Legislative Council Environment and Planning Committee

Hearing Date: 11 October 2023

Questions taken on notice Directed to: Melbourne Water **Received Date:** 2 November 2023

1. **The Chair, page 85**

Question Asked to John Woodland:
The CHAIR: … Ron and Geoff – earlier today were talking about some rain tables that in their opinion were not the correct rain tables. I think they talked about – it is a bit of a crude term – 'garbage in, garbage out'. They are saying, 'We believe that there were the wrong rain tables used for the predictions.' Do you have any response in regard to that?

Response:

For clarity, we understand the reference to rain tables to mean rating tables. A rating table shows the relationship between river height and river flow and is an input to flood forecasting modelling. It is important because the model works by using rainfall and catchment runoff data to calculate river flow at various locations, and the rating table converts this flow to the corresponding river height. The predicted river height is then used to determine the likely impacts of flooding at that location.

Melbourne Water has considered the concerns raised by Mr Crapper that the rating table at Darraweit Guim was inaccurate. We have reviewed our records, including the Darraweit Guim rating table and the peak flows at the two gauges immediately downstream from Darraweit Guim.

We respectfully disagree with Mr Crapper's claims and conclusions:

- The rating table for Darraweit Guim that Melbourne Water used during the flood event has been verified as accurate and fit for purpose.
- Melbourne Water has found no record that the rating table, purportedly for Darraweit Guim, contained in Mr Crapper's submission (see Figure 8 on p.22 and 10 on p.24), was ever in use and has confirmed that it is materially inaccurate.
- Melbourne Water has reconciled the peak flows at the Darraweit Guim gauge, calculated at 276 m^3/sec by Melbourne Water, with downstream peak flow at the Keilor gauge, calculated at 766 m^3/sec by Melbourne Water. The flows at Keilor were also measured and validated in the field by hydrographers around the peak.
- In addition, the Jacobs post-event report commissioned by Melbourne Water reviewed flow rates at Darraweit Guim, Keilor and Maribyrnong, and it supports Melbourne Water's assessment of the peak flow at Darraweit Guim.
- In light of this analysis and verification, we conclude that Mr Crappers' calculations regarding the flow at Darraweit Guim having reached 700 m^3/sec is incorrect.

Darraweit Guim Rating Table

Figure 1 below shows a plot of various iterations of the rating table from the Darraweit Guim gauge from the mid-1970s to post the October 2022 flood event. The close alignment of the tables over this period provides good confidence in the rating table.

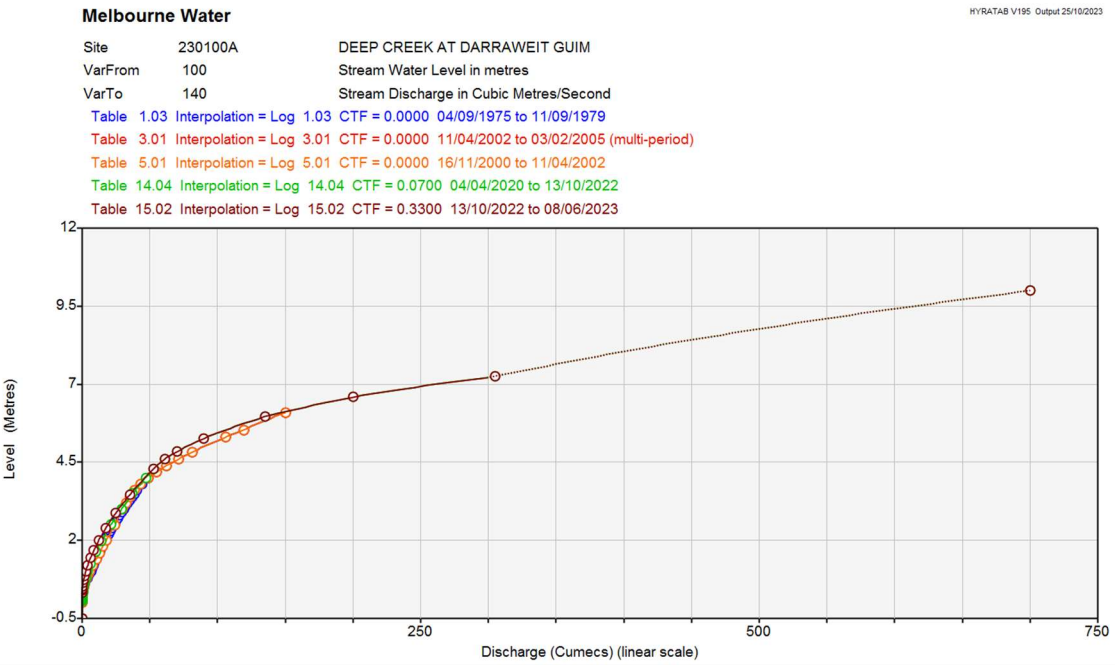

Figure 1: Plot of Various Rating Tables for Deep Creek at Darraweit Guim

In practice, all flow information used by Melbourne Water for real-time flood modelling is derived from our current rating tables. This information is regularly reviewed and updated in response to flow gaugings undertaken. Rating tables are quality-controlled, peer-reviewed by experienced hydrographers and are held in a secure, specialist and dedicated database.

Melbourne Water is unable to verify the source of the flow rate information cited by Mr Crapper in his submission (see Figure 8 on p.22 and 10 on p.24). In an attempt to do so the rating table that Melbourne Water located for the period covering September 2003 is shown in Figure 2 below. This is different from that cited in Mr Crapper's submission in the following ways:

- The rating table in Figure 2 extended to 6.1 metres, in contrast to 6.99m (see Figure 10 of Mr Crapper's submission). The basis for the extension of the rating table in Mr Crapper's submission is unclear.
- The flows shown in Figure 10 of Mr Crapper's submission do not reconcile with the rating table in Figure 2 below. For example, Mr Crapper's submission shows a corresponding flow of 294.35 m^3/sec at 6.1 m, whereas the 2003 rating table shows a flow of 150 m^3/sec.

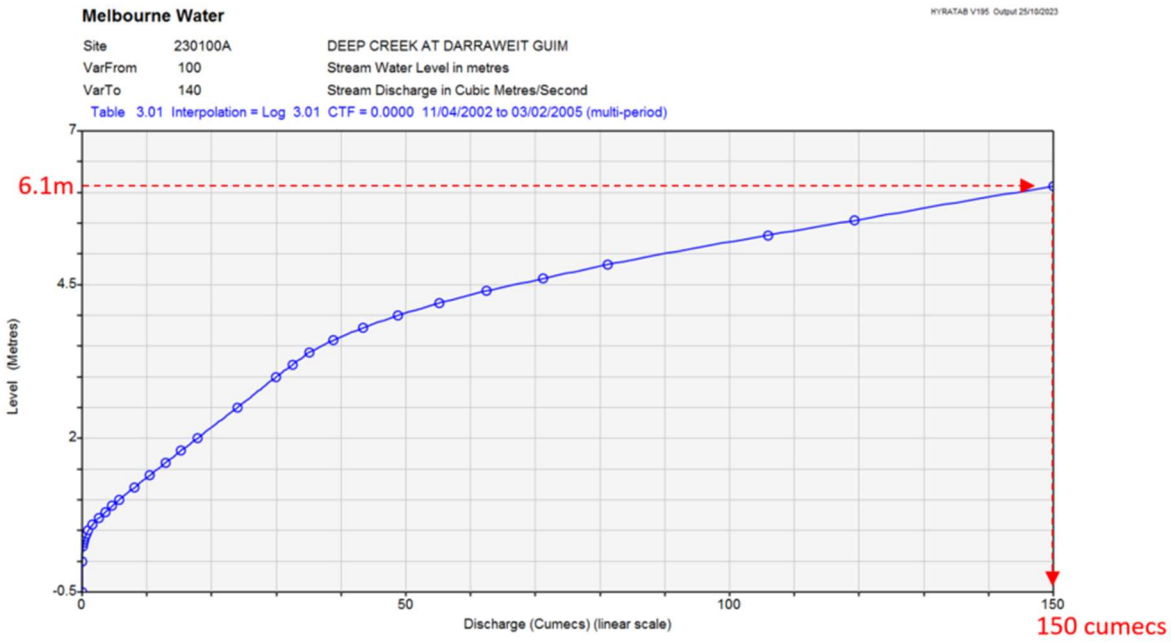

Figure 2: Plot of the Rating Table for Deep Creek at Darraweit Guim used from April 2002 to February 2005

Peak Flows Verification

Melbourne Water assessed the measured peak flows at the Deep Creek at Konagaderra and Deep Creek at Bulla gauges, which are both downstream of Darraweit Guim. These peak flows were 367 and 562 m^3/sec respectively. This is consistent with the recorded peak at Darraweit Guim of 276 m^3/sec, see Figure 3 below.

If 700 m^3/sec had been recorded at Darraweit, as claimed by Mr Crapper, then flows consistent with this should have been recorded at the gauges immediately downstream.

In addition, Melbourne Water engaged hydrographers to take real time flow measurements at the Keilor gauge around the time of the peak on the morning of Friday 14th October. These readings averaged 766 m^3/sec which is again consistent with the peak flows flowing from upstream.

Considering the catchment area to Darraweit Guim is approximately 500km^2, and to Keilor is approximately 1300km^2, the flow rate at Darraweit Guim would be considerably less than at Keilor for the October 2022 Flood Event.

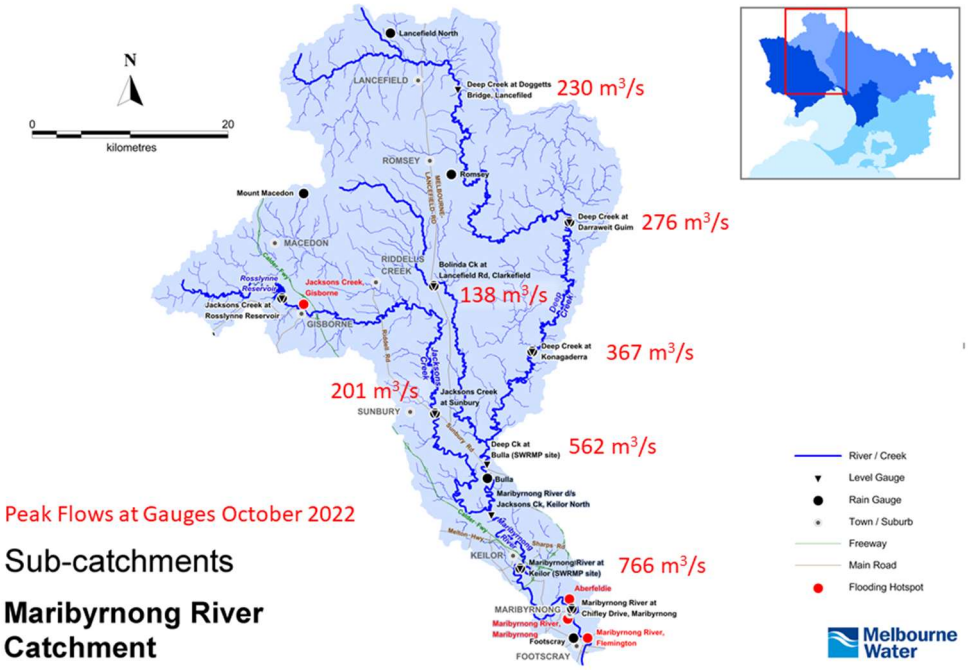

Figure 3: Peak flows at gauges for the October 2022 flood event

In addition to internal analysis, Melbourne Water also commissioned engineering consultants Jacobs to undertake a report immediately following the October flood event with the aim of understanding the conditions that led to the event and its magnitude. The report reviewed flow rates at Darraweit Guim, Keilor and Maribyrnong, and it supports Melbourne Water's assessment of the peak flow at Darraweit Guim.

Please find attached the report on the Maribyrnong Flood Event October 2022 – Post Event Analysis. It was published on Melbourne Water's website as part of the Maribyrnong River Flood Review.

2. **Response Melina Bath, page 89**

Question Asked to John Woodland:
I was going to ask about the Arundel basin, so you might want to give that on notice.

Response:

Melbourne Water commissioned a study of infrastructure and non-infrastructure options for the Maribyrnong township in 1986. The study concluded that the flood levees around the Maribyrnong township would be the most cost-effective solution but would not protect other

areas of the floodplain. It also found that the Arundel Retarding Basin would be the most effective solution for reducing flood levels across the lower catchment, however it was significantly more expensive than the levee option.

There is no simple solution as both options would alter the flood extent in other parts of the catchment, impact on private land and result in environmental and cultural impacts.

The Independent Panel's report acknowledges the difficulty in making decisions about mitigation infrastructure: "There are likely to be difficult judgments to be made and trade-offs to be considered between different objectives, requiring a holistic assessment of a wide range of mitigation strategies." para 228

Recently Melbourne Water commissioned engineering consultants to review the 1986 report, and other work undertaken, to revisit options.

The engineering consultants concluded that Arundel should not be further investigated. It would have significant environmental impacts including on the Organ Pipes National Park and in relation to breeding of fish and platypus. It would also impact an area with a large number of culturally significant sites for Traditional Owners. There would also be community impacts such as the need to acquire private property.

The consultants also concluded that the option of a levee for the Maribyrnong township would be worthy of further consideration. The levee could be up to 4m high in some sections and span 1.7km. This would raise significant community amenity issues.

In Melbourne Water's response to recommendation 15 of the Independent Panel's report we commit to undertaking further analysis of infrastructure and other options when the updated model for the Maribyrnong is finalised in April 2024.

In addition to updated modelling, further work is required to understand implications including the potential environmental, community and cultural impacts of mitigation options. A detailed cost benefit analysis would also be required. Community engagement will be an important part of progressing preferred mitigation options.

We are working closely with our partner agencies to improve coordination and help further build community awareness and preparedness.

3. **Ryan Batchelor, page 90**
   Question Asked to Nerina Di Lorenzo:
   ... I particularly care about Fishermans Bend, obviously, with a large new community about to be built in my region. Their view is that the framework is not really up to the task of dealing with those types of new residential development projects. I am just wondering if you have got any views on that and any response to the City of Melbourne.

Response:

Fishermans Bend

Melbourne Water's objective with Fishermans Bend is to support a vision as a water sensitive, climate resilient, biodiverse and liveable precinct, including reducing the magnitude and impact of flooding. Melbourne Water is working alongside Department of Transport and Planning's Fishermans Bend Taskforce (FBT), other state agencies and local government and we contributed to the development of the Fishermans Bend Water Sensitive City Strategy.

The City of Melbourne and Melbourne Water worked together to complete baseline modelling for the Fishermans Bend precinct in 2019. Subsequently, Melbourne Water completed a schematic design of the required flood mitigation infrastructure for Fishermans Bend. Following this, Melbourne Water has been working in consultation with the FBT, City of Melbourne, and Development Victoria to identify the location of flood mitigation infrastructure. Modelling continues to be reviewed and updated through the process of assessing these infrastructure options.

Planning Framework

We understand the framework referred to in the question above to be the Victorian Planning Framework and the City of Melbourne's reference to be specifically about the challenges of keeping models updated and incorporating this updated information in planning schemes, particularly in light of sea level rise and climate change.

Melbourne Water is in the process of updating all our models across the Greater Melbourne region. We are planning for this work to be progressively completed between now and 2026. As new flood information is updated, we will be seeking to work with respective local councils to incorporate this information in planning schemes.

We recognise the challenges highlighted by the City of Melbourne in seeking to do this, with some planning scheme amendments taking years to be finalised at significant cost to Melbourne Water and local councils. The risk of delayed or abandoned flood amendments results in statutory gaps in decision-making whereby flood hazard is not considered during the land use and development process.

We are keen to ensure that the flood planning and building processes are streamlined so Melbourne Water is able to better manage flood risk and the community and key stakeholders have access to the best available information in a timely manner to understand their flood risk.

4. **Ryan Batchelor, page 91**
Question Asked to Nerina Di Lorenzo:
…I am wondering if you have done any research, any behavioural analysis or any engagement with people about their understanding about things like 'one-in-100-year' and

what that means to them from a prospective purchaser point of view, if someone is looking at buying a place, and just in general terms. Do you think people understand flood risk? And is there any research that you have got that you might be able to share with the committee about that?

Response:

To measure the community's understanding of flood risk, we commenced a program of monitoring in 2015 to baseline the level of 'flood readiness' in the community. This survey was repeated in 2018 and 2021:

- 2015 - Benchmarking Flood Ready Behaviour Report
- 2018 - Flood Risk Awareness Report
- 2021 - Flood Management Social Research Survey Report[1]

Over this period Melbourne Water worked with VicSES and local councils to improve community education, awareness and preparedness by delivering broad community flood education programs to 12,000 at-risk households.

The 2015 survey set a baseline and found that 41% of those residing at a flood prone address were aware of their risk. Of those surveyed 32% felt that they were prepared for flooding. In the 2018 survey there was a small increase in awareness – up 3% to 44% and a small increase in preparedness – up 2% to 34%.

In 2021 the methodology was changed. While the 2015 and 2018 research only surveyed communities targeted with VicSES activities, the 2021 research took a much broader view, sampling from all areas identified by Melbourne Water as being at risk of a one in 100-year flood event. With this changed methodology, the level of awareness decreased significantly to 19% and preparedness to 18%.

The 2021 survey also considers awareness and preparedness across a range of natural events. It finds that the levels of awareness are highest for severe weather/storms and extreme heat, with flooding ranked fifth ahead of earthquake and landslide. For preparedness, the levels of preparedness are highest for extreme heat and house fire, with flooding ranked fifth ahead of landslide and earthquake.

Melbourne Water is currently partnering with the University of Melbourne on the Community Engagement for Disaster Risk Reduction (CEDRR) project. This project explores how awareness and learning affect flood risk mitigation at a household scale. Considering the relatively low translation of receiving information about flood risk into

[1] This report estimates that Melbourne has 894,000 properties in flood-prone areas. Melbourne Water has been unable to validate this figure. Melbourne Water estimated that there are 200,000 properties at risk of flooding, based on the LSIOs and SBOs in place in 2020.

awareness or preparedness from traditional campaigns, CEDRR uses relationship building as the basis for initiating and supporting flood risk mitigation amongst participants.

The CEDRR methodology involves a two-stage process that first undertakes online or face-to-face engagement with participants and, following 4-6 months, a follow-up engagement. The objective is to increase flood risk awareness and preparedness in the households engaged, while also establishing a rigorous understanding of the range of factors on a personal and household scale that impact how information can catalyse learning, action, and 'spillover' effects that help amplify disaster resilience among communities.

Pilot projects were delivered in Whittlesea and Banyule to test in person and online methodologies. The CEDRR program is in its second year of a five-year partnership. The University of Melbourne is significantly ahead of schedule and has a dataset with more than 10,000 door knocks completed. The engagements in Kingston are complete; 95% of all households at risk of flooding in the 1% AEP were engaged. Initial engagements in Darebin are also completed and there are ongoing partnerships with not-for-profit community groups in Darebin.

Preliminary results show that 91% of CEDRR participants are now 'aware' of their flood risk as a result of the engagement with the University of Melbourne. This demonstrates the engagement approach is having a greater impact when compared to awareness raising. The increases in awareness have led to households taking action to mitigate their flood risk such as:

- moving household appliances
- preparing homes for a power outage if flooded
- landscape drainage changes, gutter work, and
- changing home insurance provider to have comprehensive cover in case of flood

72% of participants `spill over' their learning to non-participants, enhancing the overall project impact and reach.

Melbourne Water is working to support the community by building awareness of flood risk. This year we delivered a targeted social media campaign to people in the Maribyrnong catchment for flood preparedness. This reached 90,000 people. We also ran a CALD campaign in Vietnamese, Italian, Mandarin and Cantonese which reached 30,000 people. It linked to the VicSES website, enabling people to access information relevant to their area.

Melbourne Water and VicSES completed a letterbox drop to 3,000 residences in Maribyrnong, Avondale Heights, Aberfeldie, Flemington, Kensington, West Melbourne, Keilor and Ascot Vale. This contained a community bulletin on the Maribyrnong River Flood Review and a Know Your Flood Risk information. This was translated into five community languages. (Sept 2023)

We have also commenced discussions with VicSES about how to work together on flood preparedness moving forward across the Greater Melbourne region. Melbourne Water and

VicSES will be holding an agency workshop in November to identify hotspots across the region so that engagement can be targeted to specific locations. The workshop will also consider the value of different engagement approaches.

It is a requirement that a section 32 statement is provided to all potential purchasers of property. This is a legal document that is prepared by the seller's conveyancer, under the Sale of Land Act 1964 (Vic). The application of any flood related planning controls such as a Land Subject to Inundation Overlay (LSIO) or a Special Building Overlay (SBO) must be disclosed in the section 32 statement.

5. **Wendy Lovell, page 93**
Question Asked John Woodland:
…Mr Woodland, in answer to the Chair's question regarding the difference of opinion between yourself and Mr Crapper, you offered to provide the technical detail. I wondered if you could provide that to us in writing.

Response:

Please see Melbourne Water's response to Question 1 addressing the technical detail of the differences of opinion between Mr Crapper and Melbourne Water and Question 6 on the RORB modelling.

6. **Wendy Lovell, page 93**
Question Asked to John Woodland:
And I would also be interested in your views on section 2.3 of Mr Crapper's submission, on the RORB modelling.

Response:

The RORB model developed by Monash University for understanding flood extent for planning purposes was adapted by Melbourne Water to be a real time model for flood forecasting. As this was a bespoke product it was difficult to continue to provide technical support and enable further development of the modelling software.

In the mid-2000s Melbourne Water embarked on a program to update its real-time flood forecasting models. We ultimately selected URBS (Unified River Basin Simulator), to replace the Real-Time RORB. URBS is widely used for operational flood forecasting throughout Australasia, including by the Bureau of Meteorology, and is considered the industry standard. It is also fully supported technically and able to be further developed externally. Some data files from RORB were brought across so the improvements URBS provided could be leveraged.

URBS is used before and during floods to determine how much river flow is forecast from a rainfall event. The flow can then be used to determine a forecast flood hydrograph indicating minor, moderate or major flooding into the future.

The URBS models are run within the Melbourne Water's FIDSS (Flood Intelligence Decision Support System). The system brings together real-time data from sensors in the catchment (rain and river level gauges), data on catchment wetness and forecast rainfall and tide levels (provided by the Bureau of Meteorology), catchment mapping and flood modelling. It uses software known as Delft-FEWS (Flood Early Warning System), which is widely used throughout the world, and is also used the by the Bureau of Meteorology for flood forecasting.

While the time taken for a computer to run the Maribyrnong URBS model is less than 60 seconds, it can take between 30 and 90 minutes to prepare a flood forecast for the catchment. The flood forecasting process for the Maribyrnong catchment includes the following steps:

- Reviewing the recorded rainfall (10 sites) and forecast rainfall, reviewing observed river levels (11 sites)
- Discussion and selection of forecast rainfall scenarios with the Bureau of Meteorology.
- Running the model and reviewing initial results
- Tuning the model parameters to match the predicted and observed river levels
- Reviewing and interpreting the final model results
- Peer review of results
- Preparing flood maps showing the timing and extent of predicted flooding for VicSES
- Preparing the flood warning for publishing by the Bureau of Meteorology
- Discussing flood predictions with Melbourne Water Incident Team members for further action

Melbourne Water provides flood level forecasts for four sites in the Maribyrnong catchment – Darraweit Guim, Keilor, Maribyrnong and Rosslynne Reservoir.

Before the rain event, model runs are prepared for the most likely rainfall scenario, and a higher possible rainfall forecast scenario, to cater for uncertainty in forecasts and to allow the VicSES to plan.

7. **Wendy Lovell, page 94**
Question Asked to Craig Dixon:
What are your views on the pondage that they refer to as 'retarding basins', which as far as I can see are not retarding basins, they are just management of stormwater.

…

To be retarding basins they should empty. They are pondage – there is water in them. They are complaining now about carp breeding in them.

Response:

The wetlands are not 'retarding basins'. They are not intended to have a flood mitigation function.

The wetlands formed part of the development's original surface water management concept plan provided to Melbourne Water in 2003. The wetlands were designed for the primary purpose of local catchment runoff and to facilitate water recycling, and storage of treated stormwater for use in site irrigation. They also have a landscape function.

We note the submissions made by Tigcorp to the Inquiry (Submission No 524, 1 June 2023) make various references to 'retarding basins' on the site. In particular, we note the statement at page 3:

> *The previous owners had received approval from the Victorian Civil and Administrative Tribunal (VCAT) to build an aged care facility and retirement village complex on the site. The approved village design included building on part of the land that was covered by a 'Land Subject to Inundation Overlay' (LSIO) subject to various conditions including providing retarding basins and re-shaping elements of the site to mitigate the risk of flooding.*

We wish to make it clear to the Inquiry that the VCAT Order dated 21 June 2006, referred to by Tigcorp, does not impose any condition in respect of providing 'retarding basins'. The VCAT Order notes the purpose of the proposed wetlands in respect of water recycling and landscape irrigation, and that on the expert evidence before it, there was no reason to reject the application for reasons relating to the operation of the floodway and floodplain. The VCAT Order provides that the landscape plan will be subject to Melbourne Water's approval to ensure that any proposed works do not compromise floodplain objectives.

Accordingly, the relevant condition of the Permit (MV/168662004) provides:

> *39. Earthworks*
>
> *(a) Prior to the commencement of any works, detailed design plans of the proposed wetlands, including design levels and appropriate computations, must be submitted to Melbourne Water for approval.*

The impact of the wetlands on the floodplain area was the subject of expert reports and detailed landscape plans submitted to Melbourne Water throughout the development process in its capacity as the referral authority. In exercising its functions as referral authority Melbourne Water considered both the flood-flow capacity and water velocity across the wetlands and was satisfied that the landscaping and wetlands plans would not have any significant adverse impact on the Maribyrnong floodplain.

8. **Rikkie-Lee Tyrrell, page 96**
Question Asked to Nerina Di Lorenzo:
Rikkie-Lee TYRRELL: And is there any infrastructure that you see could help in the future for Melbourne Water to do their job more efficiently?

…

Nerina DI LORENZO: And we will provide the scoping report to you, so you will know what we know.

Response:

Please find attached the report by engineering consultants, commissioned by Melbourne Water, on Maribyrnong Flood Mitigation Options: Evaluation of Past Options. See our response to Question 2 above for a summary of key findings and future actions, including engagement with the community.

9. **Gaelle Broad, page 98**
Question Asked to John Woodland:
…Wendy mentioned you are providing a response to Geoff Crapper's submissions. He talked about some correspondence that he had sent; he has shared some emails. Are you able to on notice provide a response to that from Melbourne Water?

Response:

Mr Crapper emailed Mr Woodland on two occasions (7 and 8 June 2023) to provide information relating to his analysis of the flood flow data for Deep Creek at Darraweit Guim during the October 2022 flood event.

In response to emails from Mr Crapper, Mr Woodland acknowledged receipt and committed to reviewing the information provided. He also said that if there was need for further discussion that he would be in contact. Mr Woodland did not consider that there was need to engage directly with Mr Crapper further given that Melbourne Water was appearing before the Independent Review and the Parliamentary Inquiry in relation to these matters.

Please see Melbourne Water's response to Question 1 addressing the matter raised by Mr Crapper in these emails.

10. **Gaelle Broad, page 98**
Question Asked to John Woodland:
Just, also, recommendations – Geoff talked about how 10 or 15 of the recommendations were things that they used to do on a daily basis at Melbourne Water. Would you be happy to

provide a response on notice to those?

Response:

Melbourne Water has published a response to each of the recommendations from the Independent Panel's report on the Maribyrnong River Flood Review. We have attached a copy for your reference.

Modelling for forecasting purposes

Melbourne Water regularly reviews our rating tables (river height/flow relationship). Ahead of the October 2022 event, the Keilor rating table was extrapolated for the expected high flows. The expected high flows had not previously been recorded at this gauge and so it was necessary to use the best available information to extrapolate the rating table. During the event it was found that the extrapolation was inaccurate for the level. On the morning of 14 October hydrographers went to the Keilor site and measured flow to enable the rating table to be improved.

Melbourne Water has commissioned a pilot project at Keilor to extrapolate the rating table using four different methods. Those methods will be reported on and any findings will be used to inform the rollout of improvements across the gauge network for readings at more extreme levels that have not previously been recorded at each gauge. This will be increasingly important in the face of climate change impacts where storms may be more severe.

Modelling for planning purposes

Melbourne Water maintains technical specifications (AM STA 6200 Flood Mapping Project Specifications) for its flood models. The most recent Specifications were updated June 2023. These standards align with industry standard Australian Rainfall and Runoff Guidelines 2019.

Flood modelling practice has changed substantially, particularly in the new millennium. The period since the turn of the century has seen enormous growth in computing power which has facilitated more detailed and accurate representation of the floodplain. In turn, this has driven newer and more complex analyses requiring more data and computations.

Additionally, the global understanding of climate change has substantially increased. This science has now been reflected in modelling standards and is being introduced into Melbourne Water's development planning.

Flood modelling is a complex and lengthy technical process which can take years to complete. Flood models typically consist of a hydrological model (which converts rainfall into runoff) and a hydraulic model (which converts the runoff into flood extent, depth and velocity).

Key inputs are LiDAR and bathymetry. LiDAR is used to map and determine the shape of the land across the catchment and bathymetry is used for the bed of the waterway. This information is collected on a one metre grid basis and requires detailed analysis.

Once models are developed, they are calibrated against previous events. To place the effort into context it is anticipated that the hydraulic flood model will be run hundreds of times with each model run taking millions of individual calculations generating gigabytes and possibly terabytes of data. All of this information then needs to be quality analysed and quality assured.

To assure the quality of our models we also have a third-party program in place for peer review and quality assurance.

Melbourne Water is leading an escalation in the regional flood modelling program across our area of operations by 2026 which incorporates the Australian Rainfall and Runoff (ARR) Guidelines (2019), including climate change. The previous ARR (1987) did not recognise or provide guidance on the effects of climate change.