

Warragamba Dam Assessment Team  
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*Warragamba Dam Raising Project – SSI-8441;*

I am writing in support of the Warragamba Dam Raising Project – SSI8441

I have been NSW's Emergency Services Functional Area Coordinator since my appointment on 16 June 2014. I am a qualified engineer with a considerable depth of experience in both engineering and management. My engineering career has spanned health infrastructure, engineering professional associations, standards development, engineering safety regulation and engineering education.

In my current role, drawing upon the engineering capabilities of staff from across Public Works Advisory, I ensure that Public Works has the engineering expertise to help prevent, prepare for, respond to and recover from the effects of the impacts of disasters on the community.

As the NSW's Emergency Services Functional Area Coordinator, I am a member of the State Emergency Management Committee (SEMC). I was nominated as a member of SEMC by the then Minister for Finance, and appointed to SEMC by the then Minister for Police and Emergency Services.

As a professional who is called upon to respond to natural disasters, I seek to bring engineering emergency management expertise to the review of the proposal to raise Warragamba Dam and in particular the impact on the community down-stream of the dam.

Flooding in the Hawkesbury Nepean Valley is not a new problem, the high flood risk has been known for decades. The Hawkesbury-Nepean Valley Flood Management Review was commissioned following a series of storms and floods across south-eastern New South Wales in 2012. This review concluded that there was a significant flood risk in the Hawkesbury Nepean Valley that would increase as urban development increased and that the response to managing this risk was multi-faceted and noted there was no one single solution that could effectively manage this flood risk. In response to the review, the NSW Government established the Hawkesbury-Nepean Valley Flood Management Taskforce in 2014. This Taskforce was assigned the task of developing a whole-of-government approach to managing the flood risk and increasing flood preparedness in the Hawkesbury Nepean Valley. As noted in the EIS, the Taskforce identified nine outcomes to maximise the flood risk mitigation benefit:

1. Coordinated flood risk management across the valley now and in the future — including a new Hawkesbury-Nepean Valley Flood Risk Management Directorate to oversee implementation of the Flood Strategy
2. Reduce flood risk in the valley by raising Warragamba Dam wall — the preferred infrastructure solution
3. Strategic and integrated land use and road planning — including preparation of a Regional Evacuation Road Master Plan and a Regional Land Use Planning Framework to better manage flood risk in the valley

4. Accessible contemporary flood risk information — improving mapping of flood risk and making this information widely available
5. An aware, prepared and responsive community — including a coordinated focus on raising community understanding of flood risk and flood evacuation routes
6. Improved weather and flood predictions — updating the Bureau of Meteorology's Hawkesbury-Nepean weather prediction and flood forecasting model
7. Best practice emergency response and recovery — providing for periodic reviews and updates of emergency and recovery plans maintained by the NSW State Emergency Service and the NSW Office for Emergency Management
8. Adequate local roads for evacuation — undertaking around 40 high priority local evacuation road upgrades
9. Ongoing monitoring, evaluation, reporting and improvement of the Flood Strategy — establishing a monitoring, evaluation, reporting and improvement framework.

The aim of these outcomes is to lower the flood risk in the Hawkesbury-Nepean Valley to a tolerable level. While each of these outcomes is important in and by themselves, it should be remembered that they have being researched and compiled as part of a comprehensive, whole of government package. Electing not to raise the height of Warragamba Dam will have an impact on each of the other eight outcomes identified by the Hawkesbury-Nepean Valley Flood Management Taskforce.

More than 140,000 people currently work or live on the floodplain. Since 2015-16, the number of residential properties potentially impacted by floods has increased by 11,000 - from 25,500 to 36,700 in December 2018, and the population is set to increase. Over the next ten years, if all already approved developments were built, the number of properties on the floodplain would increase to approximately 54,000.

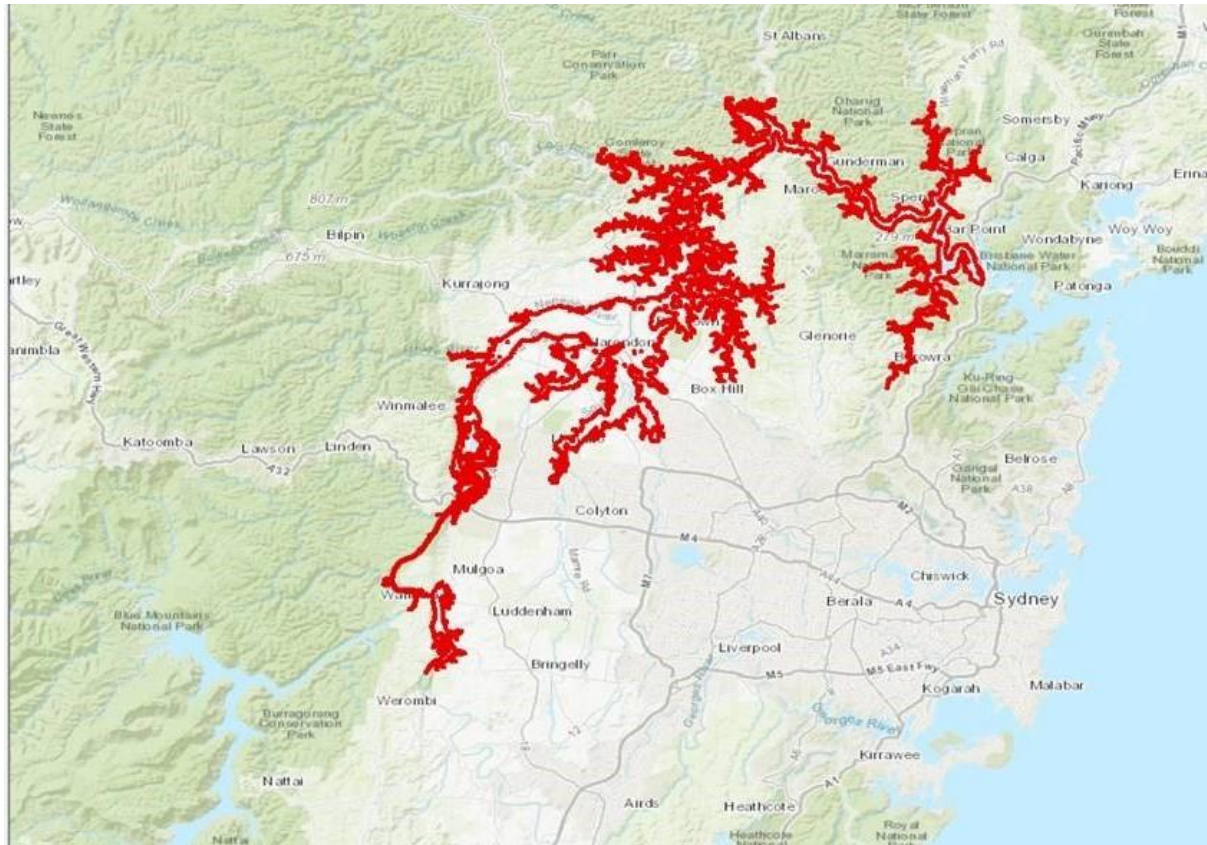
Already, the Insurance Council of Australia is on record as saying that the Hawkesbury-Nepean Valley has the highest single unmitigated flood exposure in Australia. Interestingly, while the insurance industry has withdrawn its support for the raising of Warragamba Dam, it has not included affordable flood coverage in the home insurance policies issued for policies in the Hawkesbury Nepean Valley, by-in-large, the insurance industry has abandoned the people in the Hawkesbury-Nepean Valley. If anyone is going to protect the people and their houses and businesses, it is going to be the government. By raising the level of Warragamba Dam we strive to protect those in the Hawkesbury Nepean Valley and, as noted in the EIS, the savings will be significant, in fact they are compelling in my view.

If a flood similar to the 2011 Queensland floods happened in the valley today, around 55,000 people would need to evacuate and around 7,600 homes would be impacted – resulting in a direct damages bill of more than \$3 billion. If Warragamba Dam was raised, the number of people needed to be evacuated would decrease to 14,000, the number of homes impacted would be reduced to 2,500 and the damages bill would be reduced to \$400 million. In a flood similar to the worst on record (in 1867), nearly 90,000 people would need to evacuate and around 15,500 homes would be impacted, with more than \$8 billion in damages. If Warragamba Dam was raised, the number of people needed to be evacuated would decrease to 45,000, the number of homes impacted would be reduced to 5,000 and the damages bill would be reduced to \$2 billion. Going into the future, if a flood similar to a 1 in 500 year flooding event happened in the valley in 2041 and currently approved development had taken place, around 135,000 people would need to evacuate and around 26,000 homes would be impacted – resulting in a direct damages bill of more than \$12 billion. If Warragamba Dam was raised, the number of people needed to be evacuated would decrease to 53,000, the number of homes impacted would be reduced to 6,100 and the damages bill would be reduced to \$2.2 million.

It is my understanding that the above analysis makes no allowance for the effects of climate change. With an allowance for moderate climate change by mid-century, homes built at the current 1 in 100 chance per year flood planning level will be exposed more frequently (to a 1 in 65-year chance per year flood). This means an additional 3,600 homes will be subject to a 1 in 100 chance per year flood by 2041. These figures do not include the cost of social impact of the floods.

If Warragamba Dam is to be raised, it should not be a licence for further unrestricted development. Too often in the past, the suggestion of flood mitigation has activities has resulted in additional development. For example in the map below, Spatial Services has demonstrated the areas that would be subject to flooding in a 1 in 100 year flood. Despite there being no additional flood mitigation activities being undertaken in the Hawkesbury Nepean Valley between 1995 and 2020, the number of properties that will be affected by a flood at this level has increased from 10,985 in 1995 to 14,233 in 2020. The increase at 5-year intervals is listed below.

Date	Properties
December 1995	10895
December 2000	11941
December 2005	12675
December 2010	12147
December 2015	13490
December 2020	14233



The fact that the Flood Taskforce's Strategy does not change the location of the existing floodplain levels for planning purposes is to be welcomed. Yet planning controls can only do so much, and generally only to limit the risk to new developments, while doing little to reduce the risk for already established properties.

It is also important note that flood depths in this valley are extreme. This, combined with the inland sea created by valley's 'bathtub effect', means shelter-in-place is not an option. People will need to be evacuated, quickly and often at short notice. Modelling has shown that in large floods, the number of vehicles needing to evacuate will exceed the road network capacity sometime between 2021 and 2026.

For rarer floods, such as 1 in a 1000 year or greater flood, analysis indicates that large numbers of people are already unable to evacuate before being stranded by floodwaters. With already approved development, the capacity of the road network to cope with mass evacuations will be exceeded more frequently by major floods. For example, with the projected growth to 2041 (with existing dam and current climate), in a 1 in 500 year flood (similar to 1867), over 11,000 people would take more than 12 hours to evacuate the floodplain, and it is estimated that over 5,000 people would be trapped by floodwaters. The number of deaths in this situation would number in the thousands.

I note that the March 2021 flood in the Hawkesbury Nepean was between a 1 in 10 and 1 in 20 year flood event, and emergency flood planning must account much worse events. I will not address the potential impact of raising Warragamba Dam on environmental and heritage impacts on areas up-stream of the dam as there are many others better qualified to do this. I acknowledge these

impacts. I do note however, that there are also considerable Aboriginal and heritage sites in the Hawkesbury Nepean Valley down stream of Warragamba Dam that are vulnerable to flood damage. Data from the Aboriginal Heritage Information Management System (AHIMS) has identified at least 65 areas of interest that lay within 500 metres of the Hawkesbury River, Nepean River and lower reaches of the Colo River, Macdonald River, Mangrove Creek downstream of Warragamba Dam that were either damaged or at risk of being damaged by the recent March 2021 Floods. The Aboriginal heritage items at risk downstream of Warragamba Dam include identified artefact sites, Grinding Groove sites and Potential Archaeological Deposit (PAD) sites. This heritage also of value and is worthy of protection.

It should be recalled that damage caused by water inundation downstream of Warragamba Dam tends to be more severe. This is because the increase in the water level of Lake Burragorang occurs with lower water velocities than what occurs down stream of Warragamba Dam as a result of water spilling over the dam. Put simply, during a flood in the Hawkesbury Nepean the water velocity downstream of the dam is much higher than the velocity upstream of the dam.

The modelling of the impact of an increased dam wall on the March 2021 highlighted in the EIS is telling:

- the flood peak at Windsor would have been 3.6 metres lower;
- significantly fewer properties would have been flooded;
- the spill from Warragamba Dam would have been delayed by 3 to 4 days; and
- the closure of Windsor Bridge would have been delayed by 12 hours.

These impacts would have resulted in fewer properties being damaged, a lower overall damage bill; and there would have been more time available for the population to be evacuated and also permitted earlier access to the area for emergency responders as the flood receded.

The EIS reviewed a number of alternative options that have been proposed in place of the raising of Warragamba Dam. These include lowering Warragamba Dam's full supply level by 5 or 12 metres.

Both options to decrease Warragamba Dam's full supply level are clearly not viable. The impact on Greater Sydney's potable water supply, reductions in supply of 18 and 40 per cent respectively make the proposals impractical. The 5-metre reduction proposal would only provide minor flood mitigation capacity while having a significant impact on Sydney's potable water supply. The 12-metre reduction proposal would have a much greater impact on the Sydney's potable water supply that alternative bulk supplies would need to be in place prior to implementation of the reduction at significant capital and ongoing operational cost. In addition, it would require significant and risky changes to the dam flood gates.

As pointed out in the EIS, to get the same level of flood mitigation benefits that the raising of the wall brings, the full service level storage capacity of the dam would need to be decreased to 50 per cent of current storage. The options to decrease the full service level of Warragamba Dam, while attractive to some on the surface, do not stand up to any closer analysis. Another suggestion mentioned in the media is for pre-flood releases from the dam in advance of floods. This suggestion does not understand the bathtub nature of the Hawkesbury Nepean floodplain. It would have barely any effect of flood heights. These options are not really options at all.

There is one option for flood risk mitigation other than raising the Warragamba Dam. That is to remove all dwellings below the 1 in 100 flood level in the valley. Such a compulsory buyback scheme would achieve the same level of flood risk mitigation.

It is my view that it would be unconscionable for government to once again fail to address the flood risk in the Hawkesbury Nepean floodplain. It appears to me that there are only two options that actually achieve a meaningful risk reduction. No other options achieve a satisfactory risk reduction.

In summary, it is my opinion that Warragamba wall raising pays for itself through reduced inundation and property damage during small floods and saves lives by giving time to evacuate during big floods.

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17/12/21