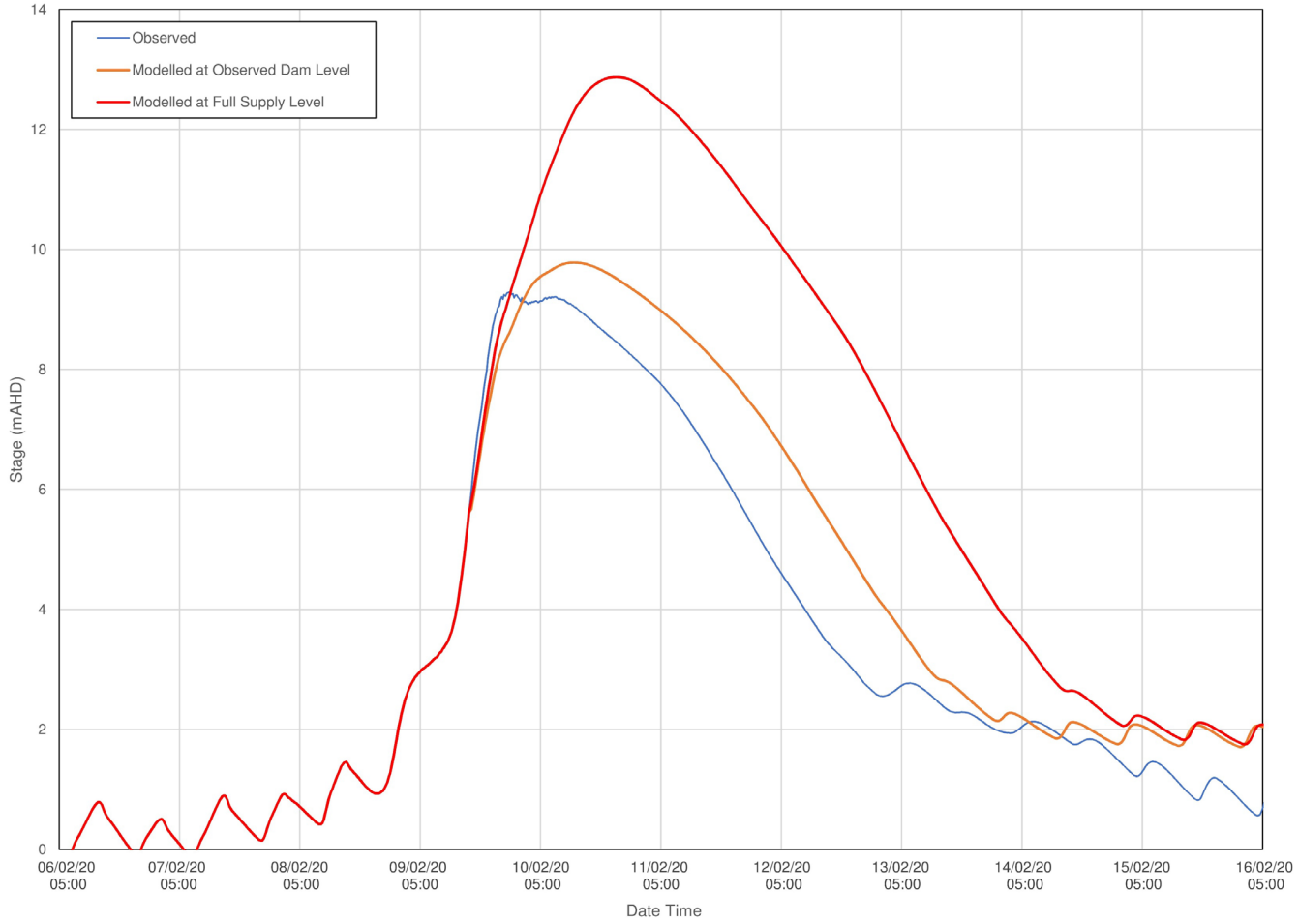


Building structures

Source: NSW SES

February 2020 flood – had Warragamba Dam been full

- **Low levels in Warragamba Dam at the start of the event (~43%) significantly reduced downstream flooding**
  - Flood experts (WMAwater) calibrated event and assessed impact of Warragamba Dam starting levels on February 2020 event
  - Peak inflow to the dam estimated to be slightly less and 1 in 20 chance per year event – best estimate of approx. 1 in 16 chance per year at the dam wall
  - Observed flooding at Windsor was just under 1 in 5 chance per year.
  - Had the dam been full, flooding would have been about three metres deeper for the Penrith/Emu Plains and Richmond/Windsor floodplains.



Source: WMAwater, courtesy Infrastructure NSW

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February 2020 flood – had Warragamba Dam been full

Impact	Consequences
Evacuation orders	• Orders for between **2,500 to 3,000** people from more than **1,000 homes** including: - parts of Windsor, McGraths Hill, Oakville, Vineyard, Pitt Town, Cattai, Mulgrave, Freemans Reach, Wilberforce, Agnes Banks, Ebenezer, Yarramundi, Jamisontown; and - all of Pitt Town Bottoms, Gronos Point, Richmond Lowlands. • Emergency services would closely monitor forecasts and prepare for further evacuations
Evacuation facilities	• Mass care evacuation facility activated at Olympic Park, Homebush for evacuees from areas east of the river • Two medium sized evacuation centres established for areas on western side of river
Roads cut	Routes cut at Regentville, Jamisontown West, Emu Heights North, North Richmond Lowlands
Bridges	Bridges closed: Wallacia, Yarramundi, North Richmond, Windsor
Railway lines	Richmond rail line closed due to rising floodwaters
Ferry services	Ferries closed at Lower Portland, Sackville, Webbs Creek, Wisemans Ferry
Essential services	• Interruptions to power and sewerage in parts of the floodplain • **Loss of power to up to 6,500 homes** Cranebrook area (not directly impacted by floodwaters) • Raw sewage overflows to Hawkesbury River
Inundation of agricultural lands	Impacts on agricultural production, potential stock losses, and damages to agricultural infrastructure
Community disruption and isolation	For some communities disruption and isolation would last for days to weeks through the closure of roads, bridges, ferries and community infrastructure, particularly for communities on the western side of Hawkesbury River
Clean up, recovery and repairs	Significant recovery effort including to repairs to people's homes, local road networks and other infrastructure - would be expected to take weeks to months
Mental health impacts	For some people directly affected, the impacts on mental health would last much longer than time taken to repair homes and local infrastructure. This is consistent with experiences in floods elsewhere and for other natural disasters.

Thank you

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