March 2021 Flood

Hawkesbury-Nepean Valley

7 June 2021

Document tendered by
Ms Maree Abood, INSW.
Received by
E. Rogerson
Date: 7 / 6 / 2021
Resolved to publish (Yes) / No

NSW GOVERNMENT

March 2021 flood – presentation for Upper House Select Committee

March 2021 rainfall event and inflows

- Rainfall event
- Inflows to storages
- Upstream impacts
- Water quality management

March 2021 flood

- In context
- The flood event
- Downstream flooding

Victoria Bridge near flood peak at Penrith - 22 March 2021

Would mitigation have made a difference?

NOTE:
Information is current as at 7 June 2021. It is based on preliminary analysis of the March 2021 flood and could be subject to change with ongoing assessment and review. Recovery operations are ongoing in the Hawkesbury-Nepean floodplain.

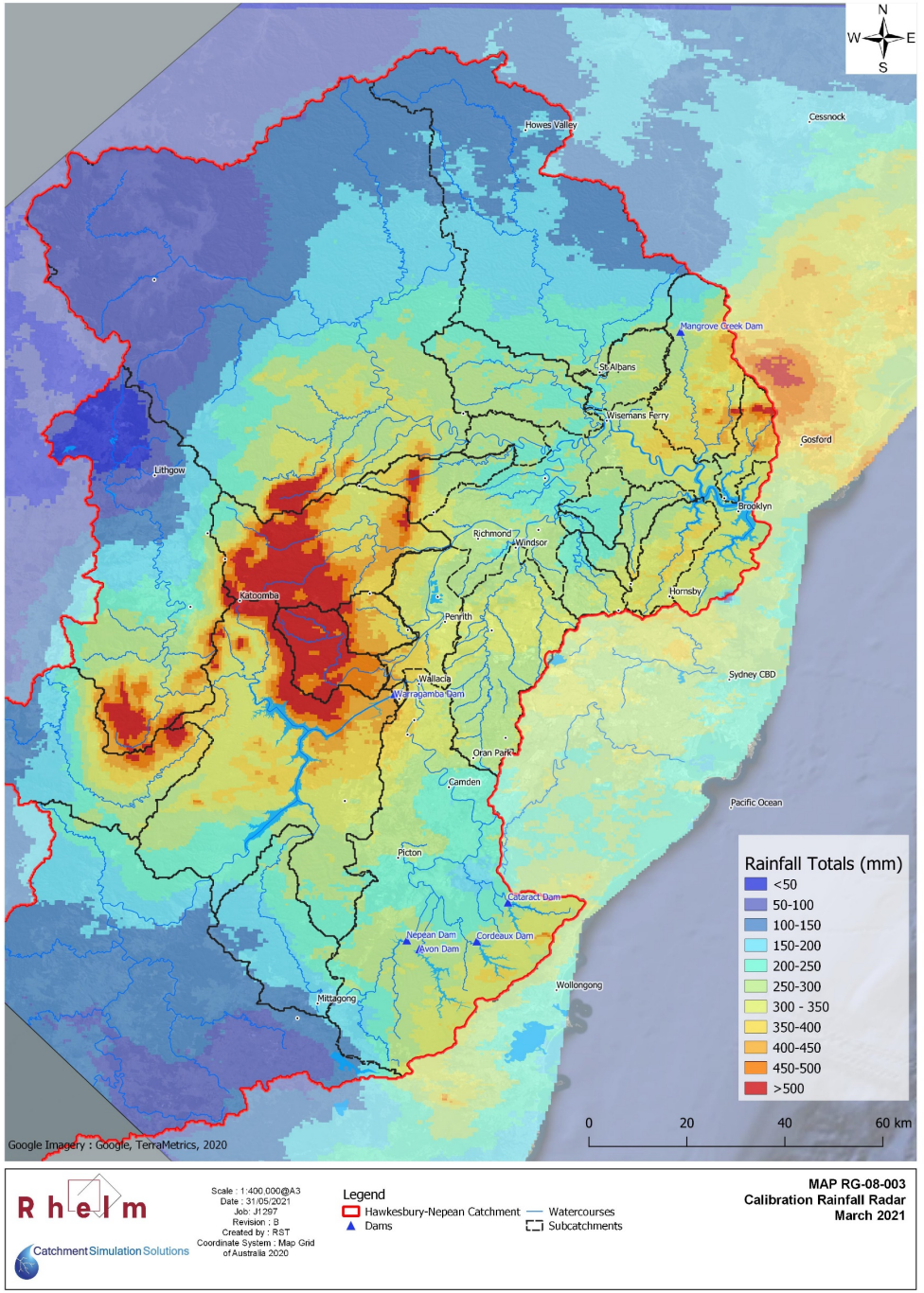
NSW GOVERNMENT

March 2021 rainfall and inflows

March 2021 rainfall event

- **Prior to March 2021**
  - wetter La Nina conditions through Spring and Summer 2020/21
  - soil moisture levels relatively high across eastern NSW

- **March 2021 - prolonged coastal trough off the NSW coast**
  - significant rainfall over the Hawkesbury-Nepean catchments – some locations recorded more than 500mm
  - event extended 17 to 24 March 2021 - most rainfall 24 hours to 9am 21 March
  - not an East Coast Low - which cause most Hawkesbury- Nepean floods



March 2021 rainfall event

- Event generated significant rainfall across Greater Sydney's water catchments:
  - 281mm at Warragamba
  - 348mm at Upper Nepean
  - 503mm at the Blue Mountains
  - 260mm in the Shoalhaven
  - 307mm at Prospect

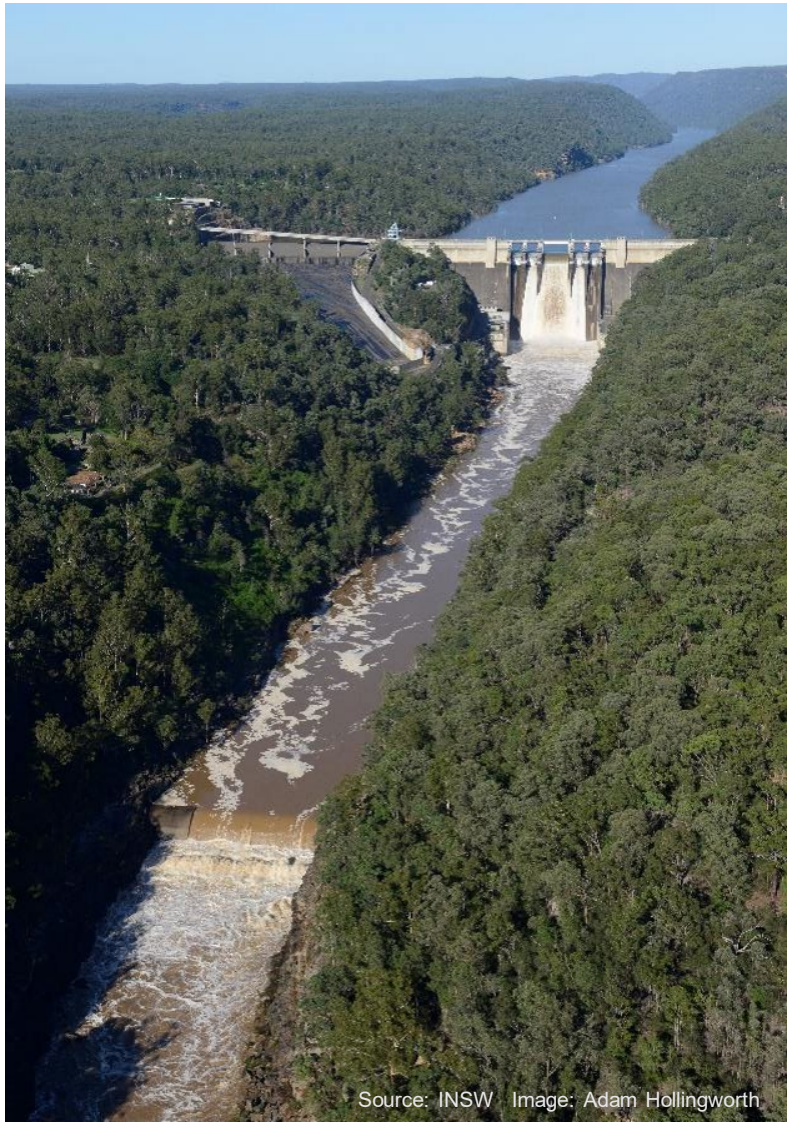
- Significant inflows to other dams
  - heavy rain pushed all Sydney's water supply dams to capacity, with most spilling

Warragamba catchment upstream – March 2021

NSW GOVERNMENT

March 2021 rainfall event – inflows to storages

- **Before the event**
  - approx. 130 GL released (from November 2020) to hold Warragamba storage at around 1m below full supply level for operation and maintenance
  - Approved operation and maintenance are the only reasons WaterNSW permitted to release water to 1m below full supply level
- **Warragamba Dam 96.3% capacity at start of event**
  - majority of dam inflows from Coxs and Kowmung rivers due to heavy rain over northern part of catchment in Blue Mountains
  - Kowmung River at Cedar Ford highest inflows since gauge installed in 1968



Warragamba Dam spilling - 26 March 2021

NSW GOVERNMENT

Inflows to Warragamba Dam

- Warragamba Dam 1.01m below full storage at the start of event
- Dam captured catchment inflows until Saturday 21 March when dam filled and began to spill
- Spilled approx. 1,200 GL in total - fourth largest spill on record
  - corresponding discharge peak approx. 500GL/d
- Event total inflow approximately 1,300 GL
  - compared to 800GL in February 2020

Warragamba Dam spilling

Warragamba Dam storage levels - preliminary analysis

- **Warragamba Dam** outflows peaked at 1.54 metres above full supply level on Sunday 21 March
- Smaller second peak on Tuesday 23 March
- Storage remained above full supply around 12 days
- Dam receded to full supply level 2 April 2021
- Drawdown operation (to -1m) concluded 14 April 2021

Impacts around the dam

- **Upstream impacts**
  - related to overland flows and local catchment flooding
  - main access roads into Warragamba damaged preventing access to much of the Special Area
  - volumes and velocity of flows resulted in erosion of trails and creek lines
  - river crossings on Wollondilly River (NPWS) had minor damage

- **Damages to water monitoring equipment**
  - during event damage at up to 9 gauging stations
  - damage ranges from minor/moderate, and at some sites to significant.

W4i, Nattai National Park, Warragamba catchment April 2021

Sheehys Creek Road (Council road)

Displaced gauge plate Warragamba Weir

NSW GOVERNMENT

Water quality management

- **Large inflows to all Sydney's dams**
  - compounding effects of bushfires and 2020 inflows
  - poorer quality water entered storages – increased levels of sediments and organic material
  - occurred despite long-term measures to improve quality of water from catchments and extensive protected Special Areas
  - presented significant challenges for the water supply system

Water quality testing

- **No impact on Sydney's raw water supply**
  - WaterNSW actively manages network to minimise issues and implications for raw water supply
  - changes are usually implemented prior to event – taking a precautionary approach
  - sophisticated monitoring and modelling, and expertise enabled WaterNSW to effectively predict, anticipate and respond

NSW GOVERNMENT

Forecasts – ahead of and during March 2021 flood

This was not forecast as a major rain event

- Until Thursday 18 March 2021 major rain event not forecast
- Based on BoM's forecast on Wednesday 17 March, only a small probability Warragamba Dam would have a minor spill
- BoM upgraded forecast late Thursday with a doubling of rainfall forecast between Thursday morning and Friday morning
- BoM increased forecast again on Saturday morning - doubled rainfall forecast between Friday and Saturday
- Actual rainfall was in line with Saturday forecast - created major flood event in the Hawkesbury-Nepean

NSW GOVERNMENT

March 2021 flood

NSW GOVERNMENT

March 2021 flood – peak, likelihood and classification

Location	Observed March 2021 peak level (metres AHD) [1]	Approximate likelihood (1 in X chance per year) [2]	Flood classification
Warragamba Dam	118.24 [3]	1 in 10-20	–
Wallacia Weir	35.16	1 in 5-10	Minor
Penrith [2]	24.13	1 in 20	Moderate
North Richmond	14.91	1 in 10-20	Major
Windsor	12.93	1 in 10-20	Major
Sackville	9.71	1 in 10-20	Major

Notes:

[1] Flood peak data sourced from WaterNSW and Manly Hydraulics Laboratory

[2] Approximate likelihood for most sites is based on the Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019). The approximate likelihood at Penrith is based on preliminary design flood level results from the 2-dimensional Hawkesbury-Nepean River Flood Study that is being developed, and may be subject to change. Modelled flood levels at Penrith have been updated to take account of revegetation in and near the river in recent years.

[3] Warragamba Dam full water supply level is 116.72m AHD. The storage peaked at 1.54m above this level.

(Flood height is expressed as metres AHD (Australian Height Datum) which is equivalent to metres above sea level)

NSW GOVERNMENT

March 2021 flood - historical context at Penrith

- **March 2021 flood:**
  - **moderate** flood – mostly within bank
  - likelihood of approx. 1 in 20 chance per year - or about a 98% chance of happening at least once in an 80-year lifetime
  - peaked at 10.0 metres (24.1 m AHD)
- **By comparison:**
  - slightly higher than 1961 flood (23.9m AHD)
  - highest since 1925 (24.5m AHD)
  - largest flood on record (1867) had approx. 1 in 500 (0.2%) chance and peaked about 3.5 metres higher (27.5m AHD).

2021 flood – downstream of Victoria Bridge (5 days after peak)

1961 flood – downstream of Victoria Bridge

NSW GOVERNMENT

March 2021 flood - historical context at Windsor

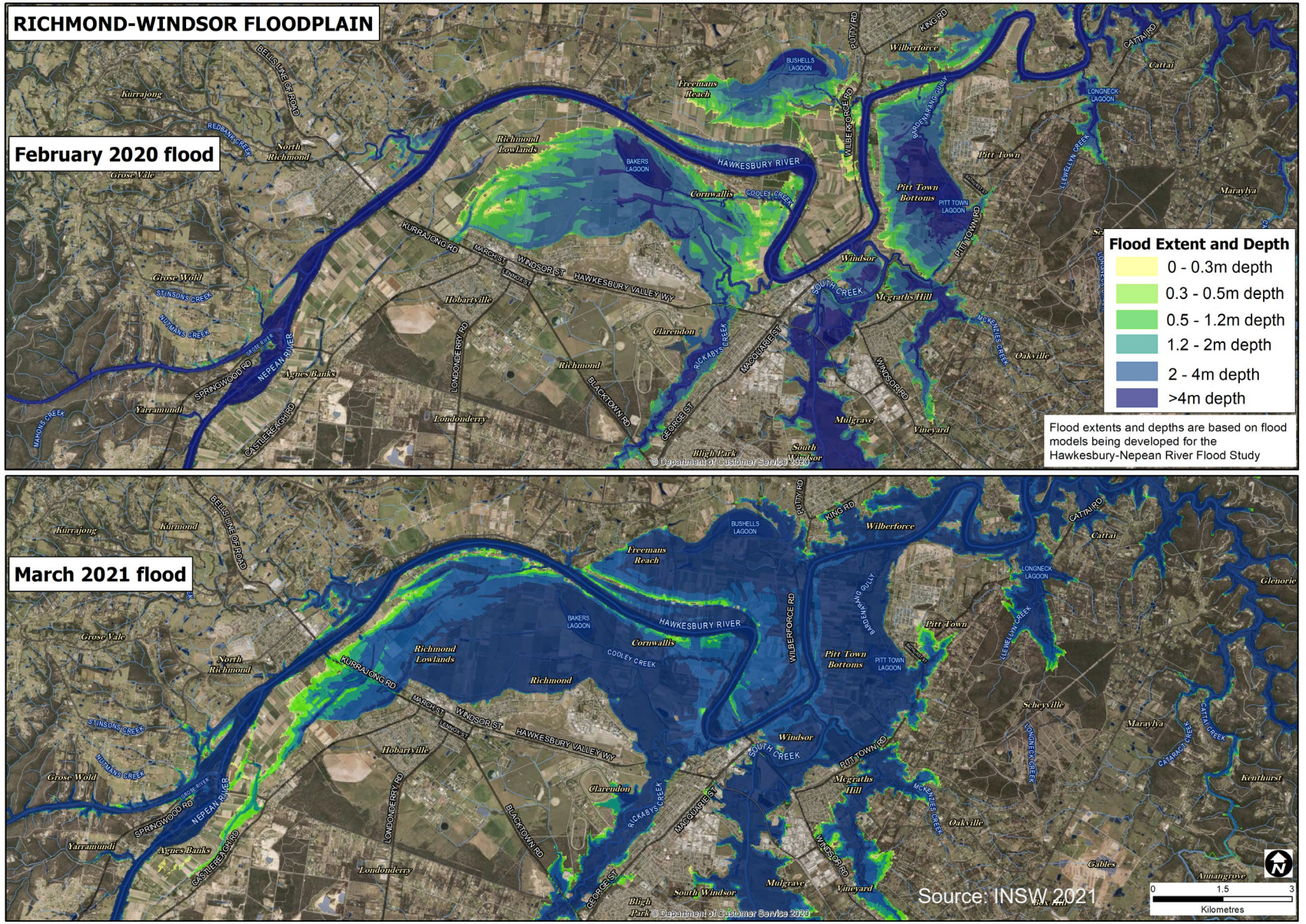
- **March 2021 flood:**
  - first **major** flood since 1990
  - likelihood of approx. 1 in 10 to 20 chance per year - or a 99.6% chance of happening at least once in an 80-year lifetime
  - peaked at 12.9 metres
- **By comparison:**
  - similar to May 1988 flood (12.8 metres)
  - largest flood in living memory in 1961 had 1 in 30 to 40 chance per year - peaked around 2 metres higher (15 metres)
  - largest flood on record (1867) had approx. 1 in 500 (0.2%) chance and peaked around 7 metres higher (19.7 metres)

1990 flood – McGraths Hill to Windsor

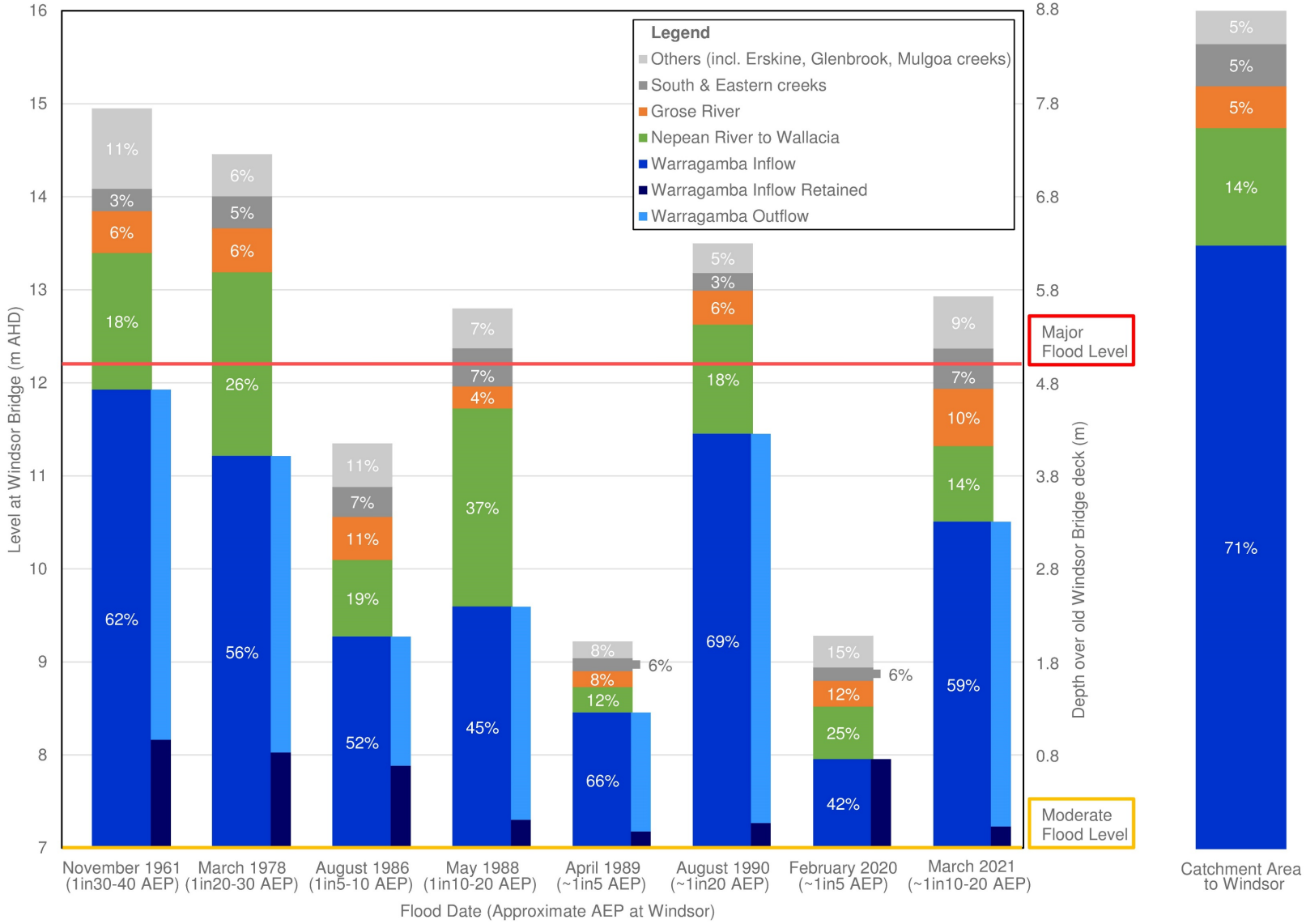
1961 flood - South Windsor

NSW GOVERNMENT

March 2021 flood – flood extent compared to February 2020



Flooding in the Hawkesbury-Nepean – catchment contributions



- Dominated by inflows from Warragamba catchment - not the Grose River catchment, or other smaller catchments
- Warragamba catchment contributed just under 60% of the floodwaters to Windsor - other catchments around 40%
- Ratio consistent with historical records as well as contemporary hydrological modelling
- Warragamba makes a higher contribution to the larger floods

NSW GOVERNMENT

March 2021 flood event – downstream communities

- **First Major flood experienced by many in the downstream communities**
  - New residents not prepared for flood impacts
  - Bridge closures caused significant disruption and concerns
  - Failure of Bells Line of Road resulted in response and re-supply issues for populations west of the Hawkesbury River
  - Local catchment and overland flooding contributed to road closures and community disruption
  - Concerns expressed by some in the community that Warragamba Dam should have been drawn down ahead of flood

"Overwhelmed and gut-wrenching. These are the words of Windsor resident Jodie Saint to describe the pain of finding her home waist deep in floodwater and fact that her family now faces an uncertain future." *Hawkesbury Gazette: 24 March 2021*

March 2021 flood event – downstream impacts

- Most significant impacts in low lying and riparian areas – Hawkesbury and Lower Hawkesbury
- Major riverbank erosion
- Multiple road closures and damage
- Impacts on riparian caravan parks and recreational areas

Freemans Reach Road, Windsor

Riverbank erosion, Hawkesbury River - 28 March 2021

Sackville Ski Gardens, Sackville – 23 March 2021

March 2021 flood in pictures - south to north

Warragamba Dam spilling – 26 March 2021

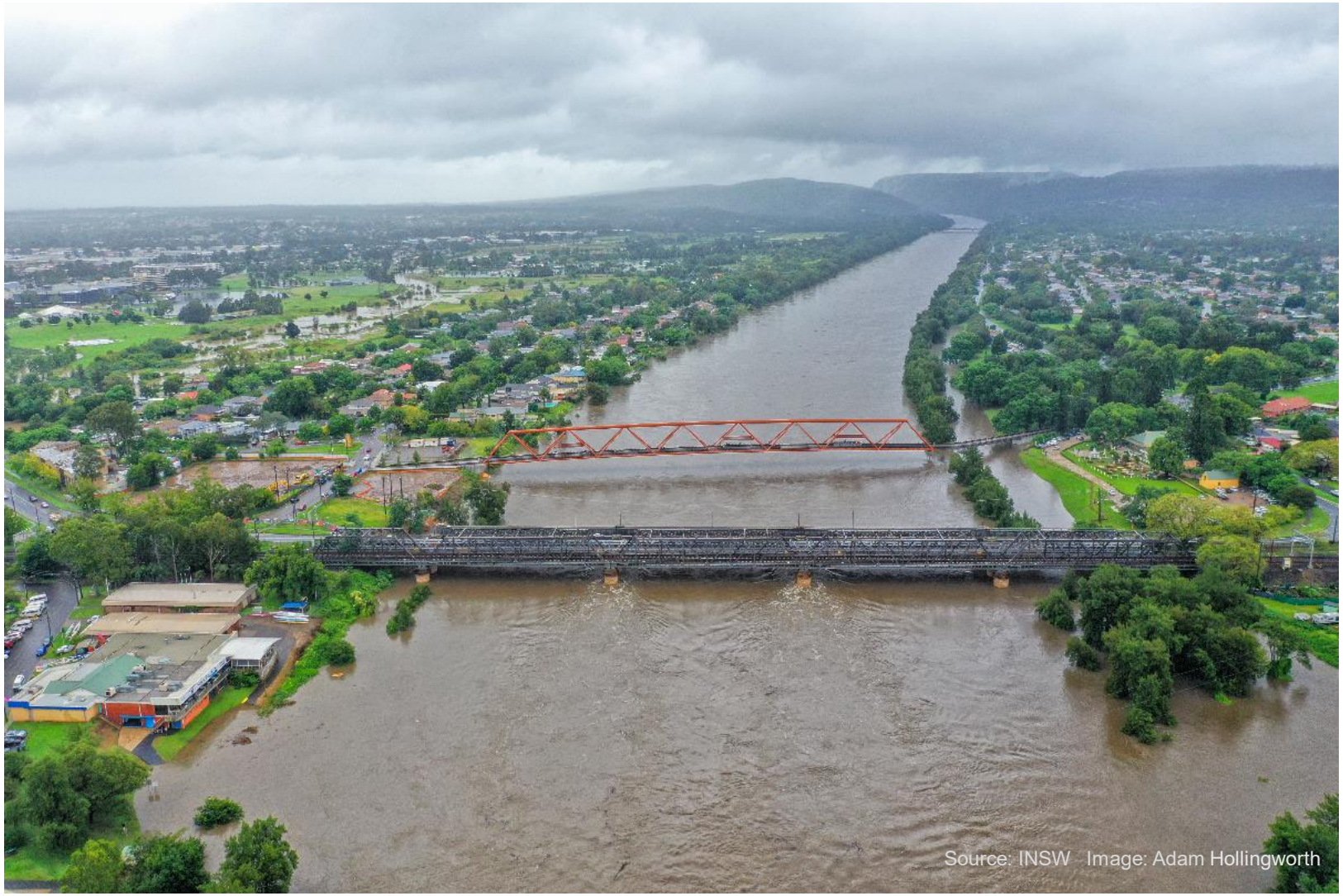
NSW GOVERNMENT

Junction of Warragamba and Nepean rivers

Floodwaters meet at the confluence of Warragamba River (left) and Nepean River around 3km downstream of the dam – 22 March 2021

NSW GOVERNMENT

Penrith-Emu Plains



Looking south along the Nepean River which stayed largely within banks at Penrith - 22 March 2021

NSW GOVERNMENT

Penrith-Emu Plains

Floodwaters nearing homes in River Road, Penrith – 22 March 2021

Nepean River floodwaters flowed in and out of Penrith Lakes – 23 March 2021

Yarramundi – junction Nepean and Grose rivers

Junction of Nepean River (left) and Grose River - 23 March 2021

Inundated recreation area Yarramundi - March 2021

NSW GOVERNMENT

Richmond-Windsor

Windsor Bridge looking West – 23 March 2021

Windsor as floodwater recede - 26 March 2021

North Windsor looking north – 23 March 2021

Richmond-Windsor

Windsor Bridge looking east towards South Creek, with floodwaters receding - 26 March 2021

South Creek

South Creek looking towards Jim Anderson Bridge, Windsor – 26 March 2021

NSW GOVERNMENT

Lowlands

Agricultural lands under water Pitt Town Bottoms - March 2021 (above & right)

Lower Hawkesbury

Junction Hawkesbury & Macdonald rivers, Wisemans Ferry -26 March 2021

Debris and damage St Georges Ski Park, Lower Portland - 26 March 2021

NSW GOVERNMENT

March 2021 flood – would mitigation have made a difference?

March 2021 - Warragamba Dam pre-releases

- **Lowering the storage level ahead of a flood**
  - Warragamba Dam is a water supply dam - flood mitigation is not an approved purpose
  - Pre-releases for flood mitigation (currently not an approved purpose) would :
    - have implications for Sydney water security
    - require a precision in forecasting over both short and longer term not currently possible
  - Pre-releases over a longer term could put Sydney's water security at risk
  - Releases immediately ahead of a forecast event could bring forward the downstream flood peak and cut off evacuation routes earlier
  - To avoid the dam spilling in the March 2021 event:
    - would have required lowering to levels below those experienced in recent drought or millennium drought (around 30%)
    - equates to more than 2.5 years of supply to Greater Sydney
    - could not be achieved within the forecast time available for this event

NSW GOVERNMENT

Warragamba Dam - flood mitigation options

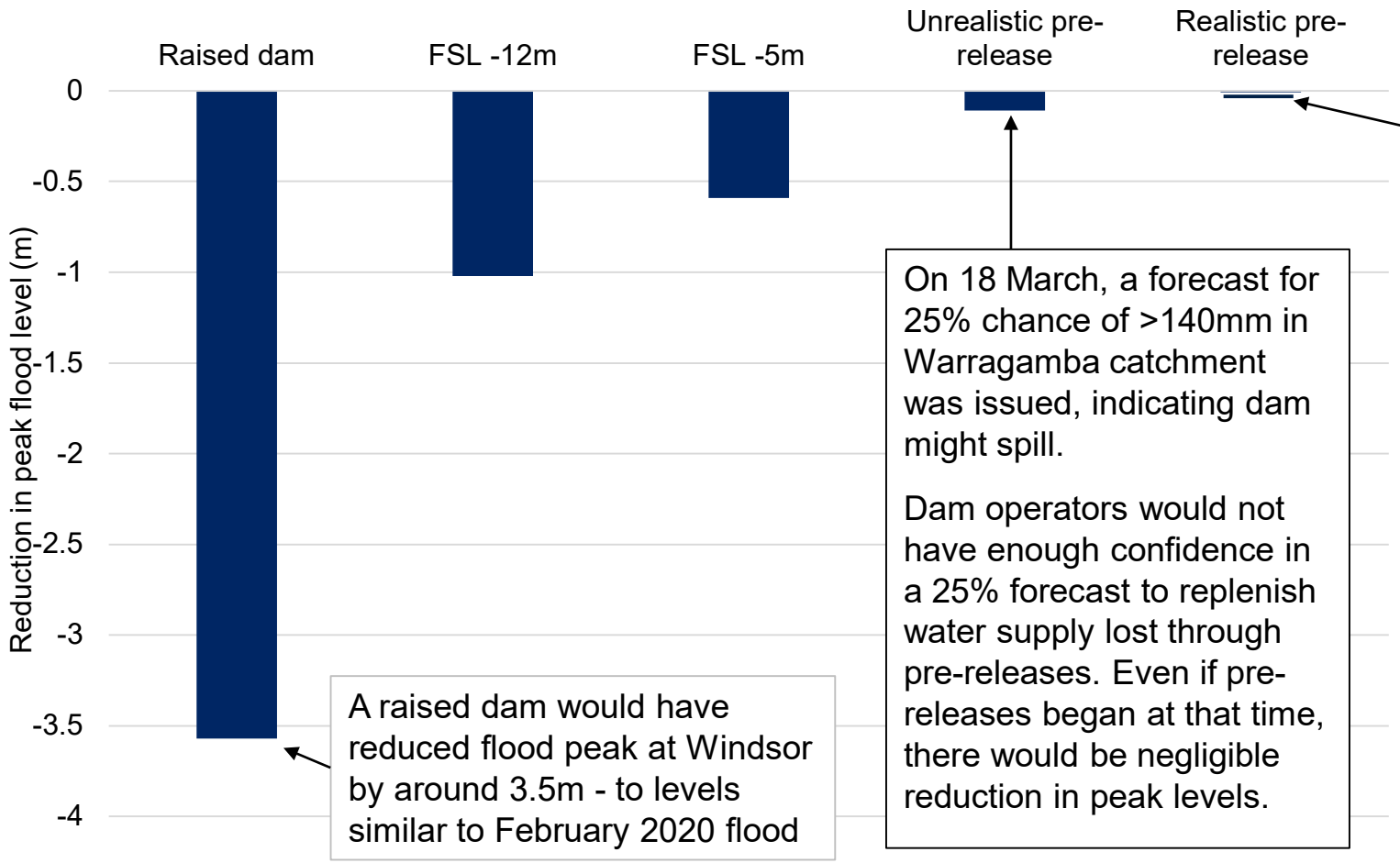
Warragamba Dam flood mitigation options investigated in detail as part of the Hawkesbury-Nepean Flood Strategy

- **Permanent lowering the full supply level**
  - by 5 metres
    - would reduce dam's capacity by around 18%
  - by 12 metres
    - would reduce dam's capacity by around 40% (approx. 30% of Sydney's water supply)

- **Dam raising proposal**
  - raise spillways to create a 14-metre flood mitigation zone
    - would increase storage by ~1000 gigalitres (approx. 50%) above the unchanged full water supply level

NSW GOVERNMENT

March 2021 flood - reduction of flood peak at Windsor with Warragamba Dam pre-releases and flood mitigation options



A raised dam would have reduced flood peak at Windsor by around 3.5m - to levels similar to February 2020 flood

On 18 March, a forecast for 25% chance of >140mm in Warragamba catchment was issued, indicating dam might spill.

Dam operators would not have enough confidence in a 25% forecast to replenish water supply lost through pre-releases. Even if pre-releases began at that time, there would be negligible reduction in peak levels.

Only on 19 March was a median forecast for >100mm in Warragamba catchment issued, indicating dam had reasonable chance of spilling.

Had pre-releases begun then, there would be negligible reduction in peak levels – less than 10cm.

Note: Review of the March 2021 flood is ongoing. Figures presented are based on preliminary analysis of flood hydrology.

NSW GOVERNMENT

Thank you

NSW GOVERNMENT