Warragamba Dam Raising Project SSI-8441
Submission by Ted Woodley[1]

17 December 2021

I wish to register my objection to the proposed raising of Warragamba Dam (the "Project") and give my permission for this submission to be made public.

I well appreciate the massive, intractable problem of flooding in the Hawkesbury-Nepean Valley ("Valley"), which is devastating for people, property and the environment. Worse still is that the frequency and intensity of flooding is likely to increase with climate change.

Development on the flood plain should never have been allowed in the first place. Unbelievably, 200 years later further irresponsible development is mooted and in fact will be revitalised by raising the Dam.

As concluded by the Hawksbury-Nepean Valley Flood Mitigation Taskforce (2014), there is no solution to flooding, just a number of options that can mitigate the impacts through better risk management, preparation and response.

Raising the height of Warragamba Dam would mitigate downstream flood damage. But it would result in further unacceptable environmental damage through regular inundation of vast areas of upstream wilderness, including the Greater Blue Mountains World Heritage Area. Precious, irreplaceable areas of natural pristine environment would be compromised and destroyed.

Raising the Dam would be too great a price to pay.

And no doubt the raised Dam would also be used as a pretext for approving even more irresponsible development of flood-prone land, putting more people and property at risk.

The EIS itself refers to the expected need to raise the wall again this century due to climate change. We need to stop perpetuating a never-ending cycle of flood-plain development and dam raising.

Findings

- The EIS is deficient and misleading in many aspects, and fails to adequately examine alternatives
- The benefits from mitigating downstream flooding are substantially overstated:
    - Warragamba Dam's contribution to downstream flooding averages less than half that of all sources, contrary to the EIS's misleading claim of 'up to 70%'
    - the reduction to property damage would be far less than the claimed 75%, especially given the 'green light' effect of the raising to further irresponsible floodplain development
- On the other hand, the impacts of upstream inundation are significantly understated:
    - the area would be at least twice as large and the duration substantially longer than

[1] Ted Woodley BSc BE (Hons1) Dip CD FAIM FAICD FIEAust has held senior positions in a number of major infrastructure companies in the energy, water, transport, agricultural and care sectors. He was the Deputy Director, NSW Department of Water Resources (1987-88), responsible for operating NSW rural dams, rivers and irrigation areas and a Director of NSW Water Corporation (2004-06). He is a member of the Executive of the National Parks Association of NSW.

modelled
    - the environmental impacts and biodiversity offset costs would be at least double the EIS estimates
- No justification is given for creating a Flood Mitigation Zone (FMZ) of 14 metres, compared to some other height - the proposed FMZ is actually 12 metres

Recommendations

i) Refuse the Project due to:
- the extent of incorrect and misleading information and skewed analysis in the EIS, including overstated benefits and grossly understated impacts
- its failure to adequately assess alternatives, including alternative dam heights, as required in the Secretary's requirements for the Project
- the extensive environmental damage to the upstream catchment, including the Greater Blue Mountains World Heritage Area, which would be entirely disproportionate to any transitory benefit from flood mitigation

ii) Implement other options to improve flood management, immediately:
- in particular, require WaterNSW to develop a protocol to lower the Dam's full supply level on a flexible basis, to provide a variable flood mitigation zone
- commence a rolling program to buy-back properties in the most vulnerable areas of the floodplain

iii) Prepare a State Environmental Planning Policy prohibiting further development on the Hawkesbury-Nepean floodplain, forever

The remainder of this Submission covers:

1 Overstated downstream benefits
2 Massive upstream impacts, but still understated
3 Other actions
4 Questions

1 Overstated downstream benefits

The stated justification for raising Warragamba Dam wall is to enable peak inflows from the upstream catchment to be temporarily held in the Flood Mitigation Zone (FMZ) airspace, thereby reducing outflows and the severity of downstream flooding. However, the EIS overstates the extent of mitigation that the raised Dam would provide.

1.1 Warragamba contribution to downstream flooding is overstated

The primary reason for the Project is encapsulated in the statement at the front of the EIS (page 4):

> *"The large Warragamba Dam catchment historically contributes up to 70 percent of flows during flooding in the Hawkesbury-Nepean (see Figure 2)."*

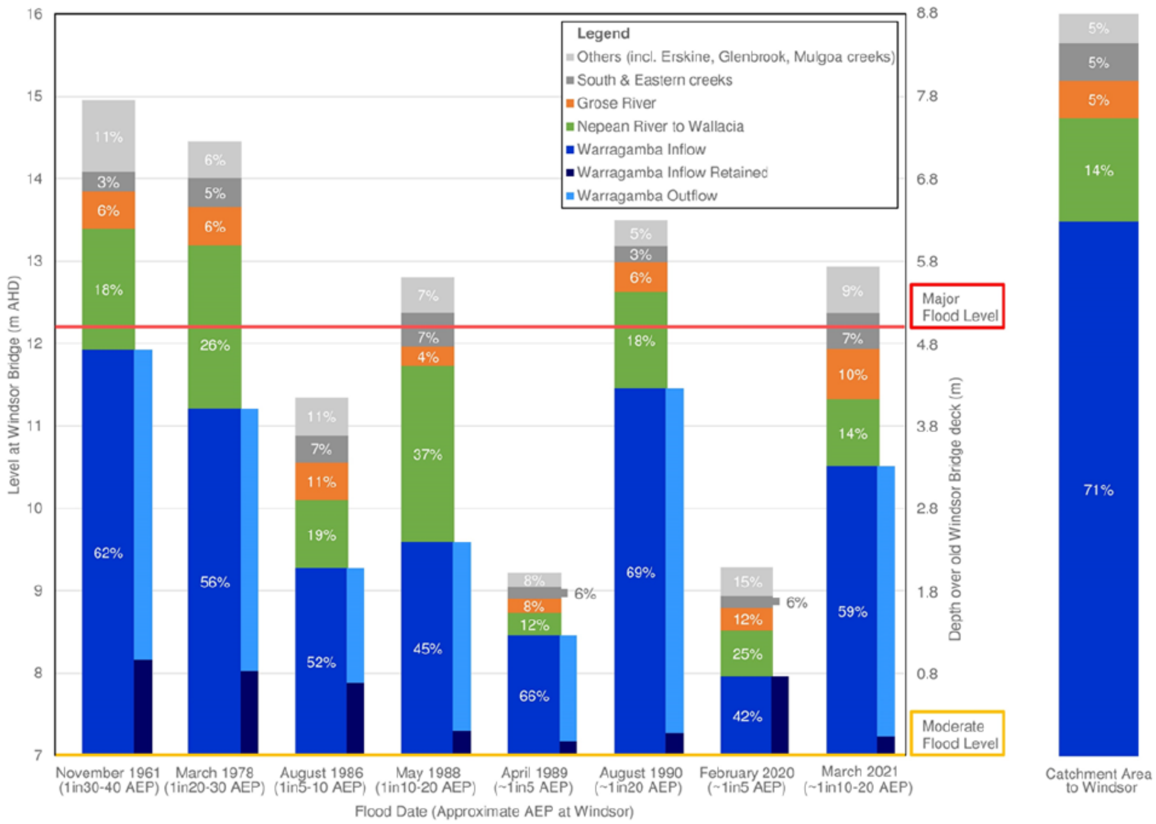

Figure 1 – Relative contribution of river catchments in the Valley (Figure 2 in EIS)

This statement is repeated throughout the EIS, but it is highly misleading and beside the point.

Figure 2 shows relative contributions from the Warragamba catchment for the eight largest floods in the sixty years since the Dam was commissioned. The Figure focuses on Warragamba inflows from its catchment (dark blue bars).

But inflows are irrelevant as far as downstream flooding is concerned, as is the 'up to 70%' contribution quote.

The only relevant contribution to flooding is the outflow from the Dam to the Valley (light blue bars), which is obviously less than the inflow by the amount retained in the Dam (black bars) – i.e. the spare capacity in the Dam at the time.

Figure 2 indicates that outflows from Warragamba Dam during the eight floods contributed 0% to

65% to downstream flooding, averaging slightly less than half:

- Warragamba Dam did not contribute at all to the February 2020 flood, as the Dam did not spill – it was at less than 50% capacity at the time.
- The maximum contribution to flooding from Warragamba Dam occurred in the August 1990 flood, at around 65%.

Another example of overstating the Warragamba Dam contribution is the comment (page 17) that for *"the recent large flood of March 2021 … the large Warragamba Catchment contributed around 60 percent of flows for this event, with the other small catchments contributing around 40 percent combined."* However, Figure 2 shows that whilst the Warragamba inflow for that flood constituted 59%, the outflow was slightly less due to retained inflows.

In this case it is a small exaggeration, but such overstatements are rife throughout the EIS and undermine any confidence in its integrity.

1.2 Reduction to property damage overstated

The EIS states (page 7) that property damage will be reduced by 75%:

> *"the Project … by reducing the depth and extent of flooding, would provide a reduction to property damages to people's homes and communities by on average around 75 percent over the long term."*

Again, this is overstated.

Taking the best-outcome scenario where the raised Dam contained all future flood inflows within its FMZ, downstream flood levels would be reduced by the inflow percentages in Figure 2 (dark blue bars) – i.e. 42% to 69%, averaging about 56%.

But raising the wall cannot eliminate Warragamba outflows from all flood events (see below) so the reduction to property damage will be less than 56%, well short of the claimed 75%.

1.3 Why a 14-metre flood mitigation zone?

The EIS proposes raising the central spillway by 12 metres and the auxiliary spillway by 14 metres, creating a "14-metre flood mitigation zone":

> *"Warragamba Dam Raising is a project to provide flood mitigation to reduce the significant existing risk to life and property in the Hawkesbury-Nepean Valley downstream of the dam. This would be achieved through raising the level of the central spillway crest by around 12 metres and the auxiliary spillway crest by around 14 metres above the existing full supply level (FSL) for temporary storage of inflows. The spillway crest levels and outlets control the extent and duration of the temporary upstream inundation. There would be no change to the existing maximum volume of water stored for water supply."*

The EIS offers no basis for selecting a FMZ of 14 metres above Full Supply Level (FSL), as opposed to a lower or higher height, other than the unsupported assertion that:

> *"The further review of the below alternatives and options found that the preferred option remained to be a raising of the dam wall to create a 14-metre flood mitigation zone".*

This 14-metre FMZ would provide capacity to temporarily hold 1000 gigalitres (GL), which is in addition to the 2000 GL for water supply below FSL.

It is a requirement of an EIS to assess alternatives. The lack of such an assessment of alternative heights, especially a smaller increase, fails to comply with the Secretary's requirements for the Project. Of itself, this is reason enough to reject the proposal.

1.4 The FMZ is actually 12 metres

The controllable flood mitigation zone is actually 12 metres, the height of the central spillway, constituting approximately 850 GL [1000GL*12/14]. Any water higher than 12 metres above FSL will pass over the central spillway, uncontrolled.

But the EIS consistently refers, incorrectly, to a flood mitigation zone airspace of 14 metres.

So, a critical question is whether the EIS modelling is based on a FMZ of 12 or 14 metres. This is especially pertinent for the calculations on discharging from the FMZ.

Can it be confirmed that the modelling was (correctly) based on a controllable FMZ airspace of 12 metres?

To avoid confusion this Submission adopts the EIS definition of a 14-metre FMZ of 1000 GL.

1.5 Discharge modelling for floods that top the spillway

The discharge hydrograph for a 1 in 100-year flood (Figure 2) shows a 50-hour delay before controlled releases over the ensuing 310 hours from the FMZ.

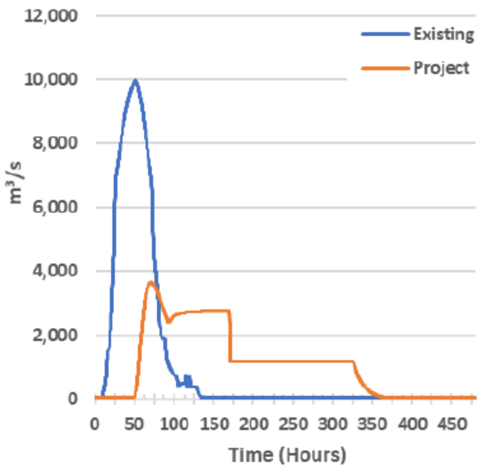

Figure 2 – Discharge Hydrograph for 1 in 100 Year Flood (Figure 15-36 in EIS)

The graph indicates that all inflows up to that time, when the flood peaks, are contained in the FMZ, and that the subsequent releases are controlled according to the proposed drawdown procedure outlined in Section 2.3.

However, Figure 5 indicates that a 1 in 100-year flood would reach 15.3 metres above FSL, 3.3 metres over the crest of the central spillway and 1.3 metres over the auxiliary spillway, resulting in uncontrolled spilling from both spillways. This uncontrolled discharge is not evident in Figure 2. Can this apparent anomaly be explained?

If Figure 2 is in error, the downstream flows from Warragamba will be much higher and possibly start earlier than indicated. If so, the flood mitigation benefits of the dam raising will have been overestimated. The impact of this misrepresentation would be even more acute for a flood of greater than 1 in 100-years.

2 Massive upstream impacts, but still understated

Whilst raising the Dam wall mitigates downstream flooding, it comes at the 'cost' of upstream inundation and damage to the environment. The EIS understates the extent and duration of inundation, and hence the environmental impacts.

2.1 Upstream inundation depth increases by up to 400%

Figures 3 and 4 show the Dam water levels for various flood events before and after raising the wall.

Event (1 in x chance in a year)	Existing			Project			
	Level (mAHD)	Depth (m)	Inundation* (days)	Level (mAHD)	Depth (m)	Increase in inundation (days)	Total inundation (days)
5	117.4	0.7	2.8	120.3	2.9	4.6	7.4
10	118.0	1.3	3.4	123.1	5.1	6	9.4
20	118.6	1.9	4.0	126.8	8.2	8.6	12.6
100	121.5	4.8	4.0	132.0	10.5	10.8	14.8
PMF	131.2	14.5	4.2	143.9	12.7	7	11.2

* Duration of temporary inundation has been calculated as when the rising limb of the hydrograph exceeds FSL (116.7 metres) and the falling limb of the hydrograph reaches FSL.

Figure 3 – Dam wall: Changes to temporary inundation levels and durations (Table 15-14 in EIS)

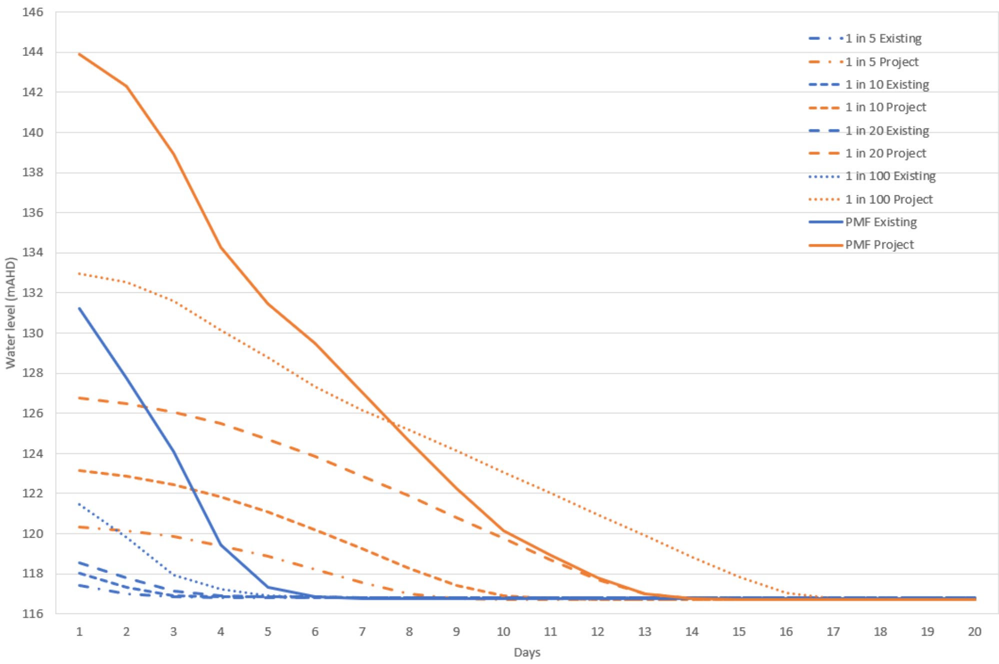

Figure 4 – Dam wall: Depth-duration curves (Figure 15-30 in EIS)

The information provided in these figures is incorrect and inconsistent. The title in Figure 3 under Project should be 'Increase in Depth (m)', not 'Depth (m)', while the time for emptying the FMZ after a 1 in 100-year flood is shown as 4.0 days (existing) and 14.8 days (Project) in Figure 3 but 5.5 days and 16.5 days in Figure 4.

The most relevant information on the increased level of upstream inundation is extracted in Figure 5 (and correcting the erroneous title in Figure 3).

Event (1 in x chance in a year)	Existing	Project		
	Depth (m)	Depth (m)	Increase in Depth (m)	Increase in Depth (%)
5	0.7	3.6	2.9	414%
10	1.3	6.4	5.1	392%
20	1.9	10.1	8.2	432%
100	4.8	15.3	10.5	219%
PMF	14.5	27.2	12.7	88%

Figure 5 – Increase in upstream inundation level (extracted from Figure 3 in this Submission)

As shown, the upstream depth after the Project varies from 3.6 metres for a 1 in 5-year flood, a 414% increase, up to 15.3 metres for a 1 in 100-year flood, a 219% increase, and 27.2 metres for the Probable Maximum Flood (PMF).

The EIS estimates the historical 'likely peak inundation' as 2.8 metres – see next section. Raising the Dam will result in upstream inundation frequently exceeding this level (flood events of less than 1 in 5-years).

It would seem from Figure 5 that the increased Dam will spill (i.e. depth >12 metres) for floods of approximately 1 in 50-years and greater.

2.2 Upstream inundation frequency increases

The Project will result in far more frequent upstream inundation (Section 15.6.4):

> *"The frequency analysis also shows a leftward shift in the frequency of flood events, with an increase in the frequency of all events of a specified magnitude. For example, a 1 in about 50 chance in a year event under existing conditions would be equivalent to about a 1 in 5 chance in a year event with the Project (that is, a water level that currently occurs on average about once every 50 years would occur on average once every five-years with the Project)."*

2.3 Inundated area will be more than twice that assessed

2.3.1 Current inundation (2.8 m) understated

The EIS states that currently the Dam level during floods peaks at 2.8 metres above FSL:

> *"Currently, during large spill events from the Warragamba Dam, modelling shows the likely peak upstream inundation to be 2.8 metres above the full storage level."*

The EIS validates this 'likely peak inundation' estimate of 2.8 metres with historical evidence:

> *"These modelling results conservatively reflect the floods recorded since the completion of the dam construction. Over the past 60 years there have been two occasions where inundation exceeded two metres above full supply level; November 1961 flood peaked at 2.8 metres, and June 1964 flood at 2.2 metres above full supply level. This validates the modelling of likely inundation for the existing dam at around 2.8 metres. Further to this, there have been an additional four occasions where the dam lake level exceeded the full supply level by more than 1.5 metres, up to and including March 2021."*

The EIS provides no definition of 'likely' inundation. However, it would appear that it corresponds to a flood event somewhere around a 1 in 50-year event, as Figure 3 shows inundations of 1.9 metres for a 1 in 20-year event and 4.8 metres for a 1 in 100-year event.

So, the current extent of inundation will be far higher than 2.8 metres for floods of greater than 1 in 50-years.

2.3.2 Projected inundation (10.3 m) also understated

Unbelievably, the EIS assessment of upstream environmental impacts of the Project is based on an inundation depth of 10.3 metres above FSL – i.e. 3.7 metres below the FMZ of 14 metres. This has been determined as 'an average or likely' level:

> *"Building on previous hydrological modelling carried out for the Project, further modelling was undertaken (using Monte Carlo technique) to generate around 20,000 flood events. These events would represent around 200,000 years period of time. This was then analysed by selecting the peak inundation level for each 20-year period to determine the 'average' or likely inundation.*
>
> *Using these thousands of modelled flood events, it was determined the likely inundation level with the raised dam is about 10.3 metres above the full supply level."*

There is no explanation as to why the modelling was divided into 20-year periods and then averaged. If a longer period had been selected the calculated average inundation level would have been higher than 10.3 metres.

It seems that the modelling predicts average/likely inflows of about 650 GL [1000GL*10.3/14 minus allowing for the 'V-shape' of Lake Burragorang]. For reference, the average annual inflow is 765 GL, ranging from 87 GL (2004) to 3390 GL (1974).

An inundation depth of 10.3 metres is clearly incorrect when the FMZ can hold 12/14 metres and a 1 in 100-year flood results in a depth of 15.3 metres (Figure 5).

Basing the EIS on an inundation depth of 10.3 metres is a pivotal flaw, resulting in a serious understatement of the inundation area and the extent of associated adverse environment impacts.

2.3.3 Inundation area even further understated

The EIS further underestimates the impacted area through the false assertion that the first 2.8 metres of the FMZ, the zone which has historically been inundated during previous major floods, as having no environmental values. This is patently incorrect, as acknowledged in the EIS (Section 2.6).

As a result of these incorrect assumptions the environmental impact assessment is restricted to the 7.5 metre strip between 2.8 metres and 10.3 metres above FSL, amounting to 1,400 hectares:

> *"Based on the modelling, and validation by living record, the area between 2.8 metres and 10.3 metres above full supply level has been adopted as the upstream impact area. The size of this area is about 1,400 hectares and a conservative assumption of 100% loss for the impact area has been applied to the assessment approach for all environmental values."*
>
> *The likely inundation area between the existing inundation level and the Project inundation level defines the 'Project upstream impact area' of around 1,400 hectares (including 304 Ha of Greater Blue Mountains World Heritage Area).*

The EIS should have assessed the impacts on the area inundated from FSL to at least 15.3m above FSL.

In stark contrast, Figure 6 demonstrates that floods of more than 1 in 10-years affect an area of nearly 1,600 hectares, more than that assessed in the EIS. A 1 in 100-year flood would inundate 2,910 hectares, more than twice that assessed.

Event (1 in x chance in a year)	Flood affected area (ha)		Area change due to Project	
	Existing	Project	Area (ha)	%
5	560	843	283	51
10	754	1,589	835	111
20	926	2,313	1,387	150
100	998	2,910	1,912	192
PMF	2,934	5,280	2,346	80

Figure 6 – Changes to flood extents (Table 15-13 in EIS)

But again, there appears to be inconsistencies in the EIS data. For example, after the Project a 1 in 5-year flood results in a depth of 3.6 metres (Figure 5) and an inundated area of 843 hectares (Figure 6). But currently a 1 in 50-year flood results in a lessor depth of 2.8 metres (derived from Figure 3) but a larger inundated area of around 950 hectares (derived from Figure 6).

Is the area inundated after the Project further understated?

The unavoidable conclusion is that the EIS has failed to assess the significance of impacts for more than half the area that will be inundated.

2.4 The upstream area will be inundated for longer than two weeks

The EIS states that upstream inundation will increase from up to 4 days at present to up to 14 days with a raised wall:

> *"Under existing conditions inundation above full supply level can be by up to four days. The duration of increased inundation would range from hours up to around 10 days."*

A minor point noted earlier is the slightly longer durations for a 1 in 100-year flood of 14.8 days (Figure 3) and 16.5 days (Figure 4).

As stated throughout the EIS, flood events vary widely as do the appropriate responses. The key issue is whether the proposed drawdown procedure would result in the full capacity of the FMZ being restored and the upstream inundation being released within the claimed 14 days.

The proposed FMZ drawdown procedure is described in Chapter 15:

> *"15.8.4 Discharge during flood events*
>
> *The timing and rate of discharge during flood events would be determined on a case-by-case basis. Generally, the discharge of water from the FMZ during a flood event would only occur:*
>
> - *when there was a reliable prediction of significant future rainfall*
> - *when the discharge would not cause unacceptable downstream flooding impacts.*
>
> *15.8.5 Discharge after a flood event*
>
> *15.8.5.1 Piggy back discharges*
>
> *The most effective way of discharging the FMZ in a manner that restores the availability of the FMZ as soon as practical while minimising additional flooding impacts is to 'piggy back' discharges after the peak flood level has been reached. …. Flood mitigation zone releases are made after the flood at the downstream location has peaked; with a slight delay and a temporary fall in river levels whilst downstream peak is confirmed. The FMZ is then discharged at a rate that does not cause the river to exceed the previous flood level peak and is gradually*

reduced in stages. Therefore, the FMZ releases would not impact anywhere that had not already been affected by the preceding flood.

The maximum discharge rate through the new outlet conduits would be 230 gigalitres per day. This is equivalent to a 1 in 5 chance in a year flood event on the Richmond-Windsor floodplain, and consequently piggybacking at this rate would be suitable for any downstream flood greater that a 1 in 5 chance in a year flood event. For smaller floods events, the discharge rate would need to be reduced to reflect peak flood levels.

Piggy backing of discharges would generally occur for two to three days after the peak of a flood event, after which a constant discharge rate of around 100 gigalitres per day (1,160 cubic metres per second) would be implemented. For smaller flood events (1 in 20 chance in a year and lower), piggy backing would not be possible and a constant discharge would need to be adopted.

In the event of a second forecast significant flood inflow, it would be possible to empty the whole of the FMZ with piggy-backing within 3-4 days. This would allow FMZ capacity to mitigate further downstream flooding.

15.8.5.2 Constant discharge

A constant FMZ discharge rate of around 100 gigalitres per day was assessed against a range of environmental, social, and economic factors."

As stated above (Section 15.8.4), discharges from the FMZ will not occur if there were a 'reliable prediction of significant future rainfall'. Accordingly, FMZ releases will be delayed during a prolonged wet period, possibly for days, even weeks.

Further, Section 15.8.4 states that FMZ discharges will not occur if it would cause 'unacceptable downstream flooding impacts'. Again, the application of this condition could result in FMZ releases being delayed till downstream flooding had subsided.

Surely if no imminent significant rainfall is predicted, the practical approach would be to delay any releases until downstream flooding had subsided to the extent that FMZ releases would not add to or prolong any flooding. Piggy back releases seem to be highly problematic. It is almost certain that a future government would adopt a pragmatic approach, with the priority of not adding to downstream flooding rather than minimising the duration of upstream inundation.

Such delaying of FMZ releases would result in upstream inundation for significantly longer than 14 days.

Again, the **EIS fails to assess the full duration of environmental impact.**

2.5 The upstream environmental impact will be far greater than estimated

The EIS notes the variables that will determine the extent of upstream environmental impacts and consequent biodiversity offset costs for the Project:

"The increased extent and duration of temporary upstream inundation may result in the loss or damage of environmental values. The extent to which this may occur is substantially dependent on a large range of independent variables such as: flood tolerance of species; geology; flood frequency; depth and duration of flooding; geographic setting; and lake edge effects. The existing dam inundation area above FSL is evidence that a complete loss of environmental values does not occur with temporary inundation due to these variables. For the purposes of offsetting the potential impacts of the Project a conservative assumption of a complete loss of environmental values within this Project upstream impact area of around 1,400 hectares has been used."

But the EIS understates the upstream environmental impacts by:

- regarding the first 2.8 metres above FSL as already destroyed by past inundations and having no environmental value, counter to the above statement indicating this to not be the case
- only accounting for destruction of the next 7.5 metres up to 10.3 metres (1,400 hectares), albeit totally (it is agreed that this is taking a conservative (and appropriate) approach in assessing the impacts)
- not accounting for damage to the area above 10.3 metres to the top of the FMZ (14/12 metres), totalling at least 2,910 hectares
- not accounting for further inundation from overtopping the auxiliary spillway – a rare but credible event
- understating the duration of inundation, particularly for non-major floods, potentially by several weeks
- failing to assess the impacts associated with a major element of the project, works to facilitate raising the wall further to 17m FSL (see below)

These errors in assessing the extent and severity of environmental impacts represent fundamental flaws in the EIS. They demand refusal of approval for the Project.

Also, taking these factors into consideration results in substantially greater environmental impacts than assessed, warranting much higher biodiversity offset payments.

2.6 The Project facilitates a FMZ of 17m

As a further comment on understated impacts, it is relevant to note that the EIS proposes raising the side walls by 17 metres. This extra 3 metres above the proposed auxiliary spillway height is to provide for another raising of the spillways to account for expected greater flood events due to climate change:

> *"Peer reviewed climate change research found that by 2090 it is likely an additional three metres of spillway height would be required to provide similar flood mitigation outcomes as the current flood mitigation proposal. Raising the dam side walls and roadway by an additional three metres may not be feasible in the future, both in terms of engineering constraints and cost. The current design includes raising the dam side walls and roadway by 17 metres now to enable adaptation to projected climate change. Any consideration of raising spillway heights is unlikely before the mid to late 21st century and would be subject to a separate planning approval process."*
>
> *"If rainfall were to increase by 9.1 percent, the Project FMZ would need to be raised by three metres by 2090 to have about the same flood mitigation capacity as the Project FMZ under existing rainfall conditions."*

Thus, whilst this EIS proposes an increased upstream inundation of 14 metres now, it actually facilitates an increased inundation of 17 metres, with even greater environmental impacts.

Further it is relevant to note that even if the Dam is not raised again, the impacts of climate change will still eventuate, with more frequent and larger flood events expected.

3 Other actions

3.1 Other Flood Mitigation Zone options

The EIS considered other alternatives to provide a dedicated FMZ without raising the Dam wall:

i) "lower Warragamba Dam's permanent full storage level; two options considered – five and 12 metres

ii) combinations of lowering the permanent full storage level and changed gate operations."

A combination of lowering the permanent FSL by five metres to establish a FMZ of 360GL, and changed gate operations, appears to have some merit. The FSL could be 'flexible' within say a five-metre range. The water level would only be lowered to the bottom of the range when a potential flood event was looming – not easily predictable, but potentially providing some net benefit.

Such a suggestion would usually be resisted, understandably, due to the ramifications of less water availability (up to 18%), the cost of alternative supply (desalination) if followed by a drought, and the downstream benefits being limited to smaller flood events.

But in the context of there being no single solution to this intractable problem, it warrants serious consideration.

It is comforting to note that the historic levels of Warragamba have been relatively high (see Figure 7), never dropping below 30%. Had a regime been in place to lower the FSL to 82% when a flood was looming, the only time this may have triggered the need for alternate water supplies would have been once in the past sixty years (2004 – 2008).

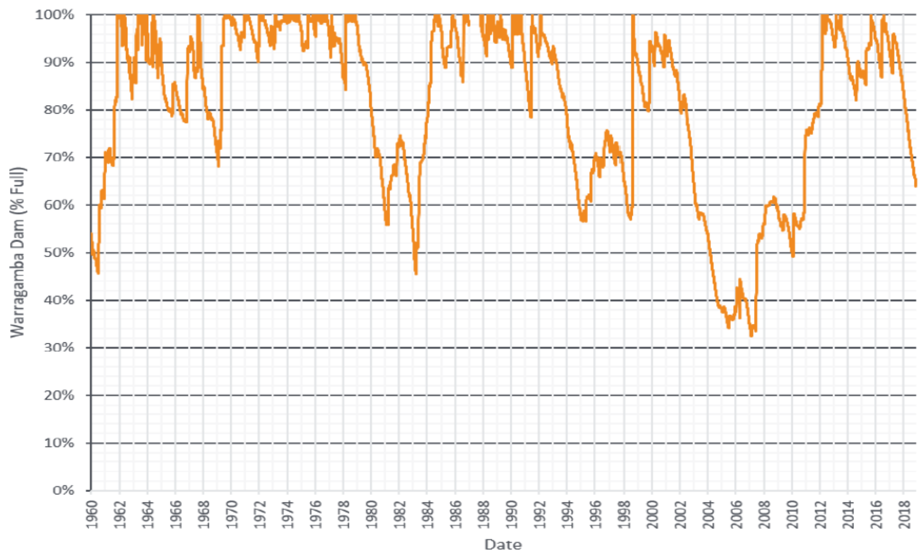

Figure 7 – Historic Dam levels (Figure 15-8 in EIS)

3.2 Further proposed development on the flood plain is just madness

The EIS mentions that one means of reducing flood impacts in the future, compared to raising the Dam height, is to prohibit new dwellings on the flood plain (page 25). It also mentions that further large areas have been approved:

> *"**Disallow all new dwellings within the 1 in 500 in a year flood extent.** This reduces future flood risk but does not reduce the large existing flood risk. Implementation would be costly and difficult, given large areas above the 1 in 100 chance in a year floodplain have been approved*

and/or zoned for residential development."

Why has further development, let alone in 'large areas above the 1 in 100 chance in a year floodplain', been approved and/or rezoned for residential development? Surely this is just compounding an already senseless situation and repeating the folly of the past 200 years. The EIS states that *"Approximately 134,000 people live in the probable maximum flood extent of the Hawkesbury-Nepean River (Infrastructure NSW 2017)."* Why add to this already excessive number?

If the Dam is raised it is likely that further ill-considered development will be approved as it would be argued that it is now 'safe from inundation'. Even if this were true as far as Warragamba outflows are concerned (which it isn't), flooding will still result from the downstream catchments. The EIS notes that contributions to flooding from catchments downstream of the Dam total up to 67% - Nepean River up to 37%, Grose River up to 11%, Southern and Eastern Creeks up to 7% and other tributaries up to 12%. Climate change will only increase the frequency and size of flood events.

There should be no further development on the floodplain, putting more lives and property at risk.

A parallel situation would be the approval of further development in coastal areas subject to erosion from rising sea levels and wilder storms.

3.3 Potential use for additional water supply

The EIS states that the increased Dam height will not be used for additional water supply, but offers no mechanism for ensuring this outcome.

On the contrary, it is entirely predictable that it would be untenable to maintain this stance if Sydney's water supply were at risk. The option of providing adequate water supplies to greater Sydney would undoubtedly outweigh increasing the risk of additional flooding of a relatively small area of the metropolis.

4 Questions

i) Why have references to historical contributions to flooding the Valley from Warragamba been erroneously based on Dam inflows rather than outflows?

ii) What has been the historical contribution to flooding from Warragamba outflows (range and average)?

iii) Has the claimed reduction to property damage from the Project (of 75%) been overstated?

iv) What is the rationale for proposing a FMZ of 14 metres, as opposed to some other height?

v) Isn't the proposed FMZ actually 12 metres?

vi) Have the modelling and assessments been based on raising the dam by 12 metres, with a further 2 metres of partly constrained storage but uncontrollable?

vii) Are the discharge hydrographs (e.g. Figure 2) correct, and take into consideration uncontrolled discharges above the two spillways?

viii) Doesn't using a 20-year period tend to understate the average inundation depth?

ix) Why use an inundation depth of 10.3 metres for assessing the impacts when the FMZ is 12/14 metres and major floods will exceed the FMZ?

x) What frequency flood will result in the FMZ being filled (from FSL)?

xi) What area will be inundated when the FMZ is full?

xii) Is it reasonable to assess the impacts on just 1,400 hectares when an area of well over twice that size is inundated by a 1 in 100-year flood?

xiii) Is it reasonable to consider the first 2.8 metres above FSL to be void of any environmental value due to past inundations?

xiv) How often and by how long will upstream inundations exceed 14 days?

xv) What are the environmental impacts after allowing for the full area of inundation and for longer durations?

xvi) What is the revised biodiversity offset payment?

xvii) When is it expected that Warragamba will need to be raised another 3 metres due to climate change?

xviii) Is a 'flexible' FSL range feasible as an alternative to a fixed FMZ?

xix) Why have large areas in the floodplain been approved and/or rezoned for residential development?

xx) Why hasn't all development on floodplain land in the Valley been stopped, forever?

xxi) What are the indicative costs of purchasing the lowest, most flood-prone land?

xxii) What conditions are proposed to ensure that the FSL for water supply will not be increased in future?

I am overwhelmed by the destruction our generation is wreaking on the environment. Our world is in far worse condition than it was when I was born, and it continues to be battered by human interventions. We need to reverse the trend so that the planet on which our lives depend is protected and healed. Our focus must be on environmental restoration for the sake of our children.

This Project definitely doesn't do that.