2022/23 Desalinated Water Order Advice

Technical Analysis

March 2022

VICTORIA State Government

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Purpose

1. This report provides technical analysis supporting the 2022/23 desalinated water order advice.

Context

Background

2. The Melbourne water supply system includes 10 major reservoirs and associated catchments that are used to harvest and store water, and the network of pipelines, pump stations, and tanks that are used to supply water to households and businesses across Melbourne and the surrounding region. The total system storage capacity of the 10 major reservoirs is 1,812 gigalitres[1] (GL). The Victorian Desalination Project (VDP), located near Wonthaggi, is connected by an 84 kilometre underground transfer pipeline to Cardinia Reservoir in the Melbourne water supply system. The VDP is operated by AquaSure, and can supply up to 150 GL/year, or around one third of Melbourne's current annual water demand. Bulk Entitlements to water produced by the VDP are held by the metropolitan water businesses (Greater Western Water, South East Water and Yarra Valley Water).

3. Melbourne's water storages supply water to the metropolitan water businesses; the regional water businesses including Barwon Water, Westernport Water, Gippsland Water and South Gippsland Water; for the environment on behalf of the Victorian Environmental Water Holder (VEWH); and from Thomson Reservoir for Southern Rural Water irrigators.

4. At 1 January 2022, around 56% of the water stored in Melbourne's water supply system was available for greater Melbourne. The rest was held by other water entitlement holders such as regional water businesses, the Victorian Environmental Water Holder (VEWH) and irrigators or is water that is inaccessible under normal operating conditions (refer to *Melbourne's Water Outlook 2022* for further detail).

5. During severe drought years such as 2006, storage volumes can drop by as much as 20% in a 12-month period. As the capacity of the VDP is less than average annual water demand this means that operational volumes only meet a proportion of water demand, and during drought periods water security is dependent on the volume of water already accumulated in water storage at the start of these periods.

[1] 1 gigalitre = 1 billion litres (the equivalent of around 400 Olympic swimming pools). In 2020/21, Melburnians (including those in the former Western Water) used 440 GL of water.

6. The aim of water supply system planning and operations with both catchment water sources and the VDP is to build and maintain a buffer of water in storage, subject to pricing impacts, to be able to supply demand while rainfall and reservoir inflows vary from year to year. A sufficient storage buffer is especially critical during severe drought periods. These periods could last for more than a decade, as experienced in the 1997-2009 Millennium Drought. Thomson Reservoir, which provides around 60% of total system storage capacity, is Melbourne's drought reserve and was last full in November 1996, immediately prior to the Millennium Drought. Thomson Reservoir is a large reservoir relative to the net inflow and while at capacity it provides reserves for major droughts, it can only fill from natural inflow. Operation of the VDP reduces water transfers from Thomson and other reservoirs and therefore is key to enabling the water supply system to manage water volumes from year to year and over extended time frames.

7. Since the VDP was completed in 2012, desalinated water has been ordered each financial year by the Victorian Government commencing from 2016/17. A total of approximately 406 GL of desalinated water has been delivered from 2017 up to 1 January 2022, with the remainder of 2021/22 order to be delivered by 30 June 2022.

8. Figure 1 shows historical water storage levels since 2012.

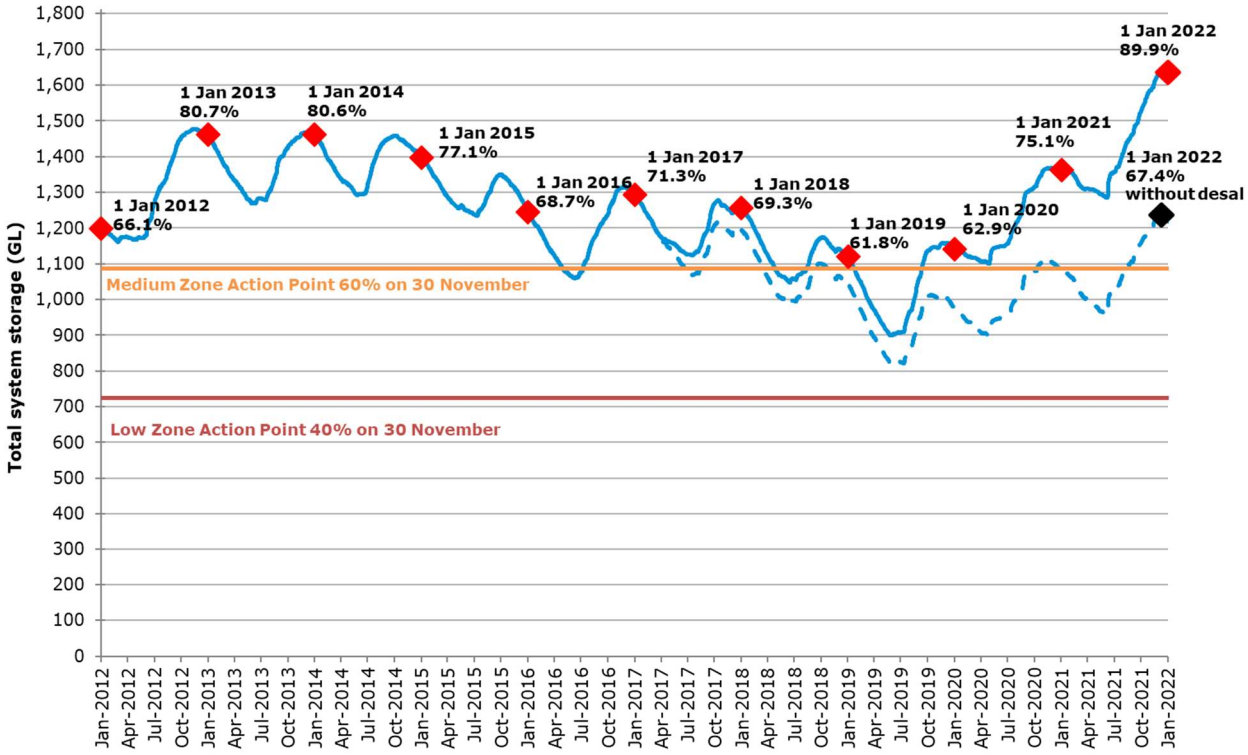

Figure 1: Historical water storage levels

9. As at 1 January 2022, Melbourne's water storages:
    - were approximately 89.9% full (1,629 GL), 268 GL higher than the same time in the previous year. Thomson Reservoir, Melbourne's drought reserve, held 975 GL (91.3% of its capacity), 189 GL more than on 1 January 2021.
    - were at their highest, for this time of year, since January 1997, due to higher than average rainfall and inflows into storages during 2020 and 2021, annual desalinated water orders since 2017 and ongoing water efficiency and conservation programs.
    - were 22.4% higher than they would have been without the 406 GL of desalinated water delivered since 2017
10. While storages are currently high, this is largely the result of above average inflows into storages during the last two years and desalinated water orders since 2017. In 2021, inflows to storages were the highest they have been in the last 25 years and approximately 41% above the last 30-year average.
11. Prior to these two years, water storage volumes and water security for the greater Melbourne area were declining, driven by lower streamflow and increased water demand. Over the past ten years:
    - Average annual streamflow into Melbourne's four major harvesting storages (Thomson, Upper Yarra, O'Shannassy and Maroondah Reservoirs) have been approximately 484 GL/year, which is 29% higher than average annual streamflow during the 1997-2009 Millennium Drought (376 GL/year) and is around 27% lower than the pre-1997 long-term average back to 1913 (615 GL/year), when reliable streamflow records began.
    - Population in Melbourne supplied by the three metropolitan water businesses has grown to a total of approximately 5 million people.
    - Average daily residential water use has decreased slightly from 161 litres per person per day in 2013/14 to 159 litres per person per day in 2020/21.
    - Due to population growth and additional supply needs to regional areas, Melbourne's water demand has grown by approximately 8%, from 407 GL/year in 2012/13 to 440 GL/year in 2020/21 (including the former Western Water region).

Melbourne's strategic water resource planning

12. In 2017, Melbourne Water published the *Melbourne Water System Strategy*, which presents a system view of water resource management across Melbourne and the surrounding region over the following 50 years. As per Victoria's strategic management framework, Melbourne's long-term water resource planning is currently being updated through the *Water for Life, Greater Melbourne Urban Water and System Strategy* and is expected

to be delivered in 2022. The draft strategy will include long-term water supply outlooks for streamflow scenarios described in the Department of Environment, Land, Water, and Planning (DELWP) *Guidelines for Assessing the Impact of Climate Change on Water Availability in Victoria*.

13. These long-term streamflow scenarios under climate change show that the reliable yield of the water supply system throughout an extended drought sequence will continue to decline over time. Without the VDP, the reliable yield of the water supply system from the surface water catchments is expected to continue to fall. The VDP will be increasingly important in providing water security for Melbourne and regional areas with growing population and in managing the impacts of changing climate conditions. Since the timing and severity of future extended drought sequences is uncertain, it is important to ensure preparedness for such an event by planning and operating the water supply system to maintain the buffer of water in storage that has been established in recent years, subject to pricing impacts.

Desalinated water order advice

14. The State of Victoria is required to place a desalinated water order with AquaSure by 1 April each year under the *Project Deed* between the two parties. Prior to this, the *Water Interface Agreement* between the Minister for Water, Melbourne Water, and the Secretary of DELWP requires Melbourne Water to provide the State of Victoria (represented by DELWP) with the following desalinated water order advice by 1 March:

    a) Its opinion of the volume of desalinated water required for the next financial year (i.e. 2022/23).

    b) Its opinion of the constrained months[2] (if any) that it considers should be subject to a constrained month cap and the proposed volume of such caps.

    c) A non-binding forecast of the quantity of desalinated water required for the next two financial years (i.e. 2023/24 and 2024/25).

15. Melbourne Water worked with the metropolitan water businesses (Greater Western Water, South East Water and Yarra Valley Water), which hold the Bulk Entitlements to water from the VDP, to coordinate the process of consultation and deliver the extensive modelling and technical analysis required to support the development of the 2022/23 desalinated water order advice. Other water entitlement holders across the water grid were also consulted to ensure the advice reflected their forecast demands from the Melbourne system.

[2] Subject to conditions specified in the *Project Deed*, the State may specify the maximum volume of desalinated water which can be delivered (i.e. a constrained month cap) during the months of August, September, October and/or November.

Water Outlook zones

16. The desalinated water order advice is a key annual planning activity supporting short and long-term water security for Melbourne and the surrounding region. The annual preparation of the advice follows from the publication of the *Water Outlook* by Melbourne Water and the metropolitan water businesses on 1 December each year, and is linked to this process through the use of the Water Outlook zones in the preparation of the advice.

17. The metropolitan water businesses' Drought Preparedness Plans specify a three-zone adaptive framework for monitoring water security based on the volume of water in Melbourne's storages on 30 November each year, as shown in Figure 2. As illustrated in Figure 1, the end of spring is typically when Melbourne's water storage volumes transition from filling during the cooler, wetter months, to falling during the warmer, drier months. Notable features of the framework are:

    - A Water Outlook is published by 1 December each year by Melbourne Water and the metropolitan water businesses to document and communicate water security status and actions needed in the short to medium term with reference to the three-zone adaptive framework.
    - Storages are managed proactively for possible future drought events when storage levels are in the High Zone including ensuring water is used efficiently and drought response measures are identified.
    - When storages are in the Medium Zone, actions are taken to ensure supply is available under severe and extended drought conditions for up to five years. Stages 1 and 2 of the metropolitan water businesses' water restrictions by-laws may also be used in this zone, although water restrictions can have significant social and economic impacts, so other approaches (e.g. voluntary water efficiency programs) may be implemented if similar reductions in water use can be achieved.
    - Actions are taken to ensure water storages do not enter the Low Zone except in extreme circumstances. Stages 3 and 4 of the metropolitan water businesses' water restriction by-laws are available to be used in such a severe event.
    - Varying water ordered from the VDP is considered in all three zones, however the amount taken is determined each year following detailed analysis that considers and balances the five principles and other factors (discussed below), including being in the Low and Medium Zones in the Drought Preparedness Plans.

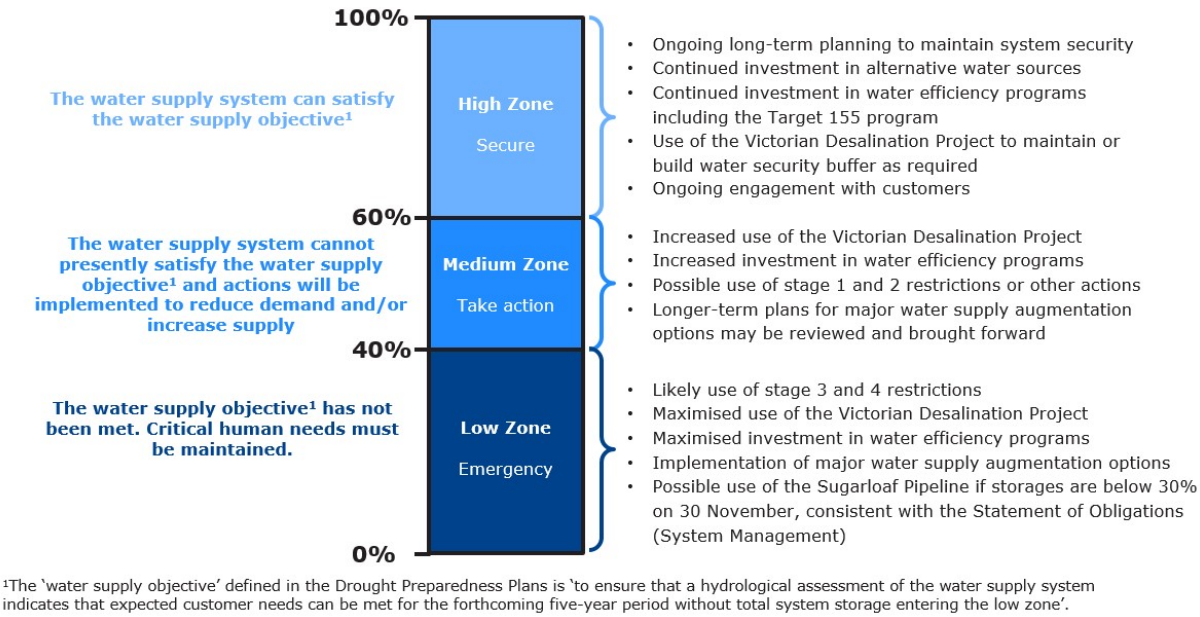

Figure 2: Melbourne's adaptive water security framework

18. In the development of the desalinated water order advice, the Water Outlook zones are used to measure potential future water security by comparing projections of future water storage levels against the three zones.

19. The metropolitan water businesses' *Drought Preparedness Plans* are periodically reviewed to ensure a consistent level of water security is maintained with growing population and changing water use, and changing streamflow conditions under climate change. The metropolitan water businesses' current *Drought Preparedness Plans* were implemented in 2017 and are being reviewed as part of the *Greater Melbourne Urban Water and System Strategy*. The review will take into account changes in expected demand growth and climate information to provide for ongoing drought security.

20. The 2022 Water Outlook for Melbourne, published on 1 December 2021, noted that storages were in the High Zone (89.6%) and therefore secure for the coming year. The Water Outlook also noted that water delivered from the VDP improves our ability to respond to unexpected events and reduces the risk of falling into the Medium Zone.

Principles

21. Consistent with the approach established by the water businesses and used in previous years, the 2022/23 desalinated water order advice is based around five principles. These were developed and assessed by the water businesses to balance the benefits of using the VDP in maintaining the short- and long-term security of supply to customers against the costs of

placing an order and the potential for foregone water harvest[3]. Short-term water security is maintained by avoiding going into the Low Zone, and minimising the risk of going into the Medium Zone, while long-term water security is achieved by building storage recovery over a number of years when there is sufficient capacity available in the reservoirs and maintaining higher storage volumes, when storages volumes are high. The advice is based on the water businesses assessing an appropriate balance across these principles. The advice is prepared recognising that while the first year order is contractually binding for the financial year, there is the opportunity to revisit the volume required in each of the second and third years, as part of the annual planning and ordering cycle. This allows adaptation based on the storage levels and outlooks at the time. The technical assessments of different potential desalinated water order volumes for 2022/23 described later in this document take this ability to adapt subsequent order volumes into account.

22. The intent of the principles is to provide for water security for Melbourne and surrounding regions supplied from the system by avoiding storages from falling to low levels, while avoiding the potential for foregoing harvest of lower cost water from within the system in wetter years (although this can potentially provide environmental benefits for downstream waterways). In satisfying these at times competing objectives, customer impacts should be minimised. The principles are:

- **Principle 1: Chance of storage volume falling below the Low Zone Action Point**
  Storages should remain above the Low Zone described in the metropolitan water businesses' Drought Preparedness Plans on 30 November 2022, 30 November 2023 and 30 November 2024 under a severe drought sequence, which is defined as the driest sequence among the modelled streamflow sequences.
- **Principle 2: Chance of storage volume falling below the Medium Zone Action Point**
  Storages should remain above the Medium Zone described in the metropolitan water businesses' Drought Preparedness Plans on 30 November 2022, 30 November 2023 and 30 November 2024 under 90 per cent of modelled streamflow sequences.
- **Principle 3: Storage Recovery**
  Storages should display a recovery trend such that the median (50th percentile) modelled total system storage levels across the modelled streamflow sequences increase in 2022/23, 2023/24 and 2024/25.

[3] 'Foregone harvest' is defined as the modelled additional flow over dam spillways from the Melbourne water supply system and/or reduced harvest into Sugarloaf Reservoir for each modelled streamflow sequence due to the desalinated water order volumes supplied.

- **Principle 4: Risk of desalinated water causing avoidable foregone harvest**
  Foregone water harvest should be less than 12.5 GL/year for at least 50% of modelled streamflow sequences, and less than 25 GL/year for at least 90% of modelled streamflow sequences in 2022/23, 2023/24 and 2024/25. 'Foregone water harvest' is defined as the modelled additional flow over dam spillways from the Melbourne water supply reservoirs and/or reduced harvest into Sugarloaf Reservoir for each modelled streamflow sequence due to the desalinated water order volumes supplied. All water may not be harvested from smaller storages and weirs in wetter years.
- **Principle 5: Customer impacts**
  The impacts on the metropolitan water businesses' customers' bills should be minimised while providing an acceptable security of supply.

23. Potential desalinated water order pathways were assessed against the five principles using detailed technical analysis described later in this report.

Technical analysis inputs and assumptions

Initial water storage levels

24. Water resource modelling for the 2022/23 advice examines possible future water storage levels for different desalinated water order volumes and operational conditions based on storage volumes observed on 1 December 2021 (1,631 GL or 90%). Approximately 193 GL of the water in storage on 1 December 2021 was allocated to entitlement holders other than the metropolitan water businesses, including the regional water businesses, the Victorian Environmental Water Holder, and Southern Rural Water. The distribution of water across the 10 major storage reservoirs in the Melbourne water supply system on 1 December 2021 is shown in Table 1. Water resource modelling supporting the desalinated water order advice considers the range of possible streamflow conditions into the reservoirs and the expected demands associated with all entitlement holders in the Melbourne system for the desalinated water order advice period.

Table 1: Distribution of water across the 10 major storage reservoirs in the Melbourne water supply system on 1 December 2021

Reservoir	Capacity at full supply (ML)	Volume (ML)	% Full
Thomson	1,068,000	962,857	90.%
Upper Yarra	200,579	181,673	90.6%
O'Shannassy	3,123	3,194	100%
Maroondah	22,179	22,119	99.7%
Sugarloaf	96,253	91,524	95.1%
Yan Yean	30,266	30,370	100%
Greenvale	26,839	25,776	96%
Silvan	40,445	35,517	87.8%
Cardinia	286,911	239,647	83.5%
Tarago	37,580	37,901	100%
Total	**1,812,175**	**1,630,578**	**90.0%**

Streamflow scenario

25. This technical analysis report was based on modelling with the 'Post-1997 step climate change' streamflow scenario described in the *2020 Guidelines for Assessing the Impact of Climate Change on Water Availability in Victoria* prepared by DELWP. The use of the 'Post-1997 step climate change' streamflow scenario is representative of streamflow conditions observed in recent history and therefore appropriate for developing the three year desalinated water order advice. The methodology used to establish this streamflow scenario results in consideration of some potential drought sequences more severe than those that have occurred historically and during the Millennium Drought (1997 – 2009).

26. The 'Post-1997 step climate change' streamflow scenario uses the observed streamflow for the period July 1997 to December 2021, with the observed streamflow from January 1913 to June 1997 scaled to match the statistical properties of the period July 1997 to December 2021. The 2021 streamflow at Melbourne's four major harvesting reservoirs (676 GL) was the highest in any calendar year for the post-1997 period. The addition of this year to the data set has resulted in an increase of the average annual streamflow for the post-1997 period and adjustment of almost 10 GL to the scaled streamflow from January 1913 to June 1997 used as the baseline for assessment purposes. The difference between the observed historical streamflow (grey bars) and the adjusted streamflow (orange bars) are illustrated in Figure 3. In the water resource modelling, the 109 years of streamflow data, with the adjusted streamflow from 1913 to 1997, are used to create 109 streamflow replicates (also referred to as streamflow sequences), that are used to assess the performance of potential desalinated water order pathways against a range of potential streamflow conditions.

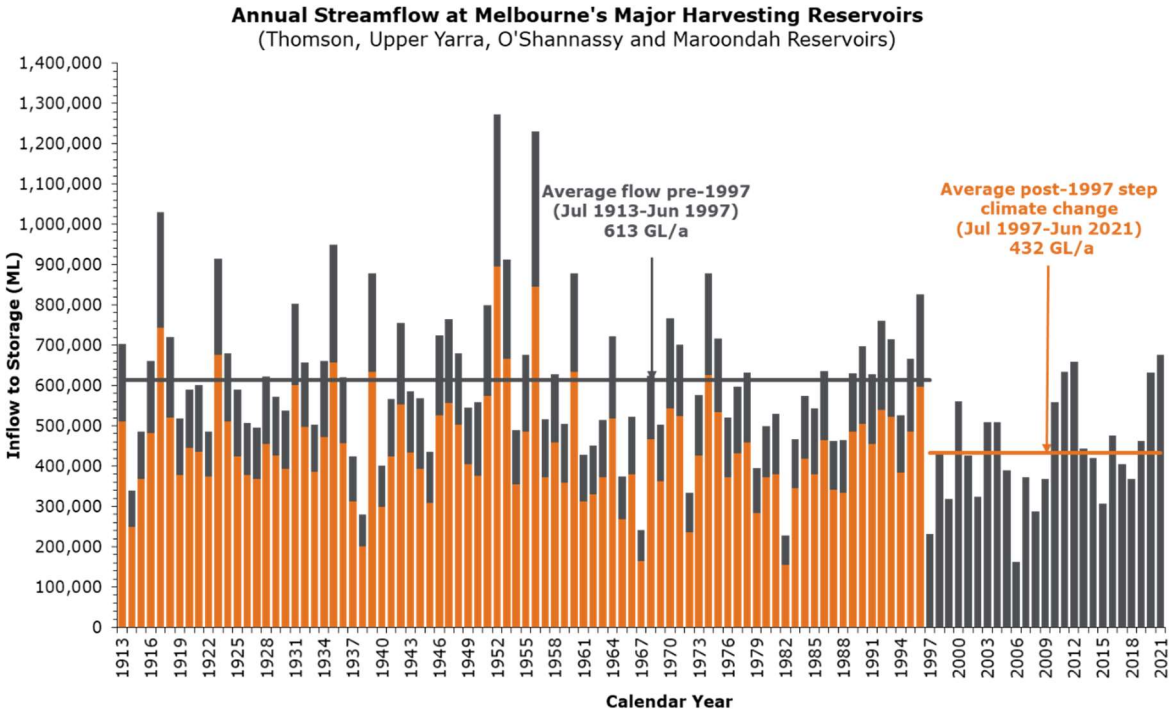

Figure 3: 'Post-1997 step climate change' streamflow scenario

Demand forecasts

27. To support the desalinated water order advice development process, the metropolitan and regional water businesses provided demand forecasts for the next 15 years. Focusing on the first three years covered by the advice, the demand forecasts are outlined in Table 2. These demand forecasts include expected water savings from the Target 155 program and Permanent Water Use Rules. In the water resource modelling, the metropolitan demand forecasts are adjusted in each modelled year using a climate index algorithm to reflect the variability in demand typically observed in warmer and drier or cooler and wetter years. The average annual demand forecasts for the metropolitan water businesses outlined in Table 2 reflect the impact of recent and forecast growth in Melbourne's population. Melbourne's water demand forecasts used for this years desalinated water assessment are lower than previous forecasts, as a result of the coronavirus (COVID-19) pandemic reducing demand growth and changing water use patterns.

Table 2: Demand forecasts provided by the metropolitan and regional water businesses

Year	Metropolitan water businesses (GL)	Regional water businesses (GL)	Total (GL)
2022/23	431	19	450
2023/24	435	19	454
2024/25	439	21	460

28. The water demand forecasts in Table 2 do not include environmental water releases from water entitlements held by the Victorian Environmental Water Holder. For modelling purposes, it was assumed that the Victorian Environmental Water Holder will use 2021/22 planned releases and the annual allocation each year thereafter. The environmental allocations for key modelled river systems include:

    - Yarra River system: 17 GL/year
    - Thomson River system: 10 GL/year plus 3.9% of inflows to Thomson Reservoir (under the 'Post-1997 step climate change' streamflow scenario, 3.9% of inflows to Thomson Reservoir is approximately 7 GL/year on average).

29. The water demand forecasts in Table 2 also do not include rural irrigation water releases from water entitlements held by Southern Rural Water. For modelling purposes, it is assumed that Southern Rural Water uses their annual allocation of 6% of inflows to Thomson Reservoir each year (under the 'Post-1997 step climate change' streamflow scenario, 6% of inflows to Thomson Reservoir is approximately 11 GL/year on average).

Operational considerations

30. The technical analysis supporting the 2022/23 desalinated water order advice also takes into account planned asset and operational factors including:

    - **Cardinia Reservoir:** The modelling includes a maximum operating volume of 263 GL (full supply level approximately 286 GL), consistent with dam management guidelines and also includes assumptions for temporary drawdown to 230 GL to support future capital works currently planned to commence in November 2023. Cardinia Reservoir is required to store desalinated water delivered as well as wet season streamflow from the upper Yarra River tributaries.
    - **Upper Yarra Reservoir:** The modelling includes a maximum operating volume of 185 GL (full supply level approximately 200 GL), consistent with system management rules.

- **Yan Yean Reservoir:** Modelling takes account of the expected timing for completion of the Yan Yean Reservoir water treatment plant upgrades in August 2023.

Other key modelling assumptions related to water supply system operations are similar to those used in previous years, including:

- **Winneke** and **Tarago water treatment plants:** The modelling includes planned operating capacity for 2022/23, and up to full operational capacity for subsequent years (130 GL/year and 16 GL/year respectively), with output depending on water availability at these sites and others.

Cost information

31. To support water resource modelling and price modelling, DELWP provided estimates of costs associated with each of the desalinated water order volume options based on the best available information.

Technical analysis results

32. Water resource modelling was undertaken to support the 2022/23 desalinated water order advice, which provides an outlook from 1 December 2021 to 30 June 2025, covering the three financial years for which advice is required under the *Water Interface Agreement*. This modelling process considers all possible desalinated water orders that could be placed under the *Project Deed* during this three year period (including 0 GL), and identifies the desalinated water orders most likely to lead to outcomes consistent with the principles described in paragraph 20.

33. The water resource modelling separately considers each of the seven possible orders from 0 to 150 GL in the first year of the three-year desalinated water order advice. For each of these seven possible first year (2022/23) orders, Melbourne's water supply system is modelled over the next three and a half years under 109 different streamflow sequences. For each streamflow sequence, the model selects the second (2023/24) and third year (2024/25) desalinated water orders that best meet the five principles under that particular sequence.

34. The water resources modelling results are summarised in Table 3. These results reflect, for a given 2022/23 desalinated water order volume, the risks after taking into account the potential to increase or decrease desalinated water orders in 2023/24 and 2024/25 in response to observed conditions. Table 3 also includes results derived from price modelling undertaken by the metropolitan water businesses, to assess the indicative impact of each potential 2022/23 order volume on a typical residential customer bill (using 150 kilolitres per year) in 2022/23 compared to 2021/22. The price modelling was focused on the change in average annual residential water bills associated with each of the various potential order

volumes, and does not reflect the impact of the annual security payment within water bills. The annual impacts on typical residential customer bills are indicative only and will vary across metropolitan water business and depend on individual household use patterns. Typical residential customer bills will also be impacted by a range of other factors in addition to the costs associated with the desalinated water order.

2022/23 desalinated water order volume (GL)	Principle 1			Principle 2			Principle 4						Principle 3			Principle 5				
	Percentage of streamflow replicates that fall into the Low Zone (below 40% on 30 November)			Percentage of streamflow replicates that fall into the Medium Zone (below 60% on 30 November)			10th percentile foregone harvest (90% of streamflow replicates have foregone harvest less than this volume) (GL)			50th percentile (median) foregone harvest (50% of streamflow replicates have foregone harvest less than this volume) (GL)			50th percentile (median) storage recovery (50% of streamflow replicates have greater storage recovery than this volume) (GL)			Average discounted cost of producing desalinated water over the three year outlook period ($M)	Indicative annual impact of 2022/23 order on typical residential customer bill (150 kL) compared to 2021/22 ($/yr)			Average order volume across all streamflow replicates (GL)	Average change in order volume between years across all streamflow replicates
	Principle target: 0%			Principle target: Less than 10%			Principle target: Less than 25 GL			Principle target: Less than 12.5 GL			Principle target: More than 0 GL			Principle target: Minimise impacts (magnitude and variability) on customer bills in all three years				
	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	All three years	Year 1	Year 2	Year 3	All three years
0 GL	0	0	0	0	0	0	0	7	12	0	0	6	-53	9	45	118	-19	69	112	80
15 GL	0	0	0	0	0	0	5	12	12	0	2	6	-40	5	33	115	-15	60	99	70
50 GL	0	0	0	0	0	0	19	35	13	1	4	5	-5	-16	17	100	-8	46	66	50
75 GL	0	0	0	0	0	0	25	52	18	3	7	5	20	-39	6	109	-2	38	63	47
100 GL	0	0	0	0	0	0	29	66	22	7	11	5	41	-53	2	111	4	29	53	46
125 GL	0	0	0	0	0	0	38	88	33	15	17	5	58	-66	-2	119	10	25	46	44
150 GL	0	0	0	0	0	0	49	102	39	20	23	5	75	-80	-9	131	16	22	41	60

Table 3: Summary of assessment against the five principles for all potential 2022/23 desalinated water order volumes

35. Table 3 suggests that:

- **Principle 1 - Avoid being in the Low Zone:** For all water order options in 2022/23, including a zero order, the assessed risk of storages falling into the Low Zone on 30 November is 0% in all three years of the advice period.
- **Principle 2 – Minimise risk of being in the Medium Zone:** For all water order options in 2022/23, including a zero order, the assessed risk of storages falling into the Medium Zone on 30 November is below 10% in all three years of the advice period.
- **Principle 3 – Maximise storage recovery:** At least 50 GL[4] is required in 2022/23 to almost enable a 50% chance of storages being maintained in 2022/23. Orders of 75 GL and above enable storage recovery in year 2022/23, however are more likely to result in small orders in the following year and a subsequent decline in storage.
- **Principle 4 – Minimise foregone harvest:** Orders of 15 GL or less will maintain foregone harvest within benchmarks in all three years of the advice period. An order of 50 GL exceeds the foregone harvest benchmark under 10% of streamflow sequences in Year 2. Orders of 75 GL and above provide unacceptable foregone harvest risk well above the principle criteria.
- **Principle 5 – Minimise customers' bill impacts:** Lower order volumes would not see metropolitan water businesses' customers' water bills rise in 2022/23, largely due to a lower desalinated water order than 2021/22 (125 GL) and routine price adjustments. With lower water orders in 2022/23 and with the anticipated higher orders associated with the forecast non-binding advice of 75 GL, customer bills may be affected in subsequent years.

36. Figure 4 illustrates projected water storage levels over the next three financial years for the 109 streamflow sequences associated with the 'Post-1997 step climate change' streamflow scenario. Figure 4 assumes, for example, that 15 GL is ordered in 2022/23, followed by orders in 2022/23 and 2023/24 adapted for each streamflow sequence as needed to deliver outcomes consistent with the principles.

[4] This compares to last year's assessment of requiring at least a 75 GL order. The difference is primarily due to the 2021 updates to the streamflow data and demand forecasts described above.

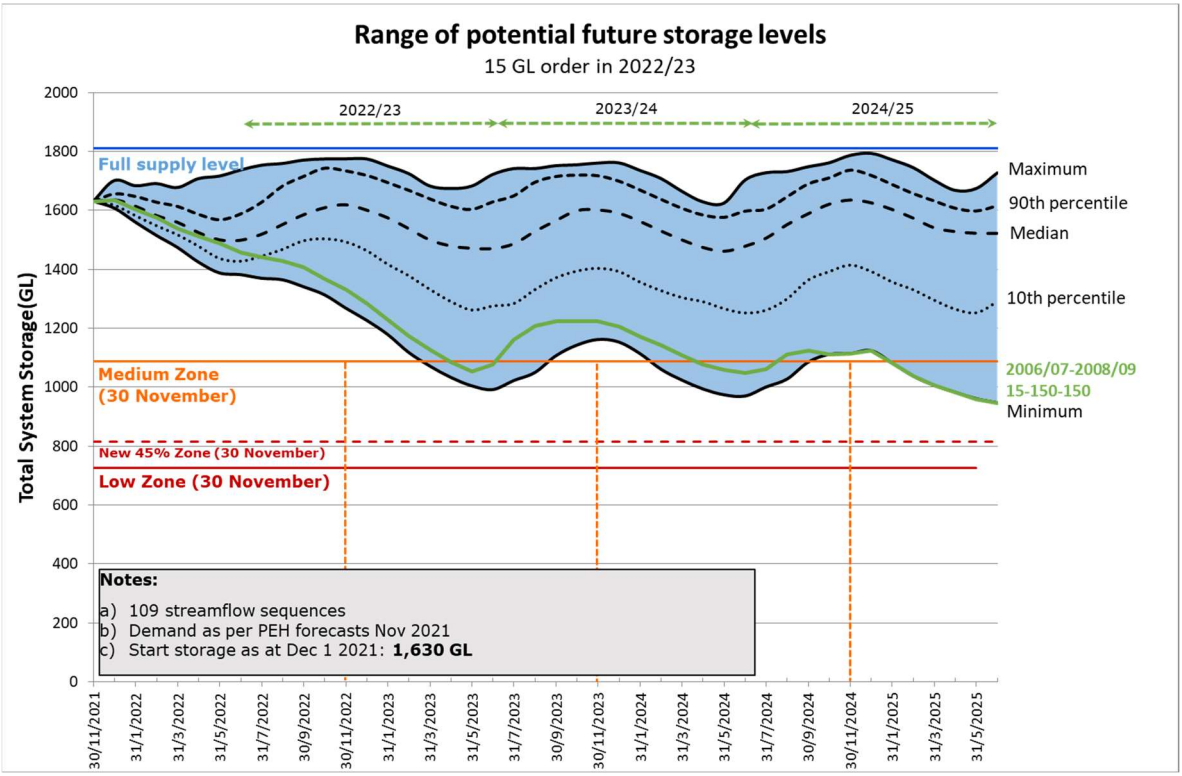

Figure 4: Modelled projection of potential future water storage levels assuming a 15 GL order in 2022/23

37. In Figure 4, the projected water storage levels if streamflow similar to those observed in 2006/07, 2007/08 and 2008/09 (a particularly dry sequence within the Millennium Drought period) were to be repeated are shown in green. For this particular streamflow sequence, the modelling suggests that it could be appropriate to order 150 GL in both 2023/24 and 2024/25 to respond to the expected fall in water storage levels resulting from severe dry conditions.

Other considerations

Value of Water in Storage

38. While 2020 and 2021 saw higher inflow conditions, the average annual streamflow into Melbourne's water supply system over the last nine years remains less than the average total annual outflows. In the medium to long term, yield is projected to decrease as a result of changing climate conditions while demand is projected to continue to increase. As a result:

    - Water storage levels will, on average, show a decreasing trend without regular water volumes provided by the VDP.
    - Desalinated water order volumes will therefore be necessary in order to maintain or recover storage levels. Depending on the sequencing of future wet and dry years, these will show an increasing trend to reflect increasing average use of the VDP.

- Prior to the VDP's capacity being required to supply growing base demand in future, larger orders can be used to build a storage level buffer for drought resilience.
- Augmentation to the water supply system will become necessary as the difference between water demand and yield diminishes and means that water security cannot be maintained otherwise.
- Maintaining high storage volumes, and larger desalinated water orders made in response to falls in high storage volumes will provide a buffer in storage levels, increasing the Melbourne region resilience to extreme climate events such as droughts and assist in delaying the need for augmentation and. This was highlighted in a 2018 Melbourne University study on the '*The economic value of water in storage'* that found that:
  - Storing additional water can have important economic value as it can reduce or defer the need to augment the water supply system.
  - Additional water in storage can reduce the severity and impact of water restrictions, and the resulting economic and social costs.

Reservoir spillway flows

39. Given current high water storage volumes and the distribution of water across the major water storages, Principle 4 - the risk of desalinated water causing avoidable foregone harvest and reservoir spills was a consideration in the technical analysis. In most years, some spillway flows occur from the smaller reservoirs in the system regardless of any desalinated water orders.
40. The 2022/23 order advice gave detailed consideration to order volumes that balanced maintaining drought reserves in Thomson Reservoir while managing the possible risk of the reservoir attaining full capacity in 2022/23 should high streamflow conditions continue. While orders less than 75 GL generally met the intent of Principle 4 in 2022/23, analysis highlighted there is an increased risk of spillway flows from Thomson Reservoir with desalinated water orders of 50 GL and above in 2022/23.

Climate outlooks

41. The desalinated water order advice was informed by the Bureau of Meteorology's seasonal streamflow forecasts and ENSO Wrap-up issued during January and February 2022.
    - The ENSO Wrap-up (issued 15 February 2022) indicated that:
      - 'La Niña is active in the tropical Pacific Ocean, but is likely past its peak. Most models anticipate the strength of the La Niña will ease over the next three months, with a return to neutral ENSO conditions by mid-autumn.'

  - 'La Niña increases the chance of above average rainfall across much of northern and eastern Australia during summer, with a weaker influence during autumn.'
- The seasonal streamflow forecasts for Melbourne's four major harvesting storages (issued mid-January 2022 and illustrated in Table 4) generally favoured near-median flow for the period January to March 2022.

Table 4: Seasonal streamflow forecast for Melbourne's four major harvesting storages for January to March 2022 (Source: Australian Government Bureau of Meteorology)

4 major harvesting reservoirs	Jan – Mar 2022
Thomson	Near-median to High flow
Upper Yarra	Near-median flow
O'Shannassy	Near-median flow
Maroondah (Watts River & Graceburn Creek)	Near-median flow

42. More generally, the Bureau of Meteorology climate outlooks issued on 10 February 2022 indicated for the period March to May 2021 approximately:
    - 45-60% chance of exceeding median rainfall.
    - 55-75% chance of exceeding median maximum temperature.
43. These outlooks do not extend over the three years of the desalinated water order advice period, but indicate short term streamflow conditions. While a La Niña event remains active, the streamflow and rainfall forecasts do not indicate low or high streamflow conditions and as such has not influenced the advice for 2022/23.

Technical outcomes

44. Order volumes of 15 GL and 50 GL were considered for the 2022/23 desalinated water order advice. These options provided water security by managing the Low and Medium Zone risks, minimised foregone harvest and major reservoirs reaching capacity and maintained a buffer against the impacts of future drought,. These two potential order volumes can also meet most of the desalinated water order advice principles in 2022/23.

45. Both of the final two order advice volumes that were considered would not result in customer bill increases from 2021/22 to 2022/23.

46. To best balance the need to manage the risk of foregone harvest while maintaining a storage buffer and minimising customer bill impacts, desalinated water order advice of 15 GL for 2022/23 is most aligned with the desalination order advice principles. Thereafter, non-binding forecasts of 75 GL in 2023/24 and 75 GL in 2024/25 are recommended.

Conclusion

47. Consistent with the requirements of the *Water Interface Agreement* described in paragraph 14, the following desalinated water order advice has been provided by Melbourne Water to the Victorian Government:

    a. The required annual water volume for the 2022/23 supply period should be 15 GL.

    b. There are no constrained months in the 2022/23 supply period.

    c. Non-binding forecasts of 75 GL for both the 2023/24 and 2024/25 supply periods are appropriate.