Submission No 284

INQUIRY INTO PROPOSAL TO RAISE THE WARRAGAMBA DAM WALL

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Date Received: 8 September 2019

Submission to the Legislative Council Select Committee on the Proposal to Raise the Warragamba Dam Wall

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9 September 2019

Summary of Recommendations

1. It is my submission that the raising of the dam wall does not build resilience for Sydney, NSW or Australia, but increases the vulnerability of the population to unnecessary and avoidable risks.
2. My submission is that the committee should recommend that the draft EIS and Draft Business cases together with the original papers requesting this proposal, cost calculations, risk and vulnerability assessments be published together with assessments of who will pay for externality risks.
3. The committee should also recommend the final EIS and final Business case be published with all the supporting cost benefit papers including how externality costs are to handled.
4. The committee should investigate why dam collapse was not included in the Hawkesbury-Nepean flood study.
5. It is a recommendation that the SES develops and test plans for a dam failure of all the major dams in NSW if they have not already done so and publish the results.
6. It is my submission that other options are available that do increase resilience for Sydney and NSW, and should be enacted. This includes developing desalination technology which has come a long way since the first desalination plant was built in Sydney, the provision of at least 10 desalination plants as well as lowering the dam water level by some 30m.
7. It is my submission that the long term risk of a terrorist over the lifetime of the dam needs to be addressed. The risk is increased by ever increasing technology, the uncertainty of political factors, the increased development on the flood plain over the lifetime of the dam and the attractiveness of the target which is far more devastating than, for example, a cyber-attack.
8. It is recommended that if a serious counter to the lobby industry and corruption in development projects is to be minimised, then Treasury should as part of the publication of projects, include calculations, risk and vulnerability assessments, externality risks and who will pay for those risk with ongoing projects and before contracts are let.
9. I submit that the assessment of the impact of raising the dam wall on Aboriginal Heritage and Culture is invalid and not aligned to good development of resilience for Blue Mountains or Hawkesbury-Nepean plains communities.
10. I recommend that funding be provided to undertake proper scientific archaeological and anthropological study of the 300 or so sites identified by independent experts recommended by UNESCO in partnership with the local Gundungurra community.
11. I also recommend that the water level in Warragamba dam be lowered by 30m to ensure that Gundungurra land is not impacted in the future and is there for future generations.
12. I submit and recommend that the Blue Mountains World Heritage area be universally protected from development and that areas adjoining the World Heritage Areas be assessed to extend the World Heritage Area.
13. I also recommend that the water level in Warragamba dam be lowered by 30m to protect the existing Blue Mountains World Heritage Area.
14. I recommend that the planning criteria be altered to 1 in 1250 years for housing on the flood plain where the river is not tidal but 1 in 2000 for housing where the river is tidal and 1in 10000 where there is high population density.

15. I would recommend improvements to the modelling to include the effects of development on localised flooding and runoff, and the effects of bushfire on runoff. The other conditions of climate change can be rerun and undertaken by changing boundary conditions within the current flood model.

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Introduction

A select committee has been established to inquire into and report on the NSW Government's proposal to raise the Warragamba Dam wall, and in particular:

(a) Conflicting reports on the planning height for the dam wall raising and the potential use of the raising for additional storage capacity as well as flood mitigation,

(b) Plans for future property development on flood prone land on the Hawkesbury Nepean Floodplain,

(c) Engagement between the NSW Government and the World Heritage Committee of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) in relation to the project,

(d) The adequacy of the Environmental Impact Assessment process to date, including the assessment of impacts on:

(i) World Heritage,

(ii) Aboriginal Cultural Heritage,

(iii) Ecological values of the Greater Blue Mountains National Park,

(iv) The Warragamba community,

(v) Communities on the Hawkesbury Nepean Floodplain,

(e) The nature and extent of the examination of alternative options for flood management that formed the basis of the Cost Benefit Analysis of the project and the 'Resilient Valley, Resilient Communities' strategy,

(f) The flood risk assessment and proposed flood management of the Hawkesbury-Nepean Valley and whether this meets international best practice standards,

(g) The estimated cost of the project and identified funding sources,

(h) The implementation of recommendations in the inquiry into the Water NSW Amendment (Warragamba Dam) Bill 2018 by the Standing Committee on State Development in October 2018, and

(i) Any other related matter.

All submissions are to be submitted by 10 September 2019.

My Submission

The proposal to raise the dam wall has to be put within a context of whether it actually builds resilience for people in Sydney. Once you answer this question, the option to raise the dam wall will or not becomes obvious.

It is my submission that the raising of the dam wall does not increase resilience for Sydney, NSW or Australia. Other options are available that do increase resilience and should be enacted. The cost benefit has to be seen in the context of both normal floods and extreme inundations not just normal floods.

Risk, Resilience and Complexity

Much rhetoric has been discussed by the Sydney City Commission on both building a resilient city[1] and the metropolis of three cities in which all people are meant to be within 30 minutes of work.[2] The Sydney City Commission is just one of many "visions" over the last several years. They all have a common theme: population growth to support housing development and infrastructure development that is proposed by lobbyists and supported by investment banks and other rent seekers (people who attempt to increase their wealth without creating new wealth[3]). In support of rent seekers and lobbyists, the Government of NSW has introduced State Significant Legislation that takes away community discussion of how their community is to develop and has transferred power to the Ministers discretion rather than being community led. This does not build 'Resilient Valley, Resilient Communities' but destroys any resilience in communities.

This process has undermined what were good planning laws in NSW and has opened Government and the Public Service to corruption by vested interests. These will be discussed below.

Resilience is used as a term in many disciplines and so there is no single definition. I will use the word resilience to mean community resilience, rather than individual resilience, as "*the sustained ability of a community to utilize available resources in response to adverse situations that enables them to withstand and recover from those situations*". In order to state whether a community is resilient requires knowledge of all mechanisms of threat, where available, and the risks they pose. These threats range from the existential such as terrorism, espionage and foreign interference, through to natural calamity and technological failure.

The committee should recognise that Warragamba dam is just one part of an interconnected society and that all infrastructure has to be fit for purpose. Warragamba dam and its water catchment are in one of the 10 categories of Australian National Security Infrastructure that is

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[1] Resilient Sydney: Preliminary Resilience Assessment 2016, 016-503932-Report-Resilient-Sydney-PRA-FINAL-ISSUED.pdf

[2] Sydney City Commission, https://www.greater.sydney/structure-plan-metropolis-three-cities, accessed 23/04/2018. The webpage is semi-interactive giving basic details of the symbols on the map and the timeframes for development for some.

[3] https://en.wikipedia.org/wiki/Rent-seeking.

deemed at risk from acts of terrorism. The social, heritage, political, economic and environmental attributes form a set of complex interdependencies surrounding the dam environment. The raising of the dam wall has to show how it properly affects all of those dimensions and that **all** are socially acceptable.

The NSW Government has released a report on the flood risks in the Nepean-Hawkesbury valley.[4] There is much wrong with this report as it does not discuss all mechanisms of flooding and inundation that can occur. The raising of the dam wall will exacerbate the risks that have not been discussed and the report does not include a discussion of the social impact or the extreme economic damage it can do to NSW and Australia. These will be discussed below.

The process adopted by the NSW Government has been a top down approach as depicted in Figure 1. In this approach government decisions are based primarily on economic advantage to investors, infrastructure companies and land developers rather than the community with low immediate cost to Government but long term cost to the community. People are seen and discussed only as consumers or customers. Social and environmental benefits or costs are monetised to make an economic judgement and where social and environmental costs tend to end up as externalities. This invariably means the cost comes back on the public purse or directly as a personal cost. An example of the former is the increased health costs for Western Sydney being imposed on the community from building and operating Western Sydney Airport. An example of the latter are the tolls on major arterial roads. The outcome is efficiency for large business interests and increased inequality for the people (mainly as a result of additional costs placed on low social economic groups which in turn requires more intervention from government – a loss loss situation).

In the proposal to raise the dam wall the Government have only taken account of the investors, developers and not the view of communities that are within the catchment area. The true importance of the World Heritage Area as a future resource for the community, to NSW and Australia is downplayed as unimportant. The loss of Aboriginal Heritage is considered inconsequential. The potential loss of life and property in communities is not properly considered as all mechanisms of risk are not discussed.

An alternative approach is shown in Figure 2, where the decision making is driven from a bottom up approach. In this approach the opportunities and disadvantages of the need for infrastructure are discussed with communities and small business prior to a decision on the technology that will be used. This process places constraints on the public private partnerships and is more balanced and equitable for the communities and local business. Clearly the economic cost still has to be manageable and the immediate cost to government may be higher. There may be a short term cost to companies, although this depends on how the government structures its contracts and risks in building the infrastructure.

This approach allows externality costs that occur, such as loss of property, loss of life, loss of World Heritage status for the Blue Mountains and preservation of Heritage, to be minimised through community agreement as to what is an acceptable loss.

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[4] The Hawkesbury –Nepean valley regional flood study final report vol 1, Infrastructure NSW, project 113031-07, 26 July 2019

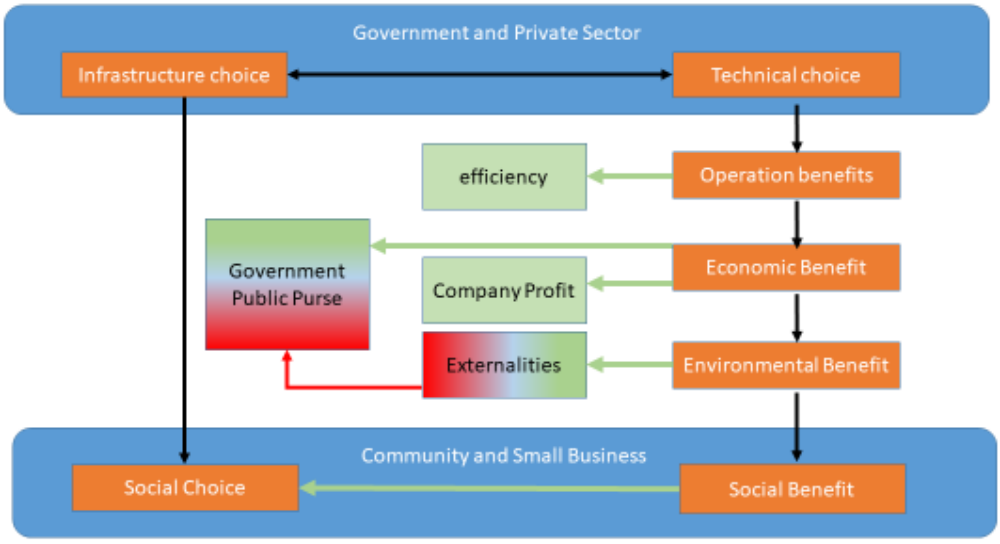

Figure 1 A top down approach to decision making. Government imposes an infrastructure solution that benefits private sector investors at the expense of the communities who are affected by the solution.

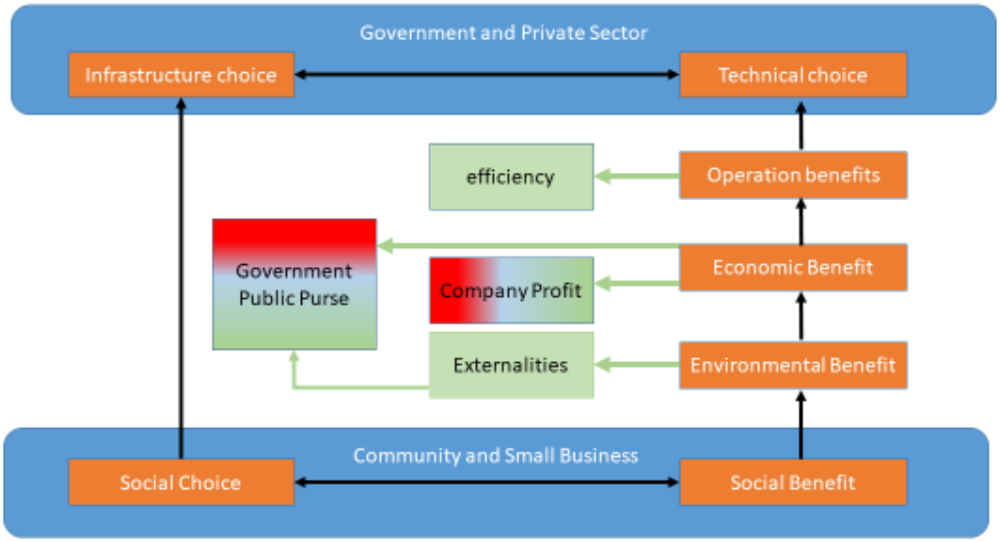

Figure 2 A bottom up approach to Infrastructure. The solution comes from communities and small business consultation that are going to be affected by the infrastructure. This puts a technical constraint on what can be done and limits investor/developer overriding of communities.

The committee also has to recognise that there is widespread anger in the community regarding the way Government imposes these types of infrastructure proposals on communities and is seen as corrupt behaviour by Government Ministers and Private Investors.

Major infrastructure projects are complex and costly. There is usually a difference in estimates of the cost of a project compared to the actual cost on completion. While there are examples of cost underruns, the majority involve cost overruns and these overruns are larger for larger projects.[5]

Flyvbjerg has found that cost overruns of 50% are common and over 100% are not uncommon.[6] He shows that demand and cost benefit forecasts are out by 20-70% compared with the actual occurrences. He also showed that 90% of projects have cost overruns, that it occurs worldwide and that there was no improvement over the 70 years of the study. Most of the studies involve transport infrastructure but these provide a guide to what happens with other infrastructure development.

For example, rail travel passenger demand reveals a 50% shortfall than that estimated for rail projects. Although road projects have a slight increase over the estimates there is a very large standard deviation in the data indicating forecast errors vary widely across projects. 84% of rail passenger forecast are wrong by more than ±20% and 50% of road projects are wrong by more than ±20% and have not improved over time.

A significant problem arises with these magnitudes of error as it impacts on the cost-benefit analysis for projects and lead to extremely misleading analyses. It also leads to refinancing of the project. There are many examples across the world including the Channel tunnel, Denver International Airport, and the London tube public-private partnership.[6] In Australia, there is the Cross-city tunnel and the airport line in Sydney, the East-West Link in Melbourne and the airport link in Brisbane to name just a few.

The large inaccuracies in forecasting have led some to at least sack the forecaster.[7,6] This raises the question as to why cost overruns and benefit shortfall in major infrastructure projects occur when forecasting techniques have improved and collection of data has increased. Three explanations claim to account for the errors: technical, psychological and political-economic errors.

The most common explanation is that imperfect forecasting techniques, inadequate data, honest mistakes, inherent problems in predicting the future, and lack of experience on the part of forecasters contribute to these errors. The improvements in all these areas, however, have not led to better forecasting. It strongly suggests that technical errors are not a prime cause.

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[5] C.C. Cantarelli, E.J.E. Molin, B. van Wee, B. Flyvbjerg, Characteristics of cost overruns for Dutch transport infrastructure projects. Transport Policy 22 (2012) 49–56.

[6] Bent Flyvbjerg, Survival of the unfittest: why the worst infrastructure gets built—and what we can do about it, Oxford Review of Economic Policy, Volume 25, Number 3, 2009, pp.344–367.

[7] Akerlof, G. A., and Shiller, R. J. (2009), Animal Spirits: How Human Psychology Drives the Economy, and Why It Matters for Global Capitalism, Princeton, NJ, Princeton University Press

Psychological explanations include optimism bias and the planning fallacy where managers make decisions based on delusional optimism rather than a rational weighting of empirical evidence leading to an overestimate of benefits and underestimate of costs.[8] While optimism bias can account for these errors, Flyvbjerg makes the point that professional expertise, which is constantly tested through scientific analysis, critical assessment and peer review in order to reduce error and bias, would result in a decrease of error and bias. The same mistakes in forecasting over many decades in his data show that Psychological explanations are not a credible hypothesis, otherwise results would have improved.

The third explanation is political-economic and strategic misrepresentation of projects. A strategic estimate of low costs would result in cost overrun while a strategic estimate of benefits would be high, resulting in benefit shortfalls. A key question is whether these are deliberately biased to get projects up through government decision making.

Two studies have found that forecasters withhold information on the true costs of a project because of political pressure to get a project funded and at the same time demonstrate all of the benefits while downplaying the risks and impacts.[9,10]

Competition for funding creates an incentive structure that makes it rational for project promotors to emphasise benefits and down play costs and risks on the assumption that a project that looks highly beneficial on paper is more likely to get funded. The two studies found that while private specialised companies were engaged to develop proposals, these consultants focused on justifying projects rather than critically scrutinising them. Getting them through the business case was required to make a profit.

There is also pressure to present a project in its best possible light as local authorities, local developers and land owners, labour unions, local politicians, local officials and local MPs and consultants all stand to benefit and have little interest to actively avoid bias in estimates of costs benefits and risks. As a result of the deliberate biasing, projects that get funded tend to be the most unfit of projects in reality for funding.

In an analysis of 38 road and rail transport projects from 1992 in Australia, Murray and Frijters[11] found that there were three accounting tricks that were used by governments and

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[8] Kahneman, D. (1994), 'New Challenges to the Rationality Assumption', Journal of Institutional and Theoretical Economics, 150, 18–36.

Kahneman, D, Lovallo, D. (1993), 'Timid Choices and Bold Forecasts: A Cognitive Perspective on Risk Taking', Management Science, 39, 17–31.

Kahneman, D Tversky, A. (1979), 'Prospect Theory: An Analysis of Decisions under Risk', Econometrica, 47, 313–27.

Lovallo, D., and Kahneman, D. (2003), 'Delusions of Success: How Optimism Undermines Executives' Decisions', Harvard Business Review, July, 56–63.

[9] Flyvbjerg, B., COWI (2004), Procedures for Dealing with Optimism Bias in Transport Planning: Guidance Document, London, Department for Transport.

[10] Wachs, M. (1986), 'Technique vs Advocacy in Forecasting: A Study of Rail Rapid Transit', Urban Resources, 4(1), 23–30.

Wachs, M. (1989), 'When Planners Lie with Numbers', Journal of the American Planning Association, 55(4), 476–9.

their private partners based on a strategy to keep the costs of building infrastructure from appearing as public debt:

- Private companies would appear to put their money at risk to build infrastructure but a high return would be guaranteed by Government even if the benefits did not accrue as estimated at the time of project approval. This binds future populations into paying if tolls, freight charges or ticket sales are insufficient to meet this return. This future liability is not counted as a public debt and allows Governments to claim the private partner was paying for the infrastructure.
- Private companies would not actually put up the money but borrow at low interest rates from the Government which they would only have to pay back once a threshold level of return was reached. The critical element is that government loans to private companies appear as government assets on its books even if they are unlikely to be paid back or earn a farcically low interest rate. It essentially allows publically funded infrastructure to be gifted to a private company. In order to succeed in this strategy the details of the transactions are kept secret on the grounds of "*commercial in confidence*"
- The contracts would specify future benefits which the private partner knew would be lucrative but which were not given a figure and legalese is used to obscure the meaning to outsiders. These benefits varied from leveeing tolls for an extended period, monopoly rights over maintenance – an incentive to build faulty infrastructure, exemption from planning laws enabling the buying and development of associated land, or a government guarantee to take on risks such as flooding or environmental damage.

As with the studies of Flyvbjerg, Murray and Fritjers found that public private partnerships (PPPs) had patronage outcomes which were 40% below forecast compared to 6% above forecasts for publically built infrastructure. While PPPs comprised of consortia of banks, construction companies, investment funds and middlemen including former politicians, many proposals did not come from government. Instead of government responding to need, they have responded to "*unsolicited proposals*" which are actually "*market led proposals*". The consortia, through donations to political parties and other means obtained changes to legislation and the use of government powers to delegate power to the PPP that benefited these consortia rather than in the public interest.

All of this produces economic damage to Australian citizens but wealth to a favoured few. Murray and Fritjers assessed the total damage as $4800 for every household in Australia since 1992. This loss of $42.8 billion is additional to the costs of $60.5 billion for the 38 projects they studied and represents an additional 60% for the cost to the public purse, ie for every dollar spent on infrastructure, the Australian public loses another $0.60 because of these arrangements. This compares very unfavourably with publicly funded projects which returned $1.98 per dollar spent.

This situation can only be reversed by determining what needs actually need to be met and then publically funding the projects that addresses these. It does require a complete model of

[11] Cameron K Murray, Paul Frijtersm Game of Mates: How favours bleed the nation, ISBN 978-0-6480611-0-6, 2017.

options to identify which projects and technologies give the best outcomes for the money spent. Any tendering would need to include a government owned construction company, to stop one bidder or several involving the same groups, acting as cartels and coordinating to charge higher prices. The other change is a requirement in open tendering where the bids and plans are fully disclosed to the public and can be assessed on that basis.

There is a greater need for openness and transparency by government. Business cases for infrastructure should be published in full and include the source of application, cost calculations, risk assessments and vulnerability analyses of any infrastructure project. It should be clear before approval what the externality risks are and who will be paying for them. It should also be made clear what loans are being made by Government to developers or buyers of infrastructure and the long term cost on the taxpayer. Such information can thwart rent-seeking behaviour by consortia at public expense. "*When a government fails to collect a nation's socially created rents such as infrastructure, that revenue stream, a stream created by everyone's endeavours, becomes detached from moral anchorage and can be exploited by anyone in a position to exploit their connections to government decision makers.*"[12]

The committee should note that the business case for raising the dam wall has not been published and the economic justification is not known publically and in particular how externality costs involving loss of life and loss of property have been used in their cost benefit analysis.

Cost Benefit Analysis for Raising the Dam Wall

Warragamba dam currently supplies 80% of Sydney's water from dam resources. The other 20% comes from other dams in the Hawkesbury-Nepean catchment.[13] The desalination plant at Kurnell has capacity to supply 15% of Sydney's daily water requirements.[14] The cost of building the desalination plant was $B1.83.[15] Due to the on-going drought in NSW the desalination plant is currently supplying 15% of Sydney's water and the Government is preparing to double the capacity to 500,000 m^3 per day.[16]

Since the first desalination plant was built, there have been technical advances in desalination systems worldwide which has brought the building cost down by a factor of 4 and have improved energy usage. Further cost and energy reduction by a factor of 5-7 is possible with

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[12] Fred Harrison, Systemic integrity: the Australian model, Chapter 5, Debt Death and Deadweight, The Acts of parliament, Land Research Trust, 2017.

[13] https://www.waternsw.com.au/supply/Greater-Sydney/greater-sydneys-dam-levels

[14] https://web.archive.org/web/20090915004807/http://www.sydneywater.com.au/Water4Life/Desalination/documents/Desalataglance.pdf.

[15] https://en.wikipedia.org/wiki/Sydney_Desalination_Plant.

[16] Sydney's desalination plant set to expand as drought continues, Australian Associated Press, The Guardian, Sun 11 Aug 2019 15.50 AEST.

newer technology.[17] The energy for desalination can come from solar, wind or tidal energy associated with the desalination installation.

For the purposes of this submission, a conservative cost will be taken as a construction cost of $B1.83 and an operating cost of $M54.75 per annum[18] for producing 15% of Sydney's water supply throughout the year. Table 1 shows the daily generating capacity and costs associated with building more desalination plants.

Parameter	No of plants 2	No of plants 5	No of plants 10	No of plants 20
Daily generating capacity (m3)	500000	1250000	2500000	5000000
Sydney Daily Consumption	30.00%	75.00%	150.00%	300.00%
Cost of additional plants ($B)	1.83	7.32	16.47	34.77
Operating costs per annum ($B)	0.11	0.27	0.55	1.10
Total cost over a 30 year lifetime ($B)	5.12	15.53	32.90	67.62

Table 1 Costs of building and operating more desalination plants.

These costs are conservative because current building costs and operating costs are lower than the values I have used.

This is an alternative strategy to raising the dam wall. It has benefits in terms of increasing society's resilience to threat. Building desalination plants along the coast moves the water supply system from one dependent on Warragamba dam to many localised centres. Loss of one can be supplemented by the others and the dam system.

This is also a strategy for increasing the resilience of communities in western parts of NSW in times of drought. Table 1 includes capacity to provide more than Sydney's needs. Consequently excess can be transported across the State to areas of need. Since droughts cause a loss to farming communities, it is clearly a way quality of life in the west of the State can be maintained.

[17] Nikolay Voutchkov, Seawater Desalination – Costs and Technology Trends, Chapter · April 2013, emst115NVProofredJAN282013.pdf, https://www.researchgate.net/publication/278309462.

[18] Based on a figure of $0.60 per m^3 of Water; https://www.sydneydesal.com.au/media/1136/desalination-operating-rules-cie-report.pdf.

In their study of the flood risks to the Hawkesbury- Nepean the government has not assessed all the ways in which flooding and inundation can occur. As will be shown below the costs of this neglect to the communities is high. While I will discuss the mechanism in detail below, the cost of a person's life and cost of loss of building has to be assessed if the cost-benefit of this proposal is to be fully understood.

The cost of losing your life has been put at $M4.2 per person and the cost from losing your life below your life expectancy in terms of productivity lost has been put at $M0.182 per annum. [19] According to the Australian Bureau of Statistics the median age of the population is 37.2 years and the median age of death is 82.1year. This means that an event such as flooding or inundation will cause a median loss of life expectancy of 44.9 years. Therefore the cost of a loss of life from such an event is $M12.37 per person ($M4.2+$M0.182 x 44.9).

The median cost of housing in Western Sydney is $815000 with areas such as Blacktown around $700000 and Hawkesbury/Hills districts at about $925000.[20] The average household consists of 2.6 people. The median rental property market in Western Sydney ranges from $350 per week to $540 per week for a 2 bedroom house or apartment. It would normally take 2-3 years to rebuild after a disaster. Consequently a conservative cost the median cost for loss of a building and providing accommodation will be in the order of $855000 per displaced family over a 2 year period.

To put this in perspective there are 5000 people living below the 1:100 flood level and a further 7000 people currently living below 1:500 flood level.[21] Suppose there is a 1% chance of a death occurring in a 1:100 flood and a 10% chance of loss of housing (this includes damage and temporary accommodation costs equivalent to a complete house) then the cost of this flood to people in the community is $B0.78 and for a 1:500 flood. $B1.88 This very simple calculation does not account for other costs such as loss of vehicles, inability to get to work, loss of bridges and railways that will add to this societal cost. It does show that it would not take much increase in loss of life or property damage to exceed the costs of an alternative water strategy of $B33.

A more detailed discussion of this will be presented below.

The flood risk assessment and proposed flood management of the Hawkesbury-Nepean Valley

The assessment of risk from Warragamba dam did not assess the complete risks associated with flooding from other sources of risk except for those posed by rainfall in the catchment to

[19] Best Practice Regulation Guidance Note: Value of statistical life, Office of Best Practice Regulation, Department of prime Minister and Cabinet, Australian Governemnt, December 2014

[20] https://www.realestate.com.au/australian-property-market/property-report-july-2018/

[21] Managing flood risk in the Hawkesbury – Nepean Valley: A report on the alternative flood management measures to raising Warragamba Dam wall. September 2018, Associate Professor Jamie Pittock,

Warragamba[22]. The assessment of impacts from water in the Penrith/Hawkesbury valley has not considered all risks of flooding and inundation in the valley. The probable maximum flood has been published as 32.8m at Penrith (Victoria Bridge) and 26.7m at Winsor Bridge.

To cause this flood, a peak outflow from Warragamba dam was indicated as 45,000 m^3/s, [23] shown in Figure 3. The diagram shows that the effect of raising the dam wall is to reduce the peak outflow by 5000 m3 per second but prolong the outflow. The consequence of this is that an additional 5000 hectares of World Heritage land will be flooded and the loss of over 300 Gundungurra aboriginal sites. Furthermore more it doesn't mitigate the flood. As Assoc. Prof. Pittock states, "I*t's a surprising result. It really undercuts the argument for raising the dam wall*."[23]

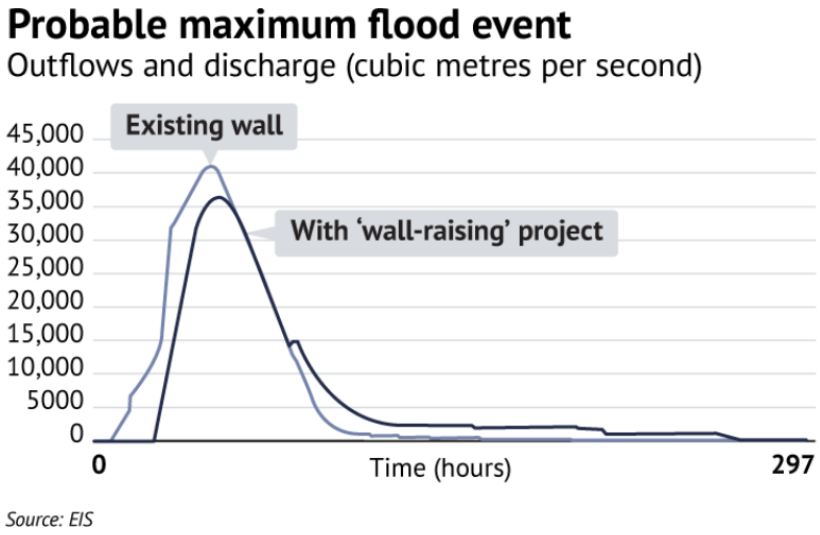

Figure 3 Outflows and discharges for a PMF event from the existing dam wall and from raising the dam wall.[23]

Table 2 shows the outflow under various release conditions for the dam based on standard equations[24]. h is the height of the crest of water over the dam, L is the width of flow perpendicular to the direction of flow, Q is the volumetric flowrate over the dam, y is the height of the wave produced downstream of the dam and V is the flow velocity downstream of the dam.

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[22] (Hawkesbury-Nepean region flood study 2019, hnv-regional-flood-study-final-jul19-vol1-main-report.pdf).

[23] Peter Hannam, Leaked charts 'undercut' case to lift Warragamba dam wall: opponents, Sydney Morning Herald, August 5, 2019 — 12.00am, https://www.smh.com.au/environment/conservation/leaked-charts-undercut-case-to-lift-warragamba-dam-wall-opponents-20190803-p52djf.html.

[24] RM Khatsuria, Hydraulics of spillways and energy dissipators, Marcel Dekker, New York, ISBN 0-8247-5789-0, 2005.

Condition of Water Release	h m	L m	Q m3/s	y m	V km/hr
Overtopping dam for a PMF event without including the spillway amount	14	90	4991	14.7	6.8
Overtopping dam for a higher wall without including the spillway amount	24	90	11332	20.4	11.3
Limited loss of drum gate	40	50	13793	23.7	19.1
Loss of centre gates and drum gate	105	90	113253	50.2	68.0
Loss of dam wall	105	300	377509	69.5	121.3

Table 2 Flow from Warragamba dam under different conditions of release. The dam is treated as a broad crested weir. Note that the first two entries did not include the overflow from the spillway at the dam which would increase the flowrate. The last three entries involve collapse of the dam structure with different areas of outflow.

Table 2 compares the outflow of a raised dam by 14m and 24m respectively to loss of the central drum gate with limited collapse, collapse at the central gates and total collapse of the current dam at full capacity. The wave height downstream which determines the level of flood or inundation in the Hawkesbury–Nepean Valley is at least 3-5 times for collapse of the dam compared to the height of the release of the dam waters with a 14m raised wall. Furthermore the inundation velocity downstream of the dam is at least an order of magnitude greater than occurs with a 14m raised wall. The table does not show the contribution of the spillway to the two flood scenarios. This will increase the flow over that of the table, but the two energy dissipaters built downstream of the dam will cause a flood not an inundation. The failure of part or the entire dam wall will cause an inundation rather than a flood as can be gauged from the difference in flow velocities downstream of the dam.

Table 3 compares the loss of the current dam wall with loss of the dam wall with increased heights of 14m and 24m. Two scenarios are compared; loss of the central gates and loss of the dam wall. The effect of increasing the height of the dam wall is to increase the height of the inundation downstream if the dam is partially or totally collapsed. If the wall height was increased by 14m then this would be approximately 5m increase or 10m if the wall was raised by 24m.

Condition of Water Release	h m	L m	Q m3/s	y m	V km/hr
Loss of centre gates and drum	105	90	113253	50.2	68.0
	119	90	138634	54.3	64.8
	129	90	158077	57.2	59.3
Loss of dam wall	105	300	377509	69.5	121.3
	119	300	462113	75.2	138.6
	129	300	526923	79.1	148.2

Table 3 Effect of partial loss and total loss of dam wall during a flood event compared to the current wall at capacity.

Compare the height, y, to the conditions of the possible maximum flood (PMF) at Penrith which is given as 32m at Victoria Bridge. It is 20m to 45m higher. The inundation level will not be much lower than y because of the mechanics of the water column. It has an effective wavelength of over 100km and can be compared to the inundation caused by a tsunami (wavelength typically greater than 600km). The confluence of the Warragamba and Nepean rivers some 3km from the dam wall will not effect this height but will lead to scouring of the valley walls where they meet and spread at that height in both directions; upstream to Wallacia and downstream to Penrith. The scouring will ensure the inundation contains trees, rocks and other debris, increasing loss of life and building damage downstream of the dam.

The inundation will overcome the 100m datum height of the northern road due to a run-up similar to a tsunami. The inundation will then flow all the way to Eastern Creek and over the Western Sydney airport site, down South Creek to Windsor effecting the housing in Shoefields, Marsden Park and the North West development area. It might also affect the South West development area around Camden. The population affected by this is in the order of 1 million people. Because of the water pressure destroying housing and the timescale over which it occurs – some 40-90 min, there will be limited opportunity to evacuate, the evacuation routes anyway will be inundated and the loss of life will be extremely high. Furthermore Sydney will be without a water supply for 80% of the population for the best part of seven years based on construction times for desalination plants or rebuilding of the dam. GDP for Sydney in 2018 was $B443 or 24,4% of Australia's GDP[25] Loss of water supply for seven years would seriously impact Sydney's ability to provide 75% of the NSW wealth over that time.

The risk that the Berijiklian Government is imposing on the people of Western Sydney is unacceptable from an international perspective. There were a number of risk levels that were originally defined on the basis of the conjoint parameter of frequency of the occurrence of the

[25] https://www.sgsep.com.au/news/latest-news/2018-gdp-report-gap-growth-closing-between-cities-and-regions

hazard and the number of people affected by the hazard. The development on the flood plain over the last five years, and with projected development over the next ten years, makes the collapse of the dam an unacceptable risk. 300,000 Australian Citizens are vulnerable based on the 2016 census and 600,000 based on Government population projections over the next decade without taking account of the Southwestern development area and Western Sydney Airport complex.

Loss of the Dam

Loss of the dam wall was not considered in the Hawkesbury-Nepean flood study. Why this is so should be a line of inquiry by the committee.

The fallacy in the whole approach that has been taken to argue for a heighten dam wall is that it ignores several mechanism by which larger floods and impacts can occur. Collapse of the dam is not discussed and yet engineering texts require assessing the impact of dam failure through mechanical failure and through terrorism.[26]

Mechanical failure occurs mainly from aging of the dam and associated pinnings as well as overflow of the dam wall in a flood event. Warragamba dam is now over 60 years old. Concrete fatigue around steel plates and bars may have weakened the dam wall such that adding to the height can cause increased sideways pressure at the base of the dam that may exceed the failure pressure. This risk is increased during flood events that overtop the dam wall. According to the flood study there is potential for an increase in 24m water pressure at the base. This may be beyond the original design limits. Work in 2006 on the wall and spillway were undertaken, as I understand it, to reduce the risk of this type of event.

The other problem with the dam was its fixing into the west wall of the valley. In 1995 I undertook on behalf of Fairfield City Council a report on the Hazard and Risks Technical Paper 10 published as part of the 1995 EIS for the location of the second Sydney Airport at Badgerys Creek. Technical Paper No 10 was primarily intended as a quantification of the risk of aircraft crashes to the people of Sydney to demonstrate that the siting of a new airport at Badgerys Creek was within acceptable criteria for the land use surrounding the site and that there were no other more suitable sites available that carry less risk. In particular I was asked to comment on the adequacy of the assessment and how any deficiencies would have potential impact on the City of Fairfield and other Councils within the Greater Western Sydney Area. As with the current EIS for the second Sydney Airport, there was a failure by Government to consider known risks of loss or consider viable alternatives. The proposal to build the airport was subsequently cancelled at that time. At the time of preparing the report I was told by a Sydney Water Engineer that the west wall was a point of vulnerability because the fixing into the Hawkesbury sandstone was relatively weak. Again this might have been rectified in the work undertaken to build the spillway.

The other way the dam wall can be collapsed is through terrorism. Terrorism is a major threat which increases the background level of risk of dam collapse. It is currently half the crash

[26] RM Khatsuria, Hydraulics of spillways and energy dissipators, Marcel Dekker, New York, ISBN 0-8247-5789-0, 2005.

rate based on incidents in the Rand database of terrorism.[27] The increase in risk arises from the Federal government decision to build WSA at Badgerys Creek. It is the only place in NSW where building an airport increases this risk. Although CSIRO undertook a study of the effect of an aircraft crash on Warragamba Dam in 1993, it used scenarios involving controlled flight into terrain at 20% and 80% with aircraft that did not have the current thrust in their engines. It did not assess an aircraft effectively at ground level targeting the dam wall, accelerating from commercial speeds to maximum speed for the height above ground. Large freight aircraft have both the thrust and can carry explosives that can bring down the dam wall when the dam is approaching full capacity.

The flight path to land at WSA from the southwest requires a merge point 10 nautical miles (18.52km) from the runway threshold. The distance of this merge point is 12.7km from the dam wall. Other approaches from the north to land from the south west pass nearer to the dam wall (8.2km away). A slight alteration in flight path can line up the dam wall rather than the runway and can hit that wall in 60-90 seconds. This time is too short for the Australian Defence Force to respond in a normal fashion by bringing fighter jets along side to direct the pilot away from the wall. If a guided missile system was operational at Orchard Hills, where they test the Navy's missile systems, which I have been assured is not the case, then flight times to intercept is in the order of 30 seconds. This leaves 30-60 seconds to establish an aircraft was targeting the dam wall and launch. This has to occur from primary radar as the route through Air Traffic Control would take too long. Automated systems without human intervention taking down a passenger plane bring other international risks, especially in downing a passenger aircraft.

If the Government's intent is to prevent catastrophic flooding in the Hawkesbury-Nepean valley as they say,[28] then the reality of ignoring a major source of inundation makes a pretence of this intent. Furthermore the building of an airport at Badgerys creek is hypocritical.

Cost of the loss from flooding

The mortality rate for rapidly rising floods is shown in Figure 4[29] as a function of water depth and gives a good fit to observed data. There is a lack of empirical data for high flood levels associated with dam breaks but the data would tend to suggest the mortality rate tends towards 1. Jonkman also gives average mortality rates for riverine floods and flash floods of 0.0049and 0.036 respectively. It would be expected that normal flooding in the Hawkesbury-Nepean would have these range of mortality rates with larger values associated with larger

[27] RAND Database of Worldwide Terrorism Incidents, https://www.rand.org/nsrd/projects/terrorism-incidents.html.

[28] (Peter Hannam, Warragamba Dam plan stirs World Heritage Committee worry over 'values', 2 July 2019, Sydney Morning herald, https://www.smh.com.au/environment/conservation/warragamba-dam-plan-stirs-world-heritage-committee-worry-over-values-20190703-p523wr.html),

[29] SN. Jonkman, J.K.Vrijling, Loss of life due to floods, J. Flood Risk Management 1 (2008) 43-56.

floods. The loss of the dam, however, would give fatality rates between 0.08 and 1 with larger values associated with larger populations exposed.

Estimates of building damage from floods is dependent on the inundation depth, the land use, the value of elements at risk and the susceptibility of those elements to damage. Examples of the variation of damage with water depth for different areas of Europe are shown in Figure 5.[30] A common feature is that they all tend to 1 for a water depth above 6m. While each area in the Hawkesbury-Nepean would need to be modelled in detail, gross estimates of the cost of damage can come from the number of properties exposed to different floods. Again the damage factor would be expected to increase from small to larger floods and approach 1 for loss of the dam.

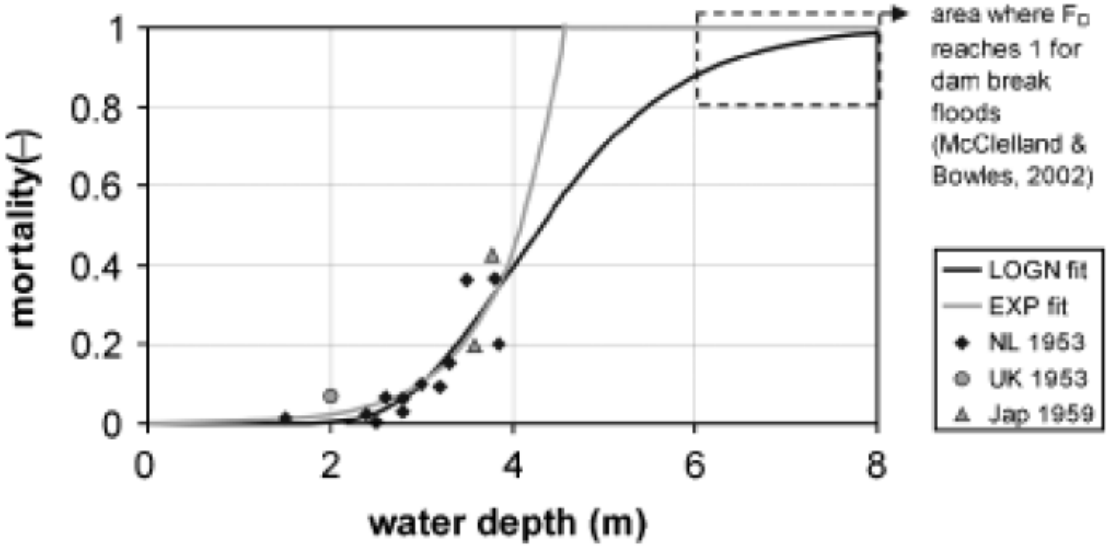

Figure 4 Mortality rate as a function of water depth with rapidly rising waters. Note that this reaches 1 for dam breaks.[31]

From the discussion above the cost of a human life in a flood event is, on average, $M12.37 per person and immediate property loss is $855000 per dwelling lost over a 2 year period.

Table 4 estimates the cost of life lost as a function of the chance of losing a life for different flood and inundation events. The shaded areas are the probable extent of life loss for the different flood events. The probable cost from loss of the dam is 2 to 3 orders of magnitude greater than normal flooding.

Table 6 indicates the range of loss from damage to buildings from different flood events. The number of dwellings has been calculated from the mean size of the population per dwelling.[32]

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[30] H. de Moel, J.C.J.H Aerts Effect of uncertainty in land use, damage models and inumndation depth on flood damage estimates, Nat. Hazards (2011) 58, 407-425.

[31] Cited in 27:DM McClelland, DS. Bowles, Estimating life loss for dam safety risk assessment – a review and new approach. IWR Report 02-R-3-, 2002.

[32] https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/1

Conditions	**Chance of loss of life**	**0.49%**	**3.6%**	**10%**	**50%**
	Number at risk	**Cost of a loss of life $B**	**Cost of a loss of life $B**	**Cost of a loss of life $B**	**Cost of a loss of life $B**
1 in100 flood	5000	0.3	2.2	6.2	30.9
1 in 500 flood	12000	0.7	5.3	14.8	74.2
PMF flood	40000	2.4	17.8	49.5	247.4
Dam Collapse	30000	18.2	133.6	371.2	1855.8

Table 4 Estimated costs of loss of life for the current exposed population

Conditions	Chanceof loss of house	10%	20%	50%	100%
	Number at risk	Cost of a loss of house $B	Cost of a loss of house $B	Cost of a loss of house $B	Cost of a loss of house $B
1 in100 flood	1923	0.2	0.4	0.9	1.8
1 in 500 flood	4615	0.4	0.9	2.1	4.3
PMF flood	15385	1.4	2.8	7.1	14.2
Dam Collapse	115385	106.7	213.5	533.7	1067.3

Table 6 Estimates of building loss costs.

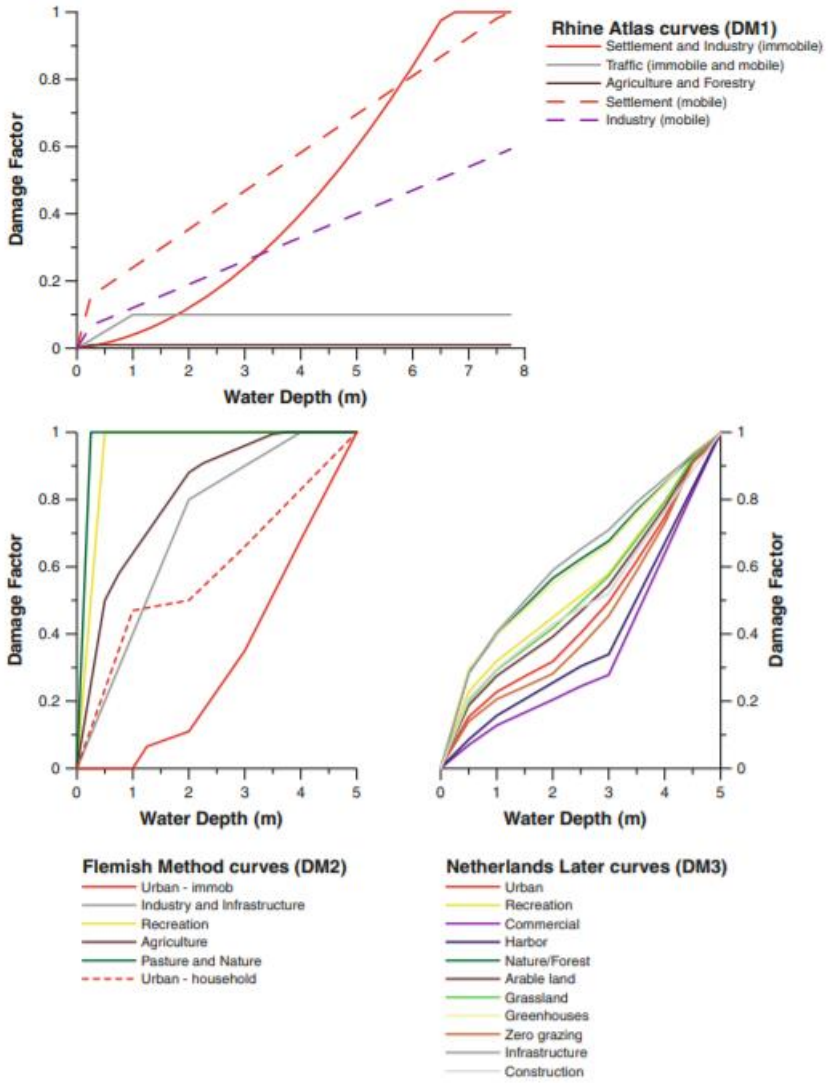

Figure 5 Damage factor for buildings in Europe.

The shaded areas are the probable damage ranges for the different flood types. Again it shows that direct damage costs for loss of the dam is at least two orders of magnitude greater than normal floods expected on the plane. Both the mortality and building estimates do not include loss of animals, loss of business, loss of Sydney's water supply or loss of industry.

Table 7 is a comparison between the cost of life and buildings with the cost of the number of desalination plants operating for 30 years for the different types of flood. It indicates that even with a possible maximum flood, the loss is equivalent to building desalination plants and operating them for 30 years that supplies 150% of Sydney's current water use. Considering a dam loss would suggest that developing desalination technology and operating plants as an alternative to raising the dam wall is a viable and cost effective option.

Conditions	Number at risk	Cost of a loss of life $B	Cost of losses to building $B	Total Loss $B	Equivalent No of Desalination plants
1 in100 flood	5000	0.3	0.2	0.48	0.26
1 in 500 flood	12000	0.7	0.4	1.15	0.61
PMF Flood	40000	17.8	2.8	20.60	10.93
Loss of Dam	300000	371.2	213.8	585.00	310.39

Table 7 Comparison of loss of life and buildings to the cost of building and operating desalination plants over 30 years.

The effect of dam loss can be mitigated to some extent by keeping the dam wall at its current height but lowering the maximum water level to 70% of current capacity. This option would give approximately 25m of additional headspace to cope with the largest inflows reported in the flood mitigation study. Because of this additional headspace the impact of large flood events will be mitigated because it would not require release of water from Warragamba dam. Flooding would therefore only arise from inflows into the Nepean and Hawkesbury rivers via their tributaries.

Decision to Raise the Dam Wall

There has been much discussion in the media regarding the proposal to increase the height of Warragamba dam in the press much of which was misleading. Mike Beard when Premier said in regards to raising the wall 14m, "*This crucial investment is being made so we can reduce the risk to people, animals and property in the event of serious flooding*" [33]. According to the World News today, the NSW government is considering raising parts of the Warragamba Dam wall significantly higher than what they've admitted to publicly. Essentially the wall will be "*structurally*" raised 17m but "operational" at 14m.[34] According to this report the government is not assessing the environmental impacts of raising the wall an additional 3m. Another news publication suggest a raising of the wall by 23m[35]. In that article Prof. Richard Kingston stated "*Building dams on rivers, and, raising dam walls causes incredible ecological damage to the river. It's because they trap the water that is essential for that river system. When you think of a river you tend to think of the main channel but it's a lot more than that. It actually relies on the flood plains, on it's sides, that's where a lot of nutrients come from*."

[33] https://www.smh.com.au/national/nsw/warragamba-dam-wall-to-be-raised-to-avoid-catastrophic-flood-event-20160616-gpkqly.html.

[34] https://theworldnewstoday.com/secret-plan-to-raise-warragamba-wall-17m

[35] https://www.abc.net.au/local/stories/2013/02/28/3700614.htm

There is a perception in the community that the dam is to increase capacity. A view promoted by social media. According to Jo-Ann Davidson, Wollondilly Labour Candidate, "*I think there is a lot of misinformation out there about what this wall-raising proposal means. For instance, people believe this is about conservation of water, which it is not. There is also a perception that raising the wall would reduce insurance premiums for people living in the flood plain, but there has been no confirmation from insurers that that is the case.*" [36]

A well-known political tactic for ensuring limited opposition occurs for a policy is through disinformation, ie the spread of false information to deceive. This is done using a twofold approach. The first is sequential releases of official information that contradicts itself. In the above instance a supposed change in height. By itself it causes confusion. The confusion is compounded by the spread of rumour. Rumour is more easily spread over the last decade through social media that allows anonymous sources to post false information. They don't have to be trolls, who create conflict by making controversial statements with the purpose of causing havoc, but just post conflicting and made up data that cause confusion and can be used politically to counter objection to the policy but pointing to an alternative set of "facts". Often these postings are undertaken by apparatchiks of the proponents. Those opposing are immediately at a disadvantage because they have to counter the disinformation rather than the true facts about a proposal. This causes disinterest in the majority of the population even when the impact directly affects them.

It is clear that the current State Government have gone down the route of disseminating misinformation. I say this because the documents in the public domain do not make a coherent case for this proposal and risk the declassification of the Blue Mountains World Heritage Area by UNESCO, as well as destroying more than 300 aboriginal heritage sites, and that allows building on the flood plain in areas that put at risk the lives of those buying those properties.

Building Criteria are Inadequate for Flood Plain Management

The Government has proposed raising the dam wall based on the flooding risk to people in the Hawkesbury-Nepean valley. The studies that have been done use a 100 year return period as a demarcation for building. This ignores larger floods that can occur and put people in harm's way. In Holland for instance, the level varies according to the type of land. Where levees or dykes are used the planning demarcation is 1 in 250 years where the population density is low and 1 in 10,000 years where the population density is high. A level of 1 in 2000 years is used near tidal rivers and 1 in 1250 years for the majority of rivers and 1 in 250 years in the upper reaches of the Meuse river.[37] In the UK the building criteria are based on zones, where unrestricted building is allowed in zone 1 corresponding to flooding of less than 0.1%AEP. No building is allowed in areas where the risk is greater than 1% AEP.[38]

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[36] https://www.giveadam.org.au/warragamba_dam_wall_raising_forum_draws_interest.

[37] Richard Jorissen, Erik Kraaij and Ellen Tromp, Dutch flood protection policy and measures based on risk assessment, FLOOD risk - 3rd European Conference on Flood Risk Management , 2016, https://www.e3s-conferences.org/articles/e3sconf/pdf/2016/02/e3sconf_flood2016_20016.pdf

[38] https://www.ses.nsw.gov.au/hawkesbury-nepean-floods/

The reliance on a 1 in 100 year flood (1%AEP) as the sole criterion for building residences is clearly inadequate. It strongly suggests that opposition to changing this criterion has been from developers for the North West and South West Development areas as well as for Western Sydney Airport. Note that the 1in 10000 years adopted for high density populations in Holland, would preclude building the North West Development area. Note also that the Hawkesbury river is tidal to Windsor. A level of a 1in 2000 year flood would be a more reasonable criterion. The river is constricted at Sackville which prevents water escaping during flooding but does not prevent the effects of high tide and storm surges on increasing the heights of flood.

With climate change and less frequent but heavier falls of rain the validity of using a 1 in 100 year return period (this is calculated as 1% of the annual exceedance probability or AEP) is questionable as the original criteria is a 1 in 20 year flood. While the new flood study published in July uses a Monte Carlo Bayesian method for estimating the extent of flooding from climate change, there is no indication that the status quo has been treated the same. There are no anomaly graphs that show the difference in flooding between the status quo and the options for increasing the dam height.

The fallacy in the whole approach that has been taken to argue for a heighten dam wall is that it ignores several mechanism by which larger floods and impacts can occur. Collapse of the dam is not discussed and yet engineering texts require assessing the impact of dam failure through mechanical failure and through terrorism.[39] Dam failure has been fully discussed above in this submission.

Furthermore the effect of development on increasing the runoff has been largely ignored. The impact on increased runoff from development from areas of increased building has not been taken into account in the recently released Nepean-Hawkesbury study. Water runoff from development within the Hawkesbury–Nepean catchment is a major concern. Runoff is much higher from developed areas of land than from natural runoff. There is anecdotal evidence that where new estates have been developed, flooding occurs into older property from runoff. While development areas are landscaped to provide areas for water runoff, they are only designed for a 1% AEP (1 in 100 year flood). They will not retain water from larger rainfall events. Because larger rainfall events can occur quickly, overtopping of these holding areas contribute to flood levels.

Development covers the whole of the Nepean-Hawkesbury basin and different areas differ in the way it impacts the catchment:

- Development in the upper Blue Mountains and east of the central ridge covering most of the townships impact on the prediction of water heights in the dam catchment area. Those in the Lower Mountains and to the west of the central ridge increase the flows into the Nepean and Grose rivers.
- Runoff from development in the area around Camden which is due to house 200000 properties of the south-western development area in the next decade flow into the Nepean river, South creek and Prospect dam.

[39] RM Khatsuria, Hydraulics of spillways and energy dissipators, Marcel Dekker, New York, ISBN 0-8247-5789-0, 2005.

- Runoff from the area around the Nepean valley in Penrith directly flows into the Nepean river. The runoff east of the northern road at Penrith flows into South Creek and then into the Hawkesbury river.
- Runoff from the North West development area directly flows into South Creek and into the Hawkesbury river.
- The runoff from building in the Kemps Creek area around Kemps Creek and Leppington flows into Kemps Creek and then into South Creek and Hawkesbury river.
- The runoff from building in the Kurrajong, Glossodia and Colo Heights, designated by Hawkesbury council as areas of development, flow into the Colo river and then into the Hawkesbury river.

The non-inclusion of the effect of water flows from urban areas for more extreme periods of rainfall has a profound effect on prediction of flows in the wider catchment areas and into the tributaries, increasing flash flooding in newly urbanised areas.

Assessment of the impact on Aboriginal Heritage

The Gundungurra Aboriginal Heritage Association and Gundungurra elders, who represent the traditional lands affected by the dam proposal, say Infrastructure NSW and its consultants have declined to fulfil the archaeological methodology for the EIS.[40]

The process undertaken by Infrastructure NSW to assess the impact on Aboriginal Heritage was unethical and immoral. The Gundungurra people have traditionally been the stewards and custodians of this area of Australia. The elders have had their DNA assessed and discovered that they are part of the first wave of peoples to come to Australia from Papua New Guinea along with those in the Northern Territories.[41] Archaeological evidence of this first wave has been dated as 87000 years ago although there is still some discussion amongst archaeologists as to whether it was as late as 70,000 years ago. This timescale should be compared to 200 years of white colonial settlement.

In 1957 part of their land was flooded by the construction of Warragamba Dam destroying communities as well as historical revered places. It is a community who have already lost significant sacred places and this proposal will destroy 300 more sites.

The Gundungurra people were not consulted at any stage in the EIS but told who would assess their Aboriginal heritage; people who were not known to them and whom they would not have chosen if they had had proper consultation. This is indicative of a Government intent on imposing a solution on communities rather than through proper bidirectional consultation.

It has taken 12 years for the Gundungurra people to survey 23% of their land for artefacts. The people engaged by Infrastructure NSW said they assessed the land that would be affected by a raising of the wall by 14m in five 5 days of field work. There are over 300 places of interest, according to the public meeting at Faulconbridge Community Hall, 16 August 2019,

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[40] SBS News, Indigenous elders oppose Warragamba plan, 7 June 2019, https://www.sbs.com.au/news/indigenous-elders-oppose-warragamba-plan.

[41] Private communication from Kazan Brown, Gundungurra elder.

all were described as insignificant in the draft EIA that the elders received from Infrastructure NSW.

There is no way that they can **all** be described as insignificant.

First this ignores the loss of culture by the construction of the dam in 1957. Any assessment would place a greater significance on subsequence loss. This can be equated to loss of the Blank-flanked Rock Wallaby, the eastern curlew, the Gouldian Finch, the Northern Quoll, or the Black–footed tree-rat, all of which are endangered with extinction in Australia, all of whose habitats have been gradually destroyed. The first flooding, even though this is considered periodic by the EIS, will destroy significant heritage items, particularly rock art. There is a great deal of difference from a heritage perspective between 100, 250, 500, 1000, 2500, 5000, 10000, 25000 and 50000 years old. It changes how modern man perceives the past. Yet there were no date determinations of these artefacts – the age of many of the cave paintings could be easily established by modern diagnostic techniques. There were no archaeological digging of trenches to establish whether there were artefacts under the surface indications. To quote Eugene Stockton in his co-authored book, Blue Mountains Dreaming 2nd Edition, "*Aboriginal sites now found at the same ground level may give a false impression of contemporaneity, but it is up to stratigraphic excavation to reveal their true depth through time*." Clearly a survey taking 5 days cannot and will not yield a true representation as to their significance. It is a Clayton's exercise to tick a process box.

Furthermore the Government have failed to investigate the discovery of bone material in a known burial ground of the Gundungurra people.[42] It is relatively easy to establish whether it is human and to extract a carbon 14 date with modern technology. DNA material if not degraded may be extracted to establish whether it belongs to an ancestor of current Gundungurra people. This failure is a clear signal of disinterest for engagement with the Gundungurra community.

Second, the places within the landscape form a network of interconnections that are related to their song lines and asterisms and are significant both in terms of their creation myths and in food in the landscape at different times of the year. It is these interconnections that are important just as much as the individual locations. The significance of these interconnection cannot be understood without archeological study of all the sites in the area and an anthropological assessment of how and why they are connected. Again this cannot be achieved in 5 days. This failure to recognise why interconnections in the landscape are important is another indication of process ticking rather than proper engagement with the community.

Third my experience in risk assessment of industrial processes and in particular of catastrophic outcomes would suggest that the assessment is pre-defined according to what outcome the Government wants. I have seen this in many risk assessments that use a subjective matrix for assessment rather than quantitative data. For example, the ability to kill a person is downplayed on the excuse that it is too low a probability of occurring. This

[42] Kathleen Calderwood, Call for identification of mystery bone found in burial ground near Warragamba Dam, ABC News, 20 Mar 2019, https://www.abc.net.au/news/2019-03-20/bone-found-at-warragamba-dam-sparks-controversy/10917860.

proposal puts the lives of some 300,000 or more on the flood plain directly at risk. This level of potential life lost is unacceptable and prior to introduction of the State Significate Development planning laws in 2011 would automatically have been stopped through the planning requirements for Major Hazards Sites as Warragamba is a Major Hazard site due to the potential for killing significant numbers of Australian Citizens from collapse of the dam.

The introduction of State Significant Development legislation allows State and Federal Government (through funding mechanisms) to circumvent local planning processes that ensure development is in line with community expectations. As such it is easily hijacked by developers through political party donations and delayed benefits to decision makers at the expense of taxpayers.[43]

The approach by Government to get a "done deal" also requires politicisation of the Public Service against the public good. A process that has been made much more easily over the last decade by downsizing the specialists within the public service, with an increase in private consultancies often owned by large international companies. These companies are there to make a profit and rely on further work from Government, consequently the studies cannot be independent.

Impact of raising the dam wall on the Blue Mountains World Heritage Area

Australia has 16 natural world heritage listed sites. The Blue Mountains World Heritage area consisting of 1.03 million hectares of sandstone plateaux, escarpments and gorges dominated by temperate eucalypt forests, is listed for its biodiversity, rare flora and indigenous sites. Both their rich biodiversity and their World Heritage Area status are strong drivers of tourism, ecotourism and associated economic benefits.

The Eucalypt forests are very important for the conservation of biodiversity. They provide habitat for many forest-dwelling and forest-dependent species of plants and animals. This includes numerous species that are endemic to Australia, and species listed as threatened under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.

The Blue Mountains National Park has the highest visitation of any National Park in Australia, more than 4 million visitors per annum, due to its accessibility and impressive natural features. [44] More than 2 million visitors per annum are estimated to converge on Echo Point (Three Sisters), with the next popular attraction being Scenic World with 850,000 visitors.[45] An estimated 1.25 million visitors per annum[46] physically undertake a bushwalk. The majority of recreational visitors are day trip visitors and the most popular activities are

[43] Cameron K Murray, Paul Frijtersm, Game of Mates: How favours bleed the nation, ISBN 978-0-6480611-0-6, 2017).

[44] (Source: National Parks Wildlife Service statistic cited in BMEE-Tourism-Industry-Profile-2015.pdf/

[45]Scenic world statistics, Cited in BMEE-Tourism-Industry-Profile-2015.pdf/

[46] Tourism Research Australia statistics, Cited in BMEE-Tourism-Industry-Profile-2015.pdf/

dining, bushwalking, abseiling and canyoning.[47] Tourism accounts for 13% of jobs within the Blue Mountains adding some $M220 per annum to the local economy.

The proposal to raise the dam wall will physically impact on 5000 hectares but the alterations to the landscape will leave visible scars that can be seen from many of the clifftop vantage points and destroys habitats for water dependent flora and fauna.

According to the Guardian a leaked report indicated "The proposed increase in inundation levels … would result in permanent environmental changes to the ecosystems and ecology of these areas."[48] In the same article, the Minister for Western Sydney states that the reason for raising the dam wall is to "*reduce the existing risk to life and property on the Hawkesbury-Nepean floodplain. The final decision to raise the wall has not yet been made and will only take place after financial, environmental and cultural assessments have concluded. While there will be environmental impacts from temporarily holding flood water from behind a raised dam wall, they must be measured against the social and financial impact a catastrophic flood would have on Western Sydney communities.*"

In response the NSW opposition environment spokeswoman, Penny Sharpe, said the dam plan was driven by a "*rapacious development agenda*" and should be abandoned. "*Instead of improving flood evacuation routes in the Nepean Valley, the real agenda here is for the government to open up more urban development to house an extra 134,000 new residents on the floodplain.*"

Harry Burkitt, from community group Give a Dam, said "*The world heritage area impacted is more than 4.5 times Sydney's CBD. More than double what Minister Ayres has admitted to parliament and the public. The world is watching Australia, and the federal government needs to act and stop this developer driven dam project. It would be nothing other than a national disgrace if the Australian government approved the dam and the Blue Mountains lost its world heritage status.*"

UNESCO is considering altering the status of this area because of the threats from the raising of the dam wall and the building of WSA. In its July meeting in Azerbaijan, UNESCO's World Heritage Committee stated that raising the dam wall would "*likely impact on its outstanding universal value*". That committee has asked Australia to provide an environmental impact statement for it to review before any decision is made.[49]

Outstanding Universal Value is the central idea underpinning the World Heritage Convention. It is something which transcends time, place on earth and culture. Once lost it is lost forever. Small impacts can have a large consequence on this value. It needs to be protected for our grandchildren and their children in the same way as the Gundungarra have protected there land for millennia and wish to protect what is left for future generations.

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[47] Blue Mountains Lithgow Oberon Tourism Destination Management Plan, 2013, cited in BMEE-Tourism-Industry-Profile-2015.pdf/

[48] Naaman Zhou, Blue Mountains wilderness would be 'permanently' changed by raising dam wall, leak reveals, Thu 13 Jun 2019 18.50 AEST,Last modified on Fri 14 Jun 2019 10.42 AEST.

[49] Lisa Cuningham, Dam wall raising 'incompatible' with World Heritage status of Blue Mountains: UNESCO, Blue Mountains Gazaette, JULY 4 2019 - 4:00PM

The impact on the World heritage can be avoided by considering other options. Lowering the water level and providing desalination is an obvious solution.

The adequacy of the Environmental Impact Assessment process to date

The draft report has not been published although made available to Gundungurra elders, with threats of a $40000 fine against them if they released aspects of the report (the committee should note the degree of bullying – another sign of a Clayton's consultation process with the elder community). The assessments rely on the reports of Molino Stewart Hawkesbury-Nepean Flood Damages Assessment: final Report (2012) and the Hawkesbury-Nepean region flood study 2019. Unfortunately these assessments do not include all mechanisms by which flooding in the Hawkesbury Nepean basin can occur. The most significant impact is from collapse of a dam wall on the Nepean river system. These include Warragamba dam (2027 Mm^3), Avon dam (146.7 Mm^3), Cataract dam (97 Mm^3), Cordeaux dam (93 Mm^3) and Nepean Dam (68 Mm^3). While Warragamba dam would have the largest impact, the other dams would have inundation impacts on the Camden, Campbelltown areas including the South West Development area.

In these assessments the 1%Annual exceedance probability (AEP) is used as the standard demarcation for building housing and industrial sites. The 2019 regional study increase the levels of flooding compared with the 2012 report of probable maximum flood is estimated based on projected rainfall in the catchment. According to the report the rainfall is increased by a third to account for climate change. While a Bayesian approach to modelling has been used for rainfall in the catchment there is no indication in the publication as whether the one third increase is really a true indication of future rainfall given that rainfall patterns cannot be predicted with any accuracy and that rainfall projections from extreme events are even more unreliable.

Since this is about flood mitigation form Warragamba dam, the question that should be asked is what rainfall in the Warragamba catchment is needed to overtop the dam and cause collapse of the dam. This is the extreme event that I would have expected to have been analysed. The reason for this is because there are engineering limits to how much pressure the dam wall can stand with an overtopping incident before it collapses. The conditions can then be found across the catchment which would cause this event to occur. These conditions include rainfall and the time interval for the rainfall to occur. A Bayesian approach would quickly help to establish a ring fence around conditions that can cause this extreme event. Only then is it compared to rainfall events across the catchment to understand how extreme an event it actually is in terms of historical data and future predictions. I could not find a reference to this type of study.

The effect of sea level rise is not adequately covered. The level of effect is dismissed as "*Sea level rise impacts on the 1 in 100 AEP are largely confined to the lower reaches of the river.*" The highest and lowest tides in Sydney vary by 2m daily.[50] This suggests that whatever the sea level rise due to climate change is, then 1m has to be added to the level to get the high

[50] https://tides4fishing.com/au/new-south-wales/sydney.

tide maximum. Similarly a storm surge will also increase sea level of 0.5m or more and it will prevent outflow from tidal rivers such as the Hawkesbury. Consequently an increase of 1.5m above sea level rise needs to be considered from a risk perspective.

The 2013 IPCC5 study on Sea level rise, coordinated by John Church, CSIRO, indicates that a rise of between 0.8m and 1.2m can readily occur by the end of the century.[51] . This publication shows that the rise in sea level predicted by previous IPCC publications has always followed the highest predictions. This indicates that there is still considerable uncertainty in exactly how quickly sea levels will rise.

A recent paper on long term sea level rise if current carbon emissions continue unabated states that sea level rise will be of the order of 54m [52]. While this is looking at 2000 to 10000 years into the future, the impacts will be locked in over the next 50 to 100 years.

A Delphi technique can be used for assessing risk. This involves obtaining views from a group of experts who independently assess estimates and give their assumptions. A poll of researchers engaged in sea level and ice field science concluded that 80% expected sea levels to rise by 0.8m by 2100 with about 17% expecting greater than 2m rise and 1% a 7m rise in the same timescale assuming a business as usual scenario with no or little mitigation[53]. There is a 50% probability that sea level rise will exceed 2.5m by 2100. It implies that there is at least a 50% probability of a 1m rise by 2060. Calculations based on the 2013 paper on Ice melting in the Antarctic would suggest that 1.4m of sea level rise has already been locked in by the year 2100[54]. A recent paper also suggests that the sea level rise will be greater than 2m by the end of the century when surface melt together with bottom ocean warming mechanisms for ice loss in the Antarctic are added to climate model[55].

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[51] Church, J.A., P.U. Clark, A. Cazenave, J.M. Gregory, S. Jevrejeva, A. Levermann, M.A. Merrifild, G.A. Milne, R.S. Nerem, P.D. Nunn, A.J. Payne, W.T. Pfeffer, D. Stammer and A.S. Unnikrishnan, 2013: Sea Level Change. In Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[52] Clark PU, Shakun JD, Marcott SA, Mix AC, Eby M, Kulp S, Levermann A, Milne GA, Pfister PL, Santer BD,, Schrag DP, Solomon S, Stocker TF, Strauss BH, Weaver AJ, Winkelmann R, Archer D, Bard E, Goldner A, Lambeck K, Pierrehumbert RT, Plattner GK, 2016, Consequences of twenty first century Policy for multi-millennial climate and sea-level change, Nature Climate Change, Advanced online publication, 8 Feb 2016

[53] (Horton BP, Rahmstorf S, Engelhart SE, Kemp AC, 2014, Expert assessment of sea-level rise by AD 2100 and AD 2300, Quarternary Science reviews 84, 1-6. Bamber JL and Aspinall WP, 2013, An expert judgement assessment of future sea level rise from the ice sheets, Nature Climate Change, Vol 3 424-427, April 2013

[54] Green A, 2015, Submission on the Environmental Impact of Badgerys Creek airport, 17/12/2015.

[55] (DeConte RM, Pollard D, 2016, Contribution of Antarctica to Past and Future Sea-level rise, Nature, vol 531, 591, 31 March 2016).

If it is assumed that 1m sea level rise occurs by 2060 and that a flood will only occur during a period of heavy rain associated with an East Coast Low cantered off Sydney then it would be expected that storm surges and high tides would lead to a sea level 2.5m above current sea levels. Figure 1 shows the extent of flooding in the Nepean-Hawkesbury basin for a 2.5m sea level rise produced from http://coastalrisk.com.au/viewer. Superimposed on this Figure is the approximate location of the North West Priority Growth Area. It spans the flood plain especially south creek. A 1% AEP flood would be increased under these circumstances compared with the flood study. It will also increase the height of more extreme floods.

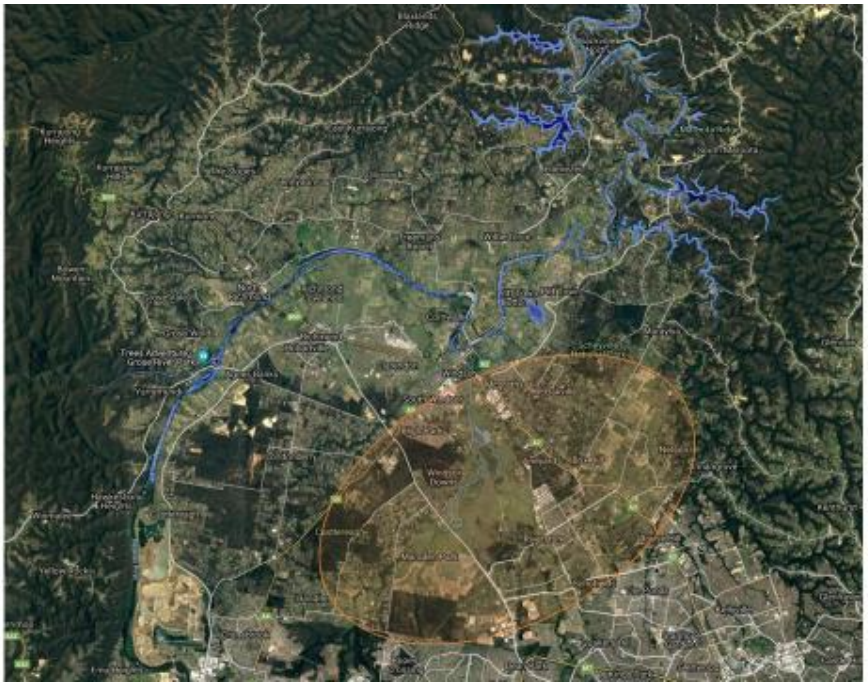

Figure 1 Flooding form a 2.5m sea level rise. This arises from two alternative scenarios. First is a 1m sea level rise with 1.5 m store surge/high tide. This has a 50% probability of occurring by 2060. Second is the mean sea level rise of 2.6m by 2060. This has a 1% probability of occurring by 2060. A storm surge and high tide on this increases the level by a further 1.5m. The approximate area of the North West Priority Growth area is shown in orange.

Conclusions and Recommendations

The proposal to raise the dam wall at Warragamba is being driven by aggressive and predatory development in Western Sydney supported by both the NSW and Federal Governments.

The argument that raising the dam wall is to increase resilience of communities downstream of the dam by protection against flooding is false. Resilience against threats only occurs when communities work together with Government. It is also a flawed logic as resilience to flood has to assess all mechanisms of causation of flood events. In this case Government has cherry picked one mechanism of causation as a means to persuade the community that destroying the Cumberland Plain and the Hawkesbury-Nepean flood plain is safe when it is not. Government have only taken the investors and developers version of what is required and not the view of communities that are within the catchment area. The true importance of the World Heritage Area as a future resource for the community, to NSW and Australia is downplayed as unimportant. The loss of Aboriginal Heritage is considered inconsequential.

The committee has to recognise that there is widespread anger in the community regarding the way Government imposes these types of infrastructure proposals on communities and is seen as corrupt behaviour by Government Ministers with Private Investors. In particular State Significant Planning Legislation takes away community involvement in the early stages of planning development and allows the Minister to override community objection later when a project does not align with the way the community wants to develop.

Warragamba dam and its water catchment is one of the 10 categories of National Security Infrastructure that is deemed at risk from acts of terrorism. The social, heritage, political, economic and environmental attributes form a set of complex interdependencies surrounding the dam environment. The raising of the dam wall has to show how it properly affects all of those dimensions and that none are socially unacceptable while provide increased resilience to the communities affected by this proposal.

It is my submission that the raising of the dam wall does not build resilience for Sydney, NSW or Australia, but increases the vulnerability of the population to unnecessary and avoidable risks.

There is a greater need for openness and transparency by all levels of government if communities are to be resilient. Government hiding behind "*commercial in confidence*" encourages distrust of government motives. The current anger and mistrust in western democracies towards government is detrimental to resilience and in the extreme leads to anarchy rather than order. Lack of openness leads to authoritarianism and repression rather than consensus required in a democracy.

EIS and Business cases for infrastructure projects should be published in full and as they are being developed. This should include the source of application, cost calculations, risk assessments and vulnerability analyses for any infrastructure project. It should be clear to the public before approval what the externality risks are and who will be paying for them. It should also be made clear what loans are being made by Government to developers or buyers of infrastructure and the long term cost on the taxpayer. Such information can thwart rent-seeking behaviour by consortia at public expense.

The committee should note that the business case for raising the dam wall has not been published and the economic justification is not known publically, in particular how externality costs have been used for their cost benefit analysis.

My submission is that the committee should recommend that the draft EIS and Draft Business cases together with the original papers requesting this proposal, cost calculations, risk and vulnerability assessments be published together with assessments of who will pay for externality risks.

The committee should also recommend the final EIS and final Business case be published with all the supporting cost benefit papers including how externality costs are to be handled.

The approach taken by Government to raise the dam wall ignores mechanisms of failure of the dam wall. Any engineering text books on Dam structures state that in addition to overtopping of the dam wall to cause failure other mechanisms including aging of the structure, maintenance routines on the dam and terrorism need to be assessed. Simple calculation based on standard equations for flow over a weir indicate that loss of the centre gates on the wall or collapse of the dam wall will result in a wave 50 to 70m lasting between 40 and 90 minutes moving onto the Hawkesbury-Nepean flood plain. The force in this wave is enough to overcome the 100m datum of the Northern road at Penrith and at Bringelly. The population exposed to this inundation is currently approximately 300000 which will rise to at least 600000 in the next decade because of the intent by Government to house an additional 1.5 million people in Western Sydney by 2026.

The death toll will be between 10% and 100% of the population based on floods risk studies worldwide and dependent on the time of day it occurs. Between 20% and 100% of buildings will be lost also based on worldwide risk studies. The SES have drawn up and published plans for flood evacuation but there seem to be no published plans for this type of inundation. Ignoring such inundations indicate that the State and Federal Governments are prepared to accept the loss of life to Australian Citizens and the damage caused including Sydney being without water for at least seven years. I believe that communities in Sydney would find this type of decision making abhorrent and demand to know why it was made.

The building of Western Sydney Airport has made collapse of the dam much more likely from terrorism as the Southwest approach from International flights is too close to the dam wall. The Australian Defence force cannot react in time to stop a freight aircraft packed with explosive from accelerating into the dam wall and causing collapse. As Security authorities here know, it is quite easy to provide falsified entries in manifests of goods destined for Australia that are only discovered on arrival. Furthermore, the trialling of Unmanned Aerial Vehicles (UAVs) for freight aircraft using current commercial aircraft suggests that over the next decade these types of flights will become routine. There are risks associated with computer and satellite technology which can easily allow a compromised flight and these mechanisms are not well understood.

There are several large dams, including Warragamba, where dam failure will affect large populations. The SES as the response agency are responsible for developing plans that can smoothly bring in associated emergency agencies as required and can scale the response to National level if the scale requires it.

The SES on their web pages say they are doing research into planning for collapse of dams. [56] The papers that this page refers to, however, are at least 20 or 25 years old. It is important that these are brought into the present. Modern simulation techniques can give realistic answers to an inundation event with evacuation to enable planning of a response to these extreme evens.

It is a recommendation that the SES develop and test plans for a dam failure of all the major dams in NSW if they have not already done so.

A simple cost-benefit analysis on the cost of loss of life and rebuilding (that does not include the cost of business interruption or loss of water supply to Sydney) demonstrates that investing in desalination plants along the coast and maybe tidal rivers increases resilience in water supply.

This solution increases the resilience of Sydney to Water shortages. It also moves the supply away from reliance on one major source; Warragamba dam. Building them at different places along the coast or in tidal estuaries ensures that if one is temporarily lost the supply can be made up from the other plants and the dam system.

This solution also allows the water level in Warragamba dam to be lowered by 30m which allows communities downstream of the dam to be safeguarded against extreme flooding. Flooding would be only from areas outside of the Warragamba catchment which would not give rise to the probable maximum flood that would occur by raising the dam wall.

The lowering of the dam water level also lessens the risk of flooding from a terrorist attack as there is less water in the dam and the lower portions of the dam wall are not being subjected to their full bearing load from the water head and the dam is thicker. While an attack will still bring down the dam wall, the outflow will not be as great compared to it being full.

The lowering of the water level to 30m below capacity will ensure that the Blue Mountains World Heritage status is not endangered and that the rich aboriginal heritage in this area of the Blue Mountains will not be harmed.

The use of a combination of desalination plants and lowering of the water level in Warragamba and other dams increases the resilience of communities in Sydney. As long as extra capacity is built into the desalination system it can be used in times of drought to supply water to the west of the state thereby increasing the resilience across the State.

It is my submission that other options are available that do increase resilience for Sydney NSW, and should be enacted. This includes developing desalination technology which has come a long way since the first desalination plant was built in Sydney as well as lowering the dam water level by some 30m.

It is my submission that the long term risk of a terrorist over the lifetime of the dam needs to be addressed. The risk is increased by ever increasing technology, the uncertainty of political factors, the increased development on the flood plain over the lifetime of the dam and the attractiveness of the target which causes far more devastation than, for example, a cyber-attack.

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[56] https://www.ses.nsw.gov.au/about-us/research/

It is clear that the current State Government have gone down the route of disseminating misinformation. I say this because the documents in the public domain do not make a coherent case for this proposal and risk the declassification of the Blue Mountains World Heritage Area by UNESCO, as well as destroying more than 300 aboriginal heritage sites, and that allows building on the flood plain in areas that put at risk the lives of those buying those properties.

It appears to be driven by the overdevelopment of Western Sydney, that is being pushed through government bodies such as Infrastructure NSW, Infrastructure Australia, the Sydney City Commission by lobbyists, developers and rent seekers. This top down approach is destroying communities in the name of greed and preys on the vulnerability of citizens rather than building resilience and sustainability.

The use of the 1%AEP as a universal indicator of safe housing is laughable. Floods above this level have occurred and will continue to occur. It provides a false narrative for government, developers and rent seekers that endangers the lives of people.

Standing committee on State Development reported last year.[57] Recommendation 2, "*That the NSW Treasury make such calculations public after projects are refused or contracts are let for all regional areas in order to allay community concerns*", goes to the heart of community concerns about lobbying and corruption in the State .

It is recommended that if a serious counter to the lobby industry and corruption in development projects is to be minimise, then Treasury should publicly release calculations, risk assessments and the externality risks and who will pay with ongoing projects before contracts are let.

The damage of the Aboriginal Heritage and culture in the Blue Mountains is not justified in the proposal to raise the dam wall. Recommendations of the Standing Committee on State Development included, "*That the NSW Government, in partnership with Aboriginal peoples and Aboriginal enterprises, invest in developing, delivering and promoting comprehensive Aboriginal tourism strategies*", and, "*That the NSW Government, when developing regional economic strategies for Aboriginal communities, include genuine consultation and involvement of local Aboriginal communities*."

The process which has been undertaken to assess the impact was immoral and does not accord with the principles outlined by the Standing Committee on State Development. The assessment was a token assessment designed to ensure the project proceeds.

I submit that the assessment of the impact of raising the dam wall on Aboriginal Heritage and Culture is invalid and not aligned to good development of resilience for Blue Mountains communities.

[57] The NSW Legislative Council, Standing Committee on State Development: Regional development and a global Sydney, Ordered to be printed 7 June 2018

I recommend that funding be provided to undertake proper scientific archaeological and anthropological study of the 300 or so sites identified by independent experts recommended by UNESCO in partnership with the local Gundungurra community.

I also recommend that the water level in Warragamba dam be lowered by 30m to ensure that Gundungurra land is not impacted in the future and is there for future generations.

The Blue Mountains World Heritage area is unique and deemed to be of outstanding universal value by UNESCO. The assessment of the impact of raising the dam wall goes much further than the 0.5% of the World Heritage Area lost by this proposal. The proposal does not provide sustainability as it is the leading edge of development that will gradually erode the land area.

UNESCO in diplomatic terms has already stated that they are reviewing its status because of this proposal and the building of Western Sydney Airport. This would be a great economic loss to the Blue Mountains community who rely on tourism and ecotourism.

I submit and recommend that the Blue Mountains World Heritage area be universally protected from development and that area adjoining the World Heritage Areas be assessed to extend the World Heritage Area.

I also recommend that the water level in Warragamba dam be lowered by 30m to protect the existing Blue Mountains World Heritage Area.

There were a number of technical issues that arise from the methodology used for assessing the height of floods apart from failure to consider the loss of the dam.

The treatment of water runoff from newly developed areas seems to be inadequate and would lead to under predicting of flood levels.

The full effect of climate change was not evaluated. In particular the change in runoff because of loss of fauna due to bushfires was not assessed. This can cause localised flash flooding within the catchment that alters the flows into Warragamba dam or other rivers. While an average effect of sea level change was discussed, the uncertainties associated with predicting this with storm surge and tide variation would suggest that a 72 hour storm causing flood would be higher than predicted. The rainfall for a storm event is predicated on a 30% rise in rainfall compared to current statistics. While this might be the average increase extreme storms are expected to be more intense with more intense East Coast Lows forming in the future.

I would recommend improvements to the modelling to include the effects of development on localised flooding and runoff, and the effects of bushfire on runoff. The other conditions of climate change can be done by changing boundary conditions within the current model.