Operating options for increasing flood mitigation at Lake Eildon

Technical assessment report

Summary

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Introduction

This is a summary of outcomes from the technical assessment of potential operating options for increasing the flood mitigation provided by Lake Eildon. The technical assessment was commissioned by the Department of Energy, Environment and Climate Action (DEECA) following the October 2022 flood in the Goulburn River basin.

Six options were explored as part of the assessment. It was found that four of these options were not robust ways to increase the flood mitigation provided by Lake Eildon. The remaining two options did increase the flood mitigation provided by Lake Eildon; however, the cost of offsetting supply reliability impacts outweighed the avoided flood damages.

This technical summary provides background information on the project, a summary of the options investigated, and a summary of project methods and findings.

Lake Eildon

Lake Eildon was constructed in 1956 and is located on the Goulburn River, approximately 140 km north east of Melbourne. It stores water for irrigation, urban water corporations and environmental water holders. Lake Eildon holds approximately 3,334,000 ML (3,334 GL) at a full supply level (FSL) of 288.9 m AHD.

Eildon Dam consists of an earth and rockfill embankment with a concrete parapet wall, at a nominal dam crest level of 296.9 m AHD. The spillway is a concrete gravity structure controlled by three 20 m wide gates. The dam was constructed in 1955, and is owned and operated by Goulburn-Murray Water (GMW).

GMW has recorded water level in Lake Eildon on a daily basis since 1975 (Figure 2). The water level varies considerably depending on inflows, releases and other factors such as evaporation. For example, from the mid-1990s to late-2000s the effect of the Millennium Drought meant that reservoir levels were well below those observed pre-1997 and post-2011. After the Millennium Drought, Lake Eildon has been at least 99% full in four years (2011, 2012, 2022 and 2023), and releases in October 2022 were the highest since October 1993.

The Lake Eildon catchment as shown in Figure 1 encompasses an area of approximately 3,900 km^2, and the catchment area of the Goulburn River between Lake Eildon and Seymour is approximately 4,500 km^2.

The influence of releases from Lake Eildon on peak flood flows at Seymour therefore varies. For example, in October 1993 the peak outflow from Lake Eildon made a significant contribution to the peak flow at Seymour. In contrast, in October 2022 – which was the largest flood recorded at Seymour – the peak outflow from Eildon occurred after the flood peak at Seymour. The Lake Eildon releases therefore had a much smaller effect on the flood peak in Seymour in October 2022 compared with October 1993.

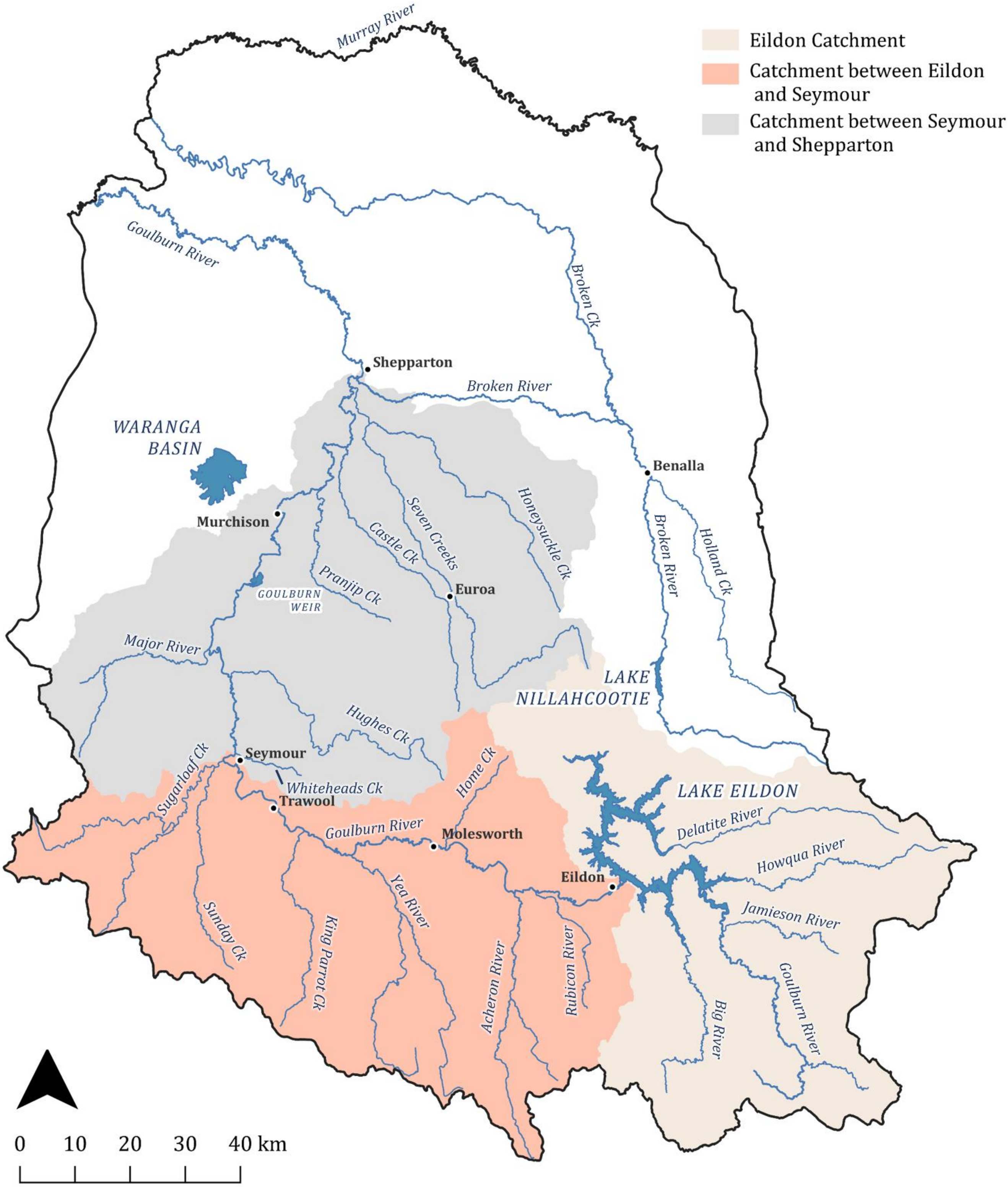

Figure 1: Overview of major river systems and major catchments in the Goulburn River basin

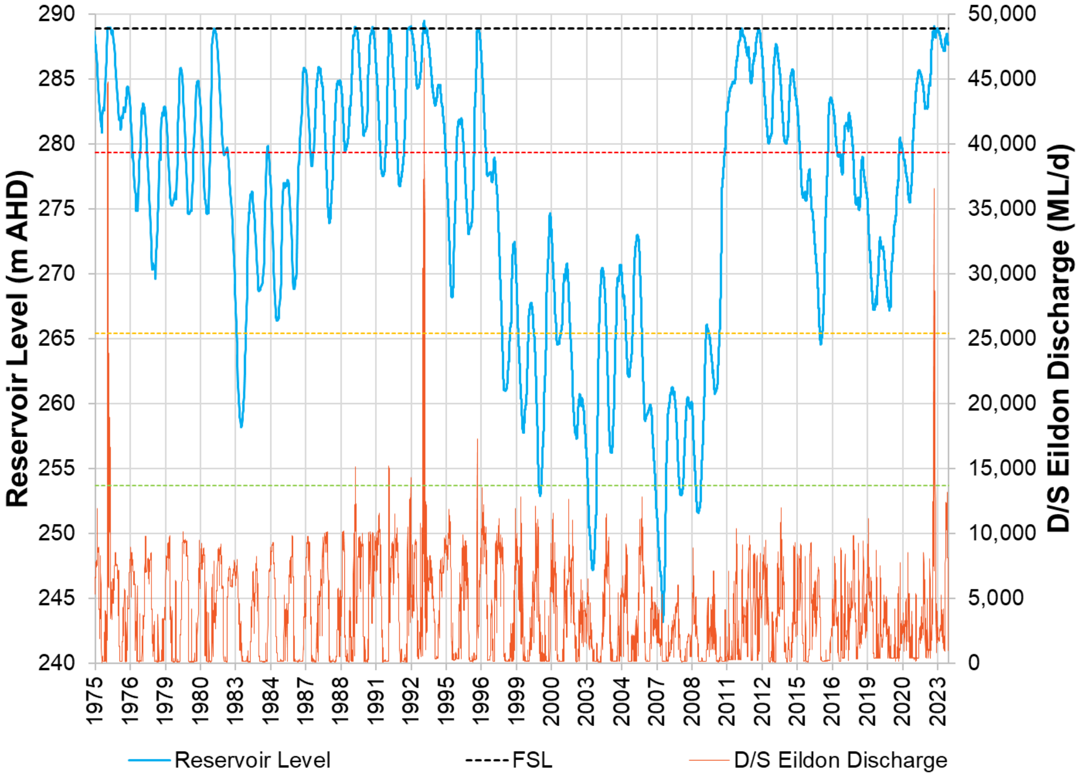

Figure 2: Recorded storage level (blue series) and releases from Lake Eildon (orange series) for the period from January 1975 to August 2023. Data supplied by GMW up until 2015 and supplemented with WMIS (https://data.water.vic.gov.au/monitoring.htm) data to 2023. The green, orange and red horizontal lines are the minor, moderate and major flood class levels downstream of Lake Eildon, respectively.

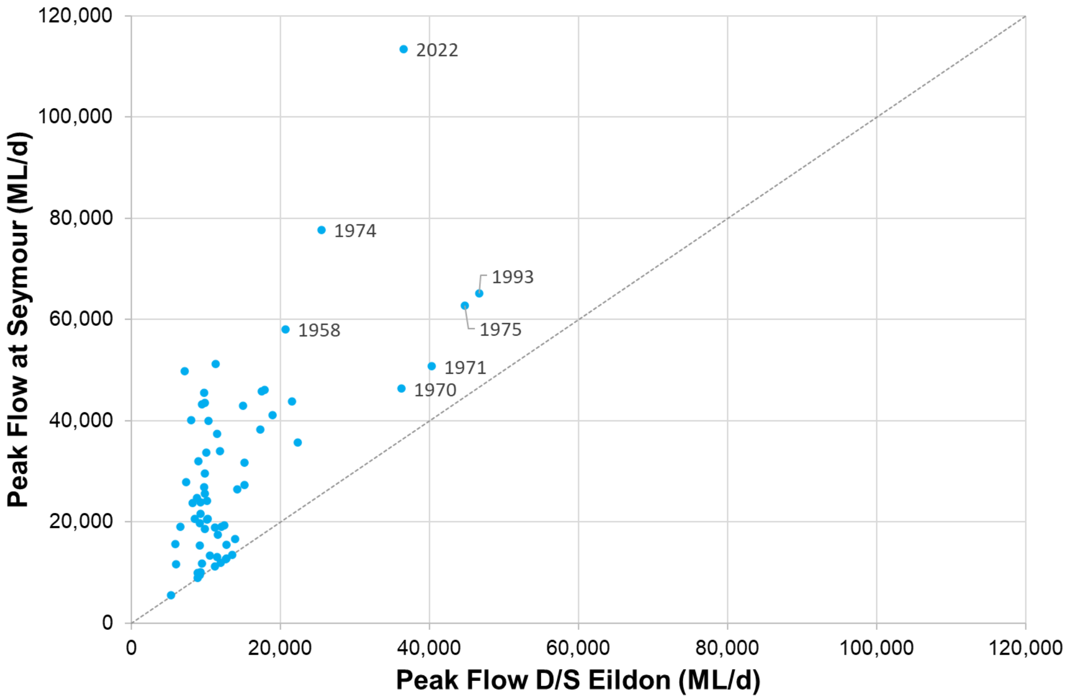

Figure 3: Peak releases from Lake Eildon versus peak flows at the Seymour for each water year, shown as an x-y scatter plot

Downstream flow constraints

The degree to which operational releases can be made from Lake Eildon depends on downstream flow constraints. The current constraints along the Goulburn River are:

- 9,500 ML/d at Eildon
- 10,000 ML/d at Molesworth (mid-Goulburn); noting though that this location does not currently have a streamflow gauge
- 9,500 ML/d at Murchison and Shepparton (lower Goulburn)

Releases above the downstream flow constraints can be made by the storage manager in order to meet the dam safety requirements in GMW's operating objectives, or if Lake Eildon is above the filling curve target and is expected to keep filling (e.g. see June-July of 2023 in Figure 2).

Options investigated for increasing the flood mitigation provided by Lake Eildon

This assessment examined six operating options for increasing the flood mitigation provided by Lake Eildon. The initial assessment (referred to as stage 1) included assessments of the water resource implications, flood frequency changes at Lake Eildon, and anticipated changes to 1993 and 2022 peak outflows from Lake Eildon (if the events were repeated) for the following options:

- Option 1 – Change the target filling curves at Lake Eildon
- Option 2 – Reduce the target storage at Lake Eildon
- Option 3 – Reduce the target storage at Lake Eildon based on climate signals that indicate 'wet' conditions
- Option 4 – Make higher pre-releases at Lake Eildon based on forecast rainfall
- Option 5 – Increase the maximum allowable surcharge level at Lake Eildon
- Option 6 – Restrict the maximum outflows from Lake Eildon

These options were selected based on a workshop with Department of Energy, Environment and Climate Action (DEECA), Goulburn-Murray Water (GMW), Goulburn Valley Water (GVW), the Goulburn Broken Catchment Management Authority (GBCMA), Melbourne Water retailers (represented by Greater Western Water), the Victorian Environmental Water Holder (VEWH), Murrindindi Shire Council, Mitchell Shire Council and Strathbogie Shire Council. Greater Shepparton City Council, Mansfield Shire Council, Coliban Water and Grampians Wimmera Mallee Water were invited to the workshop but were unable to attend.

After the stage 1 assessment, four of the six options were not progressed for further assessment, as it was found that the options were not robust ways to increase the flood mitigation provided by Lake Eildon:

- The option to reduce the target storage based on climate signals that indicated 'wet' conditions (option 3) was not a robust option because the climate signals tested were generally poor predictors of monthly inflows and storage volumes at Lake Eildon. This meant that – when combined with the influence of downstream flow constraints during wet periods – the option to reduce target storage based on climate signals was unlikely to increase the flood mitigation provided by Lake Eildon. For example, the 1993 flood occurred during El Nino conditions and during spring 2022 downstream flow constraints limited the ability to provide additional airspace.

- Increasing pre-releases from Lake Eildon based on forecast rainfall (option 4) was not deemed to be a robust option, because the uncertainty in the predicted location of where rainfall will be heaviest will constrain the degree to which storage operators can confidently make pre-releases without either reducing the water available to entitlement holders or making downstream flooding worse. Furthermore, the event-based analysis of the October 1993 and October 2022 floods showed that higher pre-releases (i.e. at the moderate flood class level flow threshold downstream of Lake Eildon), the peak flows would have increased at Seymour by up to 11%.
- The option to change the maximum surcharge (option 5) will increase the duration of Lake Eildon outflows above the minor, moderate and major flood class level flow thresholds at Eildon as floods pass through the storage, and increase the likelihood of the dam overtopping during back-to-back floods.
- The option of restricting the maximum outflow from Lake Eildon (option 6) would extend the duration of outflows above the minor, moderate or major flood class level flow thresholds at Eildon, and increase dam safety risks.

The two options which were progressed to stage 2 of the assessment were changing the target filling curve (option 1) and reducing the target storage (option 2). A brief description of each of these options is provided below.

Option 1: Change Lake Eildon target filling curve

The option to change the target filling curve involves managing the storage levels using different probability of exceedance inflows or target fill dates, so that the chance of Lake Eildon filling is reduced and/or Lake Eildon is full later in the year (e.g. January or December instead of October or November). GMW utilises the Bureau of Meteorology's seasonal streamflow forecasts for Lake Eildon and considers expected releases to help determine the target filling points. The streamflow forecasts are based on the current catchment conditions, historical inflow records and climate outlooks, and provide a range of possible inflow conditions for the months ahead.

Changes to the target filling curves would provide additional flood mitigation benefits if events occur when the storage is being held lower than under current conditions. In this technical assessment, the option to change the target filling curves considered a range of climate conditions (e.g. historical and post-1975 conditions), fill-by dates, and probabilities of exceedance for inflows was changed from 95% to 85% or 75%.

The degree to which this option reduces peak river flows diminish with increasing distance downstream of Lake Eildon, because of tributary inflows along the Goulburn River.

Option 2: Reduce Lake Eildon target storage

This option involves lowering the target storage – to the degree possible – to a defined proportion of full supply level (FSL) (e.g. 78%, 85%, 90%, 95%) all year round to provide enhanced capacity to capture flood flows.

The degree to which this option reduces peak outflows from Lake Eildon varies by event because of downstream flow constraints. For example, in 1993 and 2022 inflows in the months prior to the floods were such that the storage could not have been held at a defined target before either event without making releases in excess of the downstream flow constraint.

Assessment method

For the different filling curves (option 1) and target storages (option 2), the water resource implications, flood frequency changes, anticipated changes to 1993 and 2022 outflows from Lake Eildon (if the events were repeated), initial capital costs[1], upstream water level implications, downstream flow regime changes, and potential reductions of tangible flood damages[2] have been considered from Lake Eildon to Seymour.

The assessment was informed by applying existing water resource and flood models. Results from the technical analyses are suitable for high-level comparisons between current conditions and what is anticipated if the options were implemented. The relative differences between options are not expected to change significantly as models are updated or more work is completed, but specific values quoted in this report will become superseded.

Changes to flooding if the 1993 or 2022 events were repeated

Adopting different filling curves (option 1) or target storages (option 2) of 95%, 90% or 85% of FSL at Lake Eildon would not have significantly changed the outcomes observed in October 1993 and October 2022. The sustained inflows and downstream flow constraints in the months prior to the October 1993 and October 2022 flood events were such that the storage could not have been held at a defined target before either event. The full technical assessment report includes more detail to support these statements.

For the option to reduce the target storage to 78% of FSL, Figure 4 shows how the outflows from Lake Eildon would differ if the 1993 flood were repeated. This option would have resulted in lower outflows from Lake Eildon, and a significant reduction in peak flows at Molesworth and Seymour.

Figure 5 provides a similar analysis of the 2022 flood. In October 2022, the reduced target storage of 78% of FSL provides less additional flood mitigation downstream of Lake Eildon and at Molesworth and Seymour. Although releases from Lake Eildon are reduced this has minimal flood mitigation impact because the tributaries downstream of Lake Eildon made a much larger contribution to the flood peaks in Molesworth and Seymour in 2022 compared with 1993.

The technical assessment has therefore demonstrated that the degree to which the options will increase the flood mitigation provided by Lake Eildon will vary from event to event.

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[1] The scope of work did not include the ongoing socio-economic costs of reducing the volume of water stored in the Goulburn system.

[2] This analysis does not account for the intangible damages caused by flooding, such as mental health impacts for individuals, or unwanted changes to community dynamics as well as the duration of inundation flood damages to agricultural land uses.

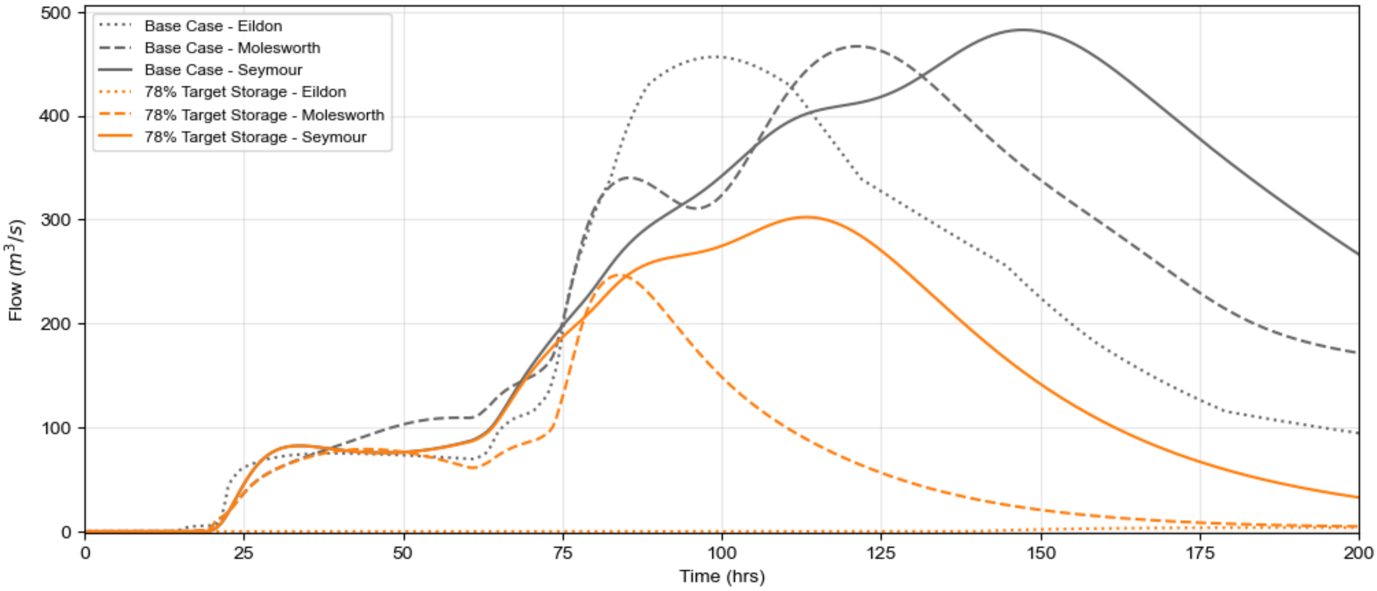

Figure 4: The modelled (in RORB) changes that 78% target storage would make to the outflows from Lake Eildon if the October 1993 flood were repeated. 1 m³/s equals 86.4 ML/d. The other target filling curve and reduced target storage options (95%, 90% and 85% of FSL) have not been plotted due to the similar hydrographs at Lake Eildon, Molesworth and Seymour.

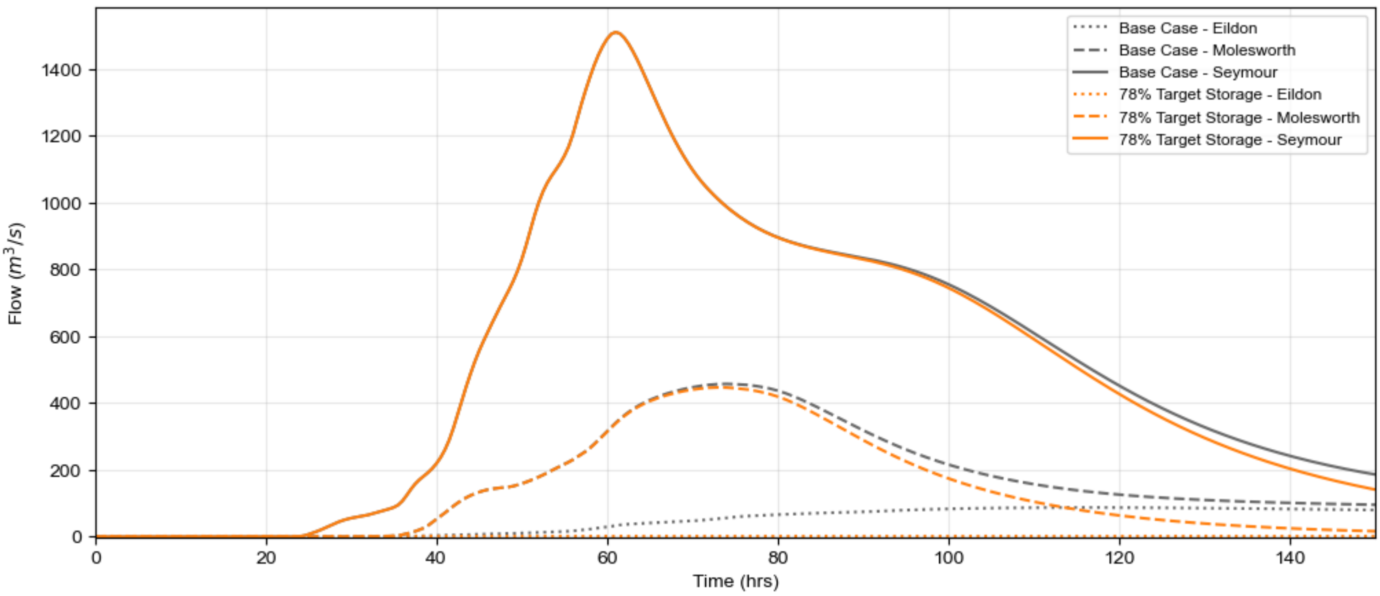

Figure 5: The modelled (in RORB) changes that various options would make to the outflows from Lake Eildon if the October 2022 flood were repeated. 1 m³/s equals 86.4 ML/d. The other target filling curve and reduced target storage options (95%, 90% and 85% of FSL) have not been plotted due to the similar hydrographs at Lake Eildon, Molesworth and Seymour.

Table 1 provides an indicative assessment of how the options would have changed flood damages from Lake Eildon to Seymour. The flood damage values combine damages estimated for buildings and contents (residential and non-residential), vehicles, road and rail, and agriculture. It should be noted that the agricultural flood damages are likely to be underestimated because they have been assessed using peak flows rather than the timing and duration of inundation. However, this is unlikely to change the conclusions of this study.

The tangible flood damages along the Goulburn River for the 2022 base case scenario was estimated to be $410 million (Table 1). The tangible flood damages in Seymour contributed to approximately 80% of the estimated total cost and the other 20% was between Lake Eildon to upstream of Seymour. For context, Deloitte (2023)[3] estimated the tangible cost of the October 2022 flood to be $432 million for the local government areas (LGAs) of Mitchell, Moira, Murrundindi and Strathbogie. Only the Mitchell and Murrundindi LGAs are within the study area for this assessment of potential options for increasing the flood mitigation provided by Lake Eildon, however, it is reassuring that the estimated tangible flood damages for the October 2022 flood are the same order of magnitude as the Deloitte (2023) estimate.

Table 1: Tangible flood damages at Lake Eildon, Molesworth and Seymour to reduced target storage options for 95%, 90%, 85% and 78% of FSL capacity if the October 1993 and October 2022 flood was repeated

Event – Option	Approximate flood damages (in millions)				
	Lake Eildon to U/S Molesworth (rounded)	Molesworth to Seymour (rounded)	Seymour (rounded)	Total (rounded)	Difference v base case
1993 – base case	$40	$20	$80	$140	-
1993 – 95% target storage	$40	$20	$80	$140	$0
1993 – 90% target storage	$40	$20	$80	$140	$0
1993 – 85% target storage	$40	$20	$80	$140	$0
1993 – 78% target storage	$20	$10	$10	$40	$100
2022 – base case	$40	$30	$340	$410	-
2022 – 95% target storage	$40	$30	$340	$410	$0
2022 – 90% target storage	$40	$30	$340	$410	$0
2022 – 85% target storage	$40	$30	$340	$410	$0
2022 – 78% target storage	$30	$30	$340	$400	$14

Water resource implications

The options that involve changing the target filling curve (option 1) or lowering the target storage at Lake Eildon (option 2) would reduce the reliability of supply to entitlement holders in the Goulburn system (Table 2). This is because less water would be held in storage (Figure 6 and Figure 7).

To return the reliability of supply to levels expected under current operating conditions, up to 10,000ML of low-reliability entitlements and water shares in the Goulburn system would need to be recovered if the target filling curve was changed by delaying the target fill date to January 1, and the probability of exceedance for inflows was changed from 95% to 75%.

For the options to reduce the target storage to 95%, 90%, 85% or 78% of FSL, a much larger volume of low reliability water shares would need to be recovered to offset the reliability of supply impacts (20,000 ML to >100,000 ML). At present, irrigators and water corporations hold

[3] https://www.parliament.vic.gov.au/floodinquiry

approximately 65% of the low-reliability entitlements and water shares in the Goulburn system, and the environment – via the Victorian and Commonwealth environmental water holders – holds the other 35%.

The initial capital cost of offsetting the supply reliability impacts if the filling curve or target storage at Lake Eildon is changed was estimated by multiplying the volume of low-reliability water shares that would need to be recovered by $1000 / ML. This approach provides an indicative estimate of the water recovery costs, but does not account for:

- The socio-economic consequences of additional water recovery in the Goulburn system
- The reduced income to GMW from fees associated with storing water if entitlements are retired from the Goulburn system
- The foregone agricultural production if the volume of water available for consumptive use in the Goulburn system is reduced
- Any works required to adapt to the increased distance between recreational facilities (e.g. boat ramps and holiday accommodation) and the water's edge if the Lake Eildon target storage is reduced.
- Impacts to water markets and foregone productivity as a result of increased write-offs of allocation in spillable water accounts.

Table 2: Modelled average February allocations to high-reliability water shares (HRWS), low-reliability water shares (LRWS) in the Goulburn system, volumes to offset changes to reliability of supply and the approximate initial capital costs of water shares

Option	Average modelled February allocations (July 1891 – June 2022)		Volumes to offset changes to reliability of supply (ML)		Approximate initial capital costs of water shares (in millions)
	HRWS	LRWS	HRWS	LRWS	
Base case	97.7%	54.8%	-	-	-
Option 1 – Change target filling curves					
75PoE to Jan 1 (post-1891 data)	97.6%	53.9%	0	10,000	$10
75PoE to Jan 1 (post-1975 data)	97.6%	54.1%	0	7,500	$7.5
Option 2 – Reduce target storage					
95% target storage	97.6%	53.7%	0	20,000	$20
90% target storage	97.5%	51.5%	0	50,000	$50
85% target storage	97.4%	48.2%	0	^100,000	^$100
78% target storage	97.4%	42.5%	0	^155,000	^$155

^ A range of initial capital costs is provided in the full technical assessment report; however, for demonstrative purposes the middle initial capital cost was adopted for the calculation of the ratio.

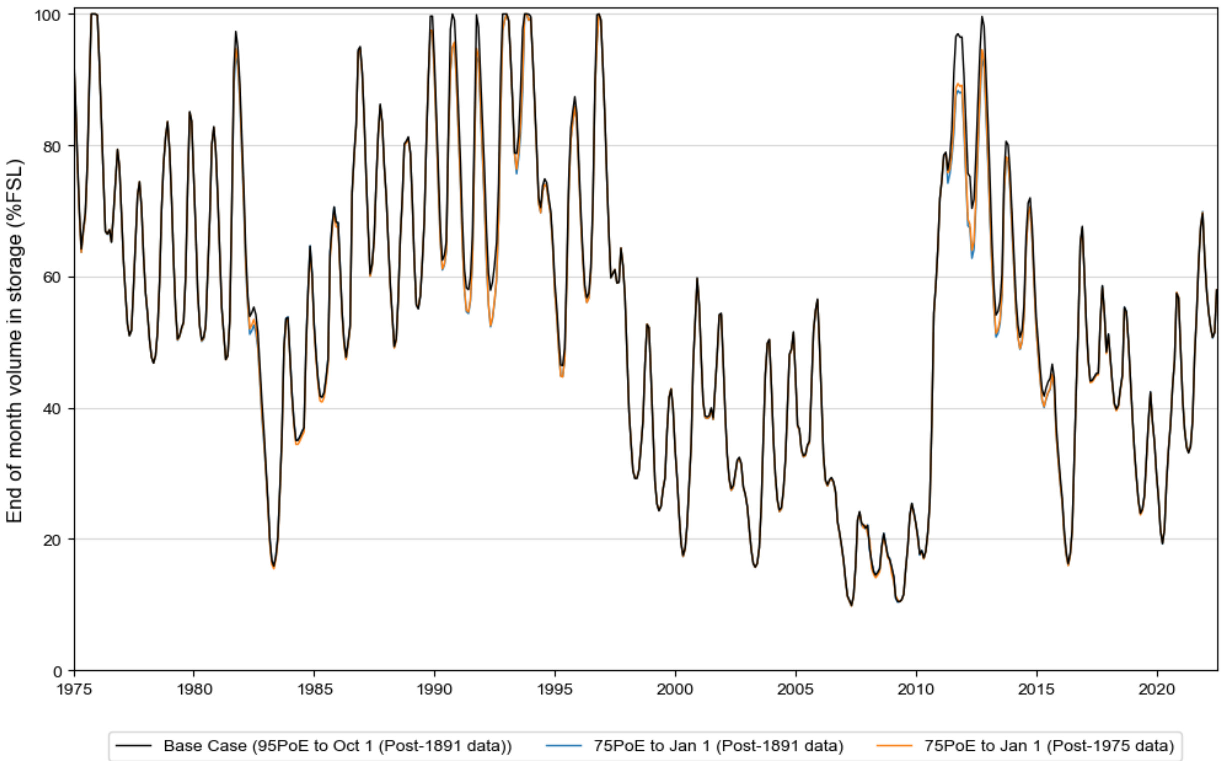

Figure 6: Monthly time-series of the modelled storage trace for Lake Eildon, from January 1975 to June 2022, for the option to change the target filling curve for 75PoE target filling curves (the figures for the 95PoE and 85PoE target filling curves are presented in the full technical assessment report)

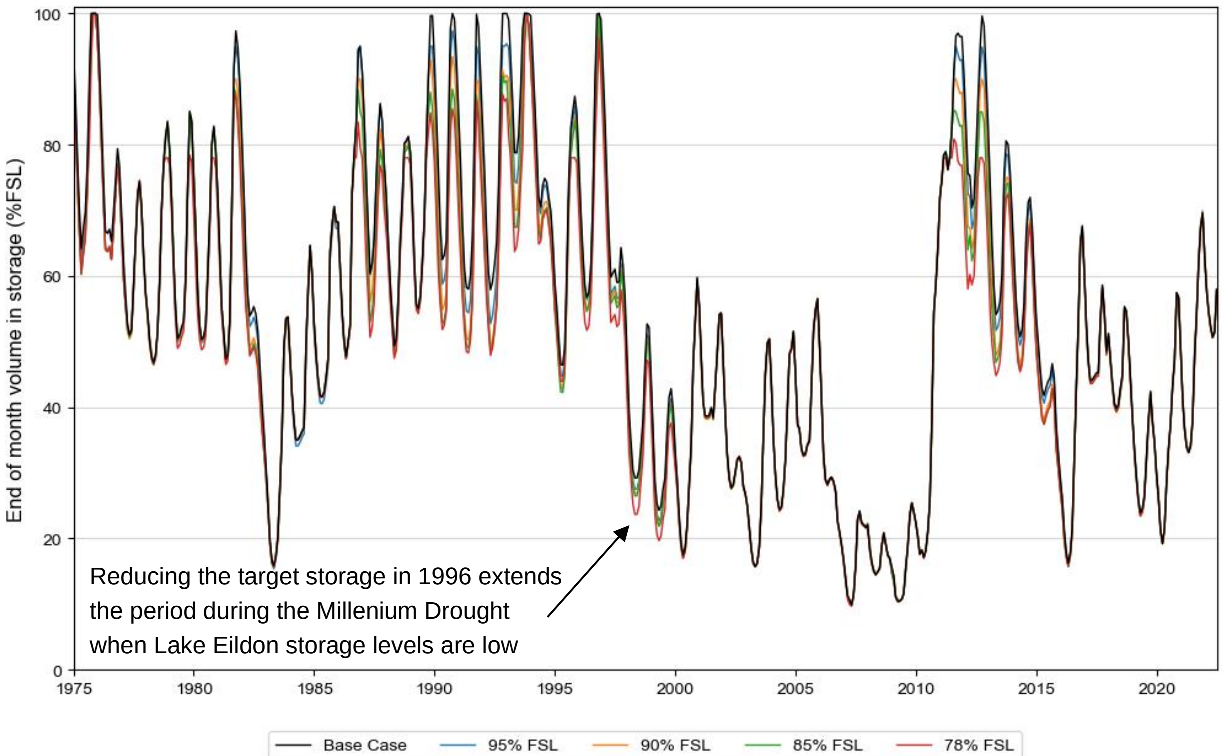

Figure 7: Monthly time-series of the modelled storage trace for Lake Eildon, from January 1975 to June 2022, for the option to reduce target storage to 95%, 90%, 85% or 78% of FSL

Changes to flood frequencies

Although changing the target filling curve (option 1) or lowering the target storage at Lake Eildon (option 2) may not make a difference to some floods – as discussed above for 1993 and 2022 – it will reduce the peak outflow from Lake Eildon during other events, and hence reduce flood frequencies downstream of the storage (Figure 8). However, the degree of peak flow reduction will decrease the further downstream the flood frequencies are assessed. That is, the degree of difference between the flood frequency curves for the base case and options investigated reduces by Molesworth (Figure 9) and is minor at Seymour (Figure 10).

This happens because the tributary flows downstream of Eildon from the Rubicon River and Acheron River influence the peak flows at towns such as Molesworth, and inflows from the Yea River, King Parrot Creek, Sugarloaf Creek and Sunday Creek influence the peak flows at towns such as Seymour. This means that changes to operations at Eildon have less influence on peak flows as the distance from the dam increases.

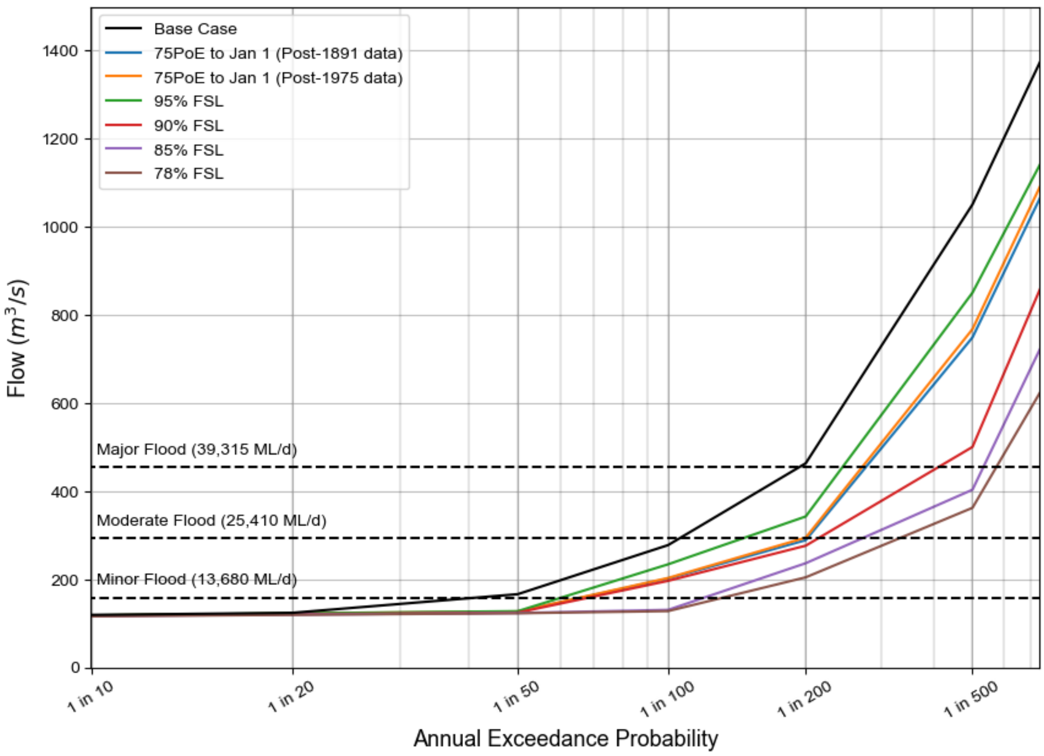

Figure 8: RORB model estimates of Lake Eildon peak outflow AEPs for the options that involve a target filling curve based on 75PoE inflow conditions and a target storage of 78%, 85%, 90% and 95% of FSL

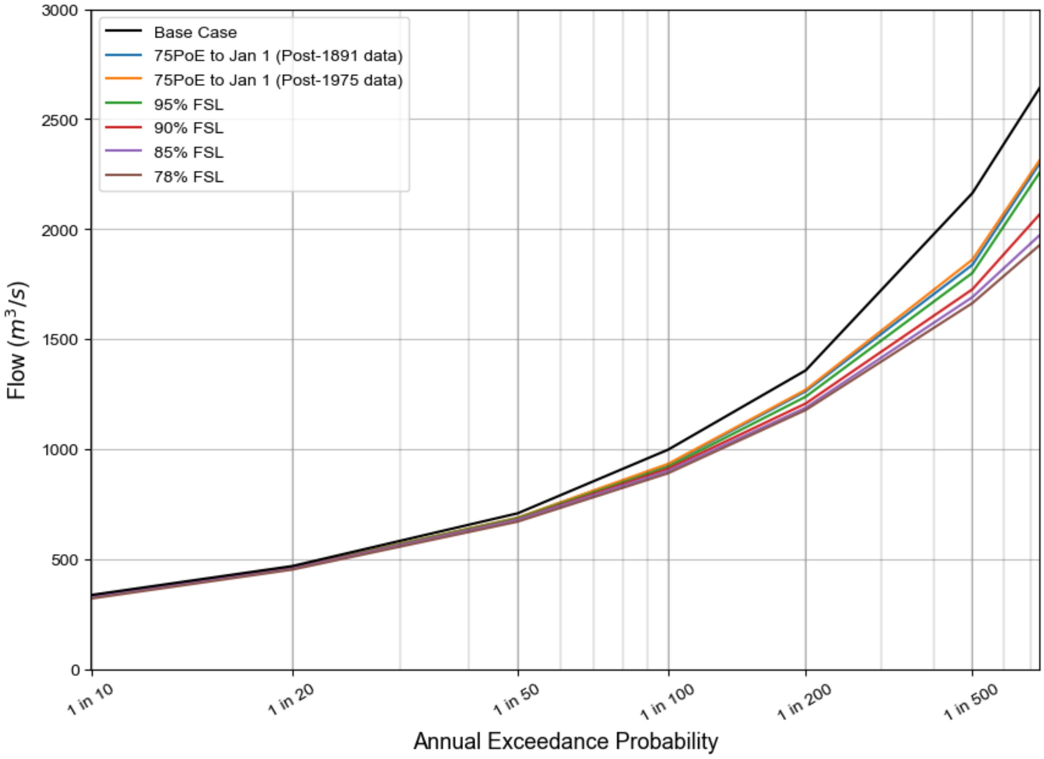

Figure 9: RORB model estimates of peak flow at Molesworth for the options that involve a target filling curve based on 75PoE inflow conditions and a target storage of 78%, 85%, 90% and 95% of FSL

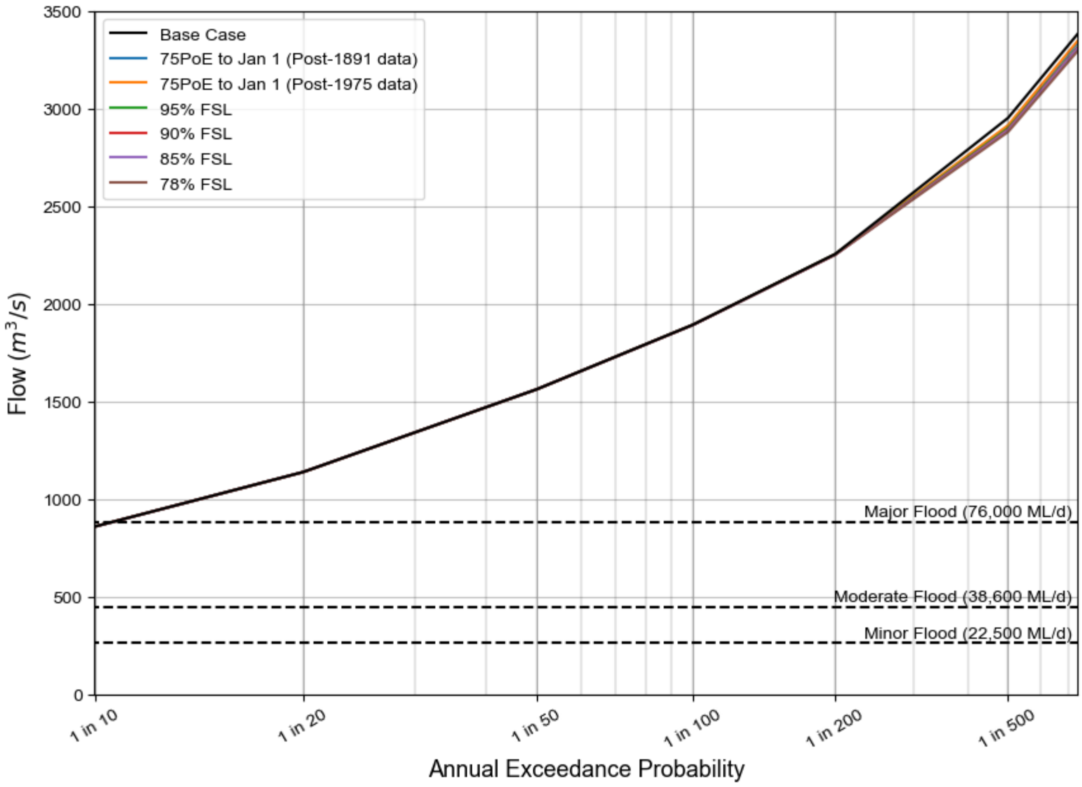

Figure 10: RORB model estimates of peak flow at Seymour for the options that involve a target filling curve based on 75PoE inflow conditions and a target storage of 78%, 85%, 90% and 95% of FSL

Downstream daily flow regime

If the Lake Eildon target filling curve is changed by delaying the target fill date to January 1, and fill is achieved in 75% of years, there will be a reduction of downstream flows in winter and an increase in autumn. This is because the May target filling point for Lake Eildon will be lower than currently the case, and therefore more flows will be passed in the lead-up, and there will be fewer spills in the subsequent months.

If the target storage at Lake Eildon is reduced, there will be generally lower flows from August to October, and higher flows in the months either side. This is because there will be fewer spills from Lake Eildon in the generally wet months, but higher flows in the shoulder months because higher releases will be required to maintain the target storage below FSL. This is likely to be a negative outcome for the environment, because the flow regime would be shifted further away from that which would have been observed under natural (unregulated) conditions. However, further investigations would be required to test this. The impact of the options on Traditional Owner values has not yet been assessed.

Flood damages

Modelled flood frequencies were combined with estimates of how flood damages vary according to peak flows along the Goulburn River to estimate the average annual damages for the base case and options 1 and 2. The differences between these values are the estimates of avoided flood damages.

Table 3 shows how the avoided flood damages if the options were in place compare with the initial capital cost of water recovery. The results show that all options have a benefit to cost ratio less than one. The estimates of avoided flood damages included in this report are approximate. This is because:

- The relationship between peak outflows from Lake Eildon and flood damages from Lake Eildon to Seymour is approximate, and has been interpolated from a steady-state assessment of flow along the Goulburn River
- The assessment of agricultural damages was based on expected changes in peak flows, rather than duration of inundation
- Flood damages downstream of Seymour were not considered.
- The estimates of average annual damage may also change once the hydraulic modelling is finalised as part of the ongoing Goulburn and Broken Rivers Flood Study, which includes calibration of the hydraulic model to inundation extents observed during the October 1993 and October 2022 floods.

For the reasons discussed above, the benefit to cost ratios are approximate and will change if the options are investigated in more detail. The options to change the target filling curve for other percentages of exceedance are not shown because they provide lesser degrees of flood mitigation downstream of Lake Eildon.

These points do not however, invalidate the results of the analysis. The ratios of avoided damages to the initial capital cost of recovering water shares would have to shift by a substantial amount to make a difference to the outcomes of this technical assessment.

Table 3: Estimates of avoided damages vs initial capital costs.

Option	Approximate benefit-cost ratio (50 years, 6% discount)		
	Avoided damages ($ m)^	Initial capital cost ($ m)*	Ratio
Option 1 – Change target filling curves			
Change target filling curves (75PoE to Jan 1 (post-1891 data))	3.1	10	0.3 : 1
Change target filling curves (75PoE to Jan 1 (post-1975 data))	2.9	7.5	0.4 : 1
Option 2 – Reduce target storage			
95% target storage	2.6	20	0.1 : 1
90% target storage	4.7	50	< 0.1 : 1
85% target storage	5.9	†100	< 0.1 : 1
78% target storage	6.7	†155	< 0.1 : 1

* For the estimates of costs:

- The costs associated with offsetting the supply reliability impacts are approximate.
- The ongoing socio-economic costs associated with reducing the volume of water stored in the Goulburn system (if the target storage at Lake Eildon is reduced) are not included.

† For the initial capital costs for 78% and 85% reduced target storage:

- A range of initial capital costs were estimated, however, the benefit-cost ratio is a similar order of magnitude if the high or low estimates of initial capital costs are used instead.

Sensitivity test

The outflow flood frequencies at Lake Eildon, and the degree of low-reliability water shares that would need to be recovered to offset reliability impacts if additional airspace is provided, are likely to be underestimated when based on the Goulburn Simulation Model (GSM) made available by DEECA for this technical assessment. This is because the GSM predictions of water level are lower than observed water levels over the recent period of record. Therefore, the differences in downstream flood frequencies and water recovery costs were also estimated using the University of Melbourne's Stochastic Goulburn Environmental Flow Model (SGEFM) model to test the sensitivity of the study outcomes to the type of model used. As expected, using the SGEFM produced different estimates of avoided flood damages and the cost of offsetting the reduced reliability of supply to water shares. However, the ratio between the avoided flood damages and initial capital cost of water recovery was similar when estimated using the SGEFM (Table 4). Therefore, the study outcomes were not sensitive to whether the GSM or SGEFM model was applied to simulate the long-term storage trace for Lake Eildon under current conditions and the options investigated.

Table 4: Estimates of avoided damages vs initial capital costs – sensitivity testing^

Option	Approximate benefit-cost ratio (50 years, 6% discount)					
	GSM			SGEFM		
	Avoided damages ($ m)^	Initial capital cost ($ m)*	Ratio	Avoided damages ($ m)^	Initial capital cost ($ m)*	Ratio
Option 1 – Change target filling curves						
Change target filling curves (75PoE to Jan 1 (post-1891 data))	3.1	10	0.3 : 1	8.4	60	0.1 : 1
Change target filling curves (75PoE to Jan 1 (post-1975 data))	2.9	7.5	0.4 : 1	7.0	50	0.1 : 1
Option 2 – Reduce target storage						
95% target storage	2.6	20	0.1 : 1	10	80	0.1 : 1
90% target storage	4.7	50	< 0.1 : 1	12	170	< 0.1 : 1
85% target storage	5.9	†100	< 0.1 : 1	16	270	< 0.1 : 1
78% target storage	6.7	†155	< 0.1 : 1	20	460	< 0.1 : 1

^ The caveats for Table 3 also apply to the estimates presented in this table

Findings

After the initial assessment, it was found that four of the six options were not robust ways to increase the flood mitigation provided by Lake Eildon. These options were:

- Option 3 – Reduce the target storage at Lake Eildon based on climate signals that indicate 'wet' conditions
- Option 4 – Make higher pre-releases at Lake Eildon based on forecast rainfall
- Option 5 – Increase the maximum allowable surcharge level at Lake Eildon
- Option 6 – Restrict the maximum outflows from Lake Eildon

The other two options which were progressed to the detailed technical assessment were changing the target filling curve (option 1) and reducing the target storage (option 2). These options did increase the flood mitigation provided by Lake Eildon; however, the cost of offsetting supply reliability impacts outweighed the avoided flood damages.

The main reason for the low benefit to cost ratio is that the flood mitigation benefits provided by the changes to target filling curve (option 1) and reduced target storage (option 2) diminish the further downstream the flood frequencies are assessed.

This is because the tributary flows downstream of Lake Eildon from the Rubicon River, Acheron River, Yea River, King Parrot Creek, Sugarloaf Creek and Sunday Creek influences the peak flows at towns such as Seymour. This means that changes to operations at Eildon have less influence on reducing the overall avoided damages downstream. In contrast, the approximate initial capital cost of water shares to implement these options ranges from $7.5 million to $266 million.

When looking at the 1993 and 2022 floods, the only option that would have made a difference to what was actually observed during these floods would have been aiming to hold the storage to

78% of FSL prior to the events. If option 1 or any other target storage within option 2 was implemented, there would have been no material difference to the flows observed downstream of Lake Eildon, Molesworth and Seymour for these historic events.

The assessment also looked at other impacts from changing the filling curve (option 1) and reducing the volume of water stored in Lake Eildon (option 2). Both options would change the downstream flow regime in the Goulburn River, by reducing flows in generally wetter months and increasing them in drier months. This may have negative environmental impacts, however further investigations would be required to confirm this.

For option 2, there would also be some recreational impacts, because the water body would be smaller and the distance between community and recreational facilities (e.g. holiday accommodation) and the water's edge would increase.

Further work could be done to improve aspects of this technical assessment. This includes:

- Using long-term time series of modelled flows from the daily Goulburn-Broken-Campaspe-Coliban-Loddon-Source model to characterise the expected change in the timing and duration of flooding, and how this will impact agricultural losses.
- Assessing the costs and benefits of different potential ways for recovering water shares.
- Refining the initial assessments of the expected costs and benefits to existing recreational and environmental values around Lake Eildon and downstream.
- A more detailed assessment of how potential future climate change is likely to influence flood frequencies downstream of Lake Eildon.

However, doing additional work is not recommended because it is not expected to change the conclusion that the cost of offsetting reliability of supply changes will be greater than the avoided flood damages for the Lake Eildon operating options considered in this study.