Stage 1A of Victorian Constraints Measures Program

Synthesis report – Hydraulic modelling

Final

September 2023

Document status

Client	Department of Energy, Environment and Climate Action
Project	Stage 1A of Victorian Constraints Measures Program
Report title	Synthesis report - Hydraulic modelling
Version	Final
Authors	Simon Lang, Andrew Northfield, Tim Craig
Project manager	Simon Lang
File name	VIC00092_Stage 1A Constraints Measures Program_HydraulicSynthesis-Final
Project number	VIC00092

Document history

Version	Date issued	Reviewed by	Approved by	Sent to	Comment
Draft A	Oct. 2022	D. Stephens	D. Stephens	Sequana	For internal team review
Final	Sep. 2023	S. Lang	S. Lang	Sequana, DEECA	Finalised report for Stage 1A

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ISBN 978-1-76136-663-5

Contents

Executive Summary

The key outcomes from the hydraulic modelling completed for Stage 1A of the Victorian Constraints Measures were:

- The development and calibration of hydraulic models tailored to simulate flow magnitudes relevant to constraint relaxation investigations for the mid-Goulburn, lower Goulburn and nine zones of the River Murray.
- The use of these hydraulic models to simulate steady-state flows at intervals of 2,000 ML/d – 5,000 ML/d between current operational constraints and potentially relaxed constraints for the Goulburn River and River Murray.
- The conversion of the hydraulic modelling results to high-resolution GIS grids of predicted water level, inundation area and water depth along the Goulburn River and River Murray.

These outcomes are consistent with recommendations made and deliverables proposed in the Stocktake Review (Sequana Partners, 2022) for Stage 1A of the Victorian Constraints Measures Program. Outputs from the hydraulic modelling task have been used to inform the assessment of the environmental benefits of constraint relaxation along the Goulburn River and River Murray, and the evaluation of potential impacts on private property and public assets.

The key differences between the Goulburn River hydraulic modelling for Stage 1A of the Victorian Constraints Measures Program and the previous work reviewed by Wilson et al. (2019) were that:

- Additional bathymetry datasets (depth soundings and cross-section surveys) for the mid-Goulburn were incorporated into the digital elevation model used in the hydraulic model.
- The hydraulic modelling results were produced using 2 m grid cells, rather than 10 m grid cells. This means the information is more meaningful at the scales that property owners and public land managers are most interested in.
- The steady-state flows simulated for the mid-Goulburn (10,000 – 14,000 ML/d) and lower Goulburn (10,000 – 25,000 ML/d) were generally lower than the range of flows modelled by Water Technology (2016) for the previous constraint relaxation business cases.

Compared with the hydraulic modelling that informed previous business cases for constraints relaxation along the River Murray, the information available from the hydraulic models developed by the MDBA and MHL for the nine zones between Hume Dam and the Wakool Junction are a step-change improvement.

This is because the 1D/2D and fully 2D hydraulic models developed by the MDBA and MHL simulate the movement of water through the river channels and floodplain, and these models have been calibrated to flow data and aerial imagery available for recent flow events. In contrast, the previous estimates of inundation extents along the River Murray were based on the RiM-FIM approach (Sims et al., 2014), which estimated a static water level for a given flow threshold by interpolating between historical inundation extents that were linked to corresponding flows at gauged locations. The estimates of inundation extents available from the MDBA and MHL hydraulic models are therefore more defensible, particularly for river reaches with no or very few streamflow gauges.

1. Introduction

1.1 Workstream objective

Hydraulic modelling is used to map the expected depth and extent of inundation under different flow conditions. When combined with hydrological modelling, hydraulic modelling results can be used to estimate and communicate the expected environmental, cultural, social, and economic outcomes of relaxing operational constraints along the Goulburn River and River Murray.

A key finding from a review of the previous hydraulic modelling done for constraint relaxation investigations (Wilson et al., 2019) was that the modelling done to date *is not suitable for assessing and communicating the third-party risks. The modelling has been undertaken at an aggregate scale for planning purposes…. The available modelling does not produce the information required to access and communicate risks to landholders, local governments, and infrastructure managers*.

Therefore, the objective of the hydraulic modelling completed under Stage 1A of the Victorian Constraints Measures Program was to *use the best available models and data to improve the confidence in the information available to assess and communicate to the community and government agencies the changes to inundation depths and extents expected under regulated flow conditions when operational constraints are relaxed*.

1.2 Scope of work

The scope of work for the hydraulic modelling for Stage 1A of the Victorian Constraints Measures Program is described in Section 4 of the Stocktake Review (Sequana Partners, 2022). In summary:

Goulburn River

- New bathymetry datasets (depth soundings and cross-sections) were incorporated into the existing hydraulic (TUFLOW 2D) model of the Goulburn River.
- The downstream boundary of the hydraulic model was moved to the River Murray.
- The model was calibrated to gauged streamflow rating curves at six locations between Lake Eildon and the River Murray, and verified against aerial imagery of areas inundated during a September 2010 high flow event.
- The model was used to simulate water levels, water depth and bed shear stress for four steady-state flow conditions in the mid-Goulburn (Lake Eildon to Goulburn Weir) and four steady-state flow conditions in the lower Goulburn (Goulburn Weir to River Murray).
- The model results were mapped in an online GIS platform.

River Murray

- Hydraulic model outputs and documentation prepared by the MDBA and MHL for the NSW Reconnecting River Country project were made available via a data sharing agreement between NSW and Victoria.

- The MDBA and MHL were engaged by Victoria to simulate two additional scenarios in each reach of the River Murray study area, and the hydraulic modelling results for these scenarios were compared with those available from the NSW Reconnecting River County project.
- The model results were mapped in an online GIS platform.

1.3 This report

In this report:

- Section 2 provides an overview of how the hydraulic modelling was done for Stage 1A of the Victorian Constraints Measures Program. More detailed model development reports are provided in the appendices.
- Section 3 includes an example of the hydraulic modelling results that have been produced, and describes how to interpret them.
- Section 4 summarises key outcomes from the hydraulic modelling.
- Section 5 includes recommendations for further improvements to the hydraulic modelling used for constraints relaxation investigations if the Victorian Constraints Measures Program proceeds to Stage 1B.

2. Approach

This report section summarises:

- The details of the hydraulic models used for each section of the study area for Stage 1A of the Victorian Constraints Measures Program.
- The flow scenarios that were simulated using the hydraulic models.
- How work done for Stage 1A addresses recommendations from the review of previous hydraulic modelling done for constraint relaxation investigations (Wilson et al., 2019).

2.1 Models used

Table 1 lists the hydraulic modelling software used for Stage 1A of the Victorian Constraints Measures Program, and the organisation that developed the model for each river / zone. Figure 1 shows the extent of the Goulburn River hydraulic model, and Figure 2 the location of the nine zones used to hydraulically model the River Murray. Zones 4 and 6 do not include areas of Victoria, and are therefore not considered in this report.

The model development reports included as Appendix A – H and referenced in Table 1 describe how the models were built and calibrated, but in general the approach was:

- Create a digital elevation model for the hydraulic model using LiDAR and bathymetry data.
- Adopt plausible Manning's n (roughness) values for the channel and floodplain areas.
- Run steady-state flows and individual flood event flows through the hydraulic model, and compare the modelled water levels and inundation extents with streamflow gauge rating curves, gauged water levels of individual events and/or historic inundation extents mapped from aerial imagery.
- Adjust the Manning's n values within acceptable bounds until there is a good match between the modelled and observed water levels and inundation extents.

Table 1: The hydraulic models used

River – Reach	Hydraulic model	Done by	Development report
Goulburn River – mid-Goulburn and lower Goulburn	TUFLOW 2D	HARC	Appendix A
River Murray – Hume to Yarrawonga (Zone 7)	MIKE FLOOD (1D / 2D)	MDBA	Appendix B
River Murray – Yarrawonga to Tocumwal (Zone 8)	MIKE21 Flow Model FM	MDBA	Appendix C
River Murray – Barmah-Millewa (Zone 1)	MIKE FLOOD (1D / 2D)	MDBA	Appendix D
River Murray – Barmah to Torrumbarry (Zone 9)	TUFLOW 1D / 2D	MHL	Appendix E
River Murray – Koondrook-Perricoota (Zone 3)	MIKE FLOOD (1D / 2D)	MDBA	Appendix F
River Murray – Wakool River reach (Zone 2)	MIKE21 Flow Model FM	MDBA	Appendix G
River Murray – Niemur-Murray-Boundary Bend (Zone 5)	MIKE21 Flow Model FM	MDBA	Appendix H

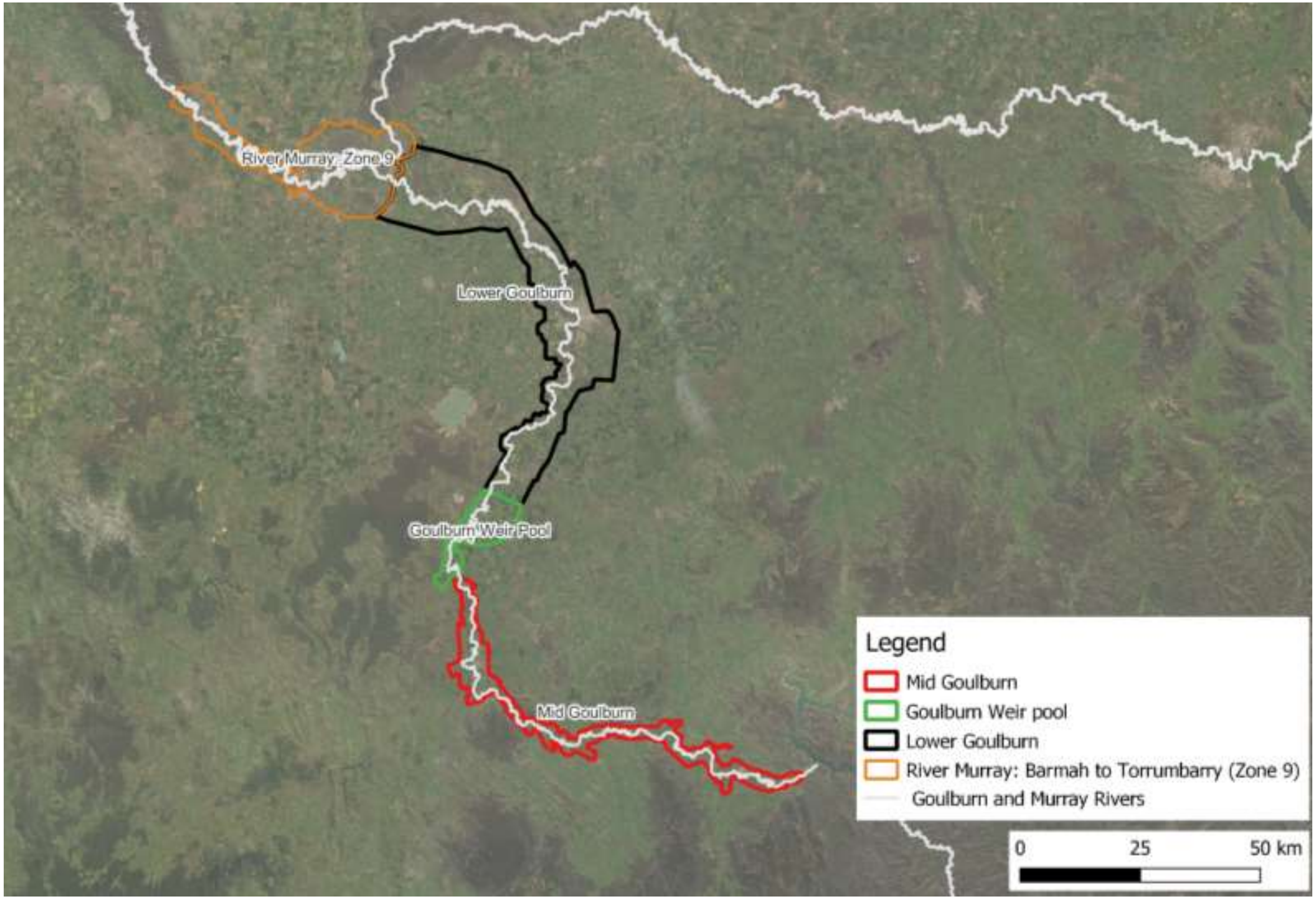

Figure 1: The extent of the hydraulic models used to simulate constraint relaxation scenarios for the mid-Goulburn and lower Goulburn River.

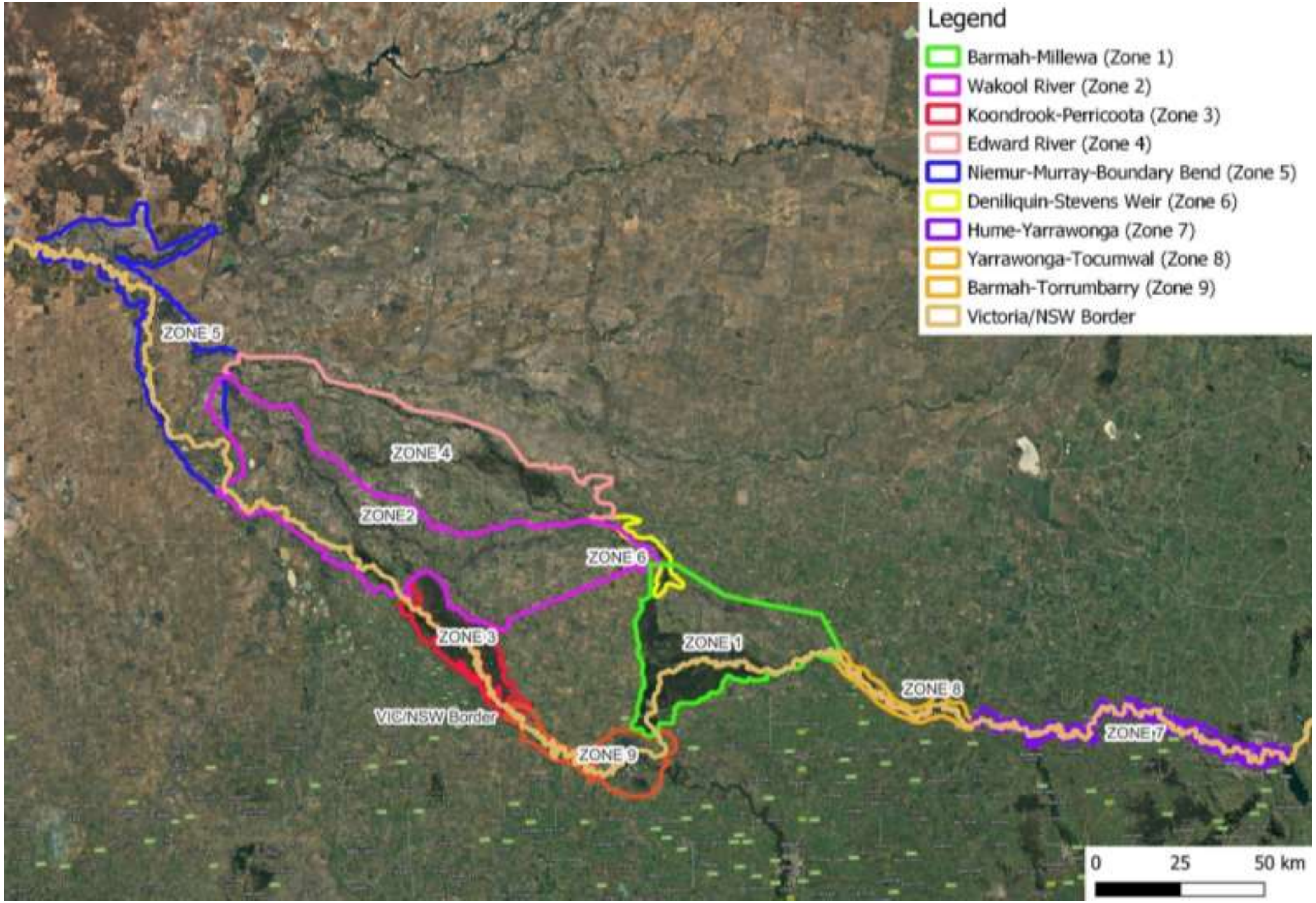

Figure 2: The nine zones used along the River Murray for the purpose of hydraulically modelling constraint relaxation scenarios

Small amounts of ground-truthing the inundation extents with public land managers and/or private landholders was also completed as part of Stage 1A of the Victorian Constraints Measures Program. And towards the end of Stage 1A, the hydraulic model results were compared with aerial imagery of areas inundated along the Goulburn River and River Murray during September-October 2022. The outcomes of these comparisons for the Goulburn River are available in a HARC (2023a) memo, which is included as Appendix J of this report. The comparisons along the nine zones of the River Murray are still being completed by the MDBA at the time of writing. Further ground-truthing is recommended if the Victorian Constraints Measures Program proceeds to Stage 1B (Section 5).

2.2 Scenarios simulated

The calibrated hydraulic models were used to simulate steady-state flows at regular intervals between the current operational constraint thresholds and the upper bounds of constraint relaxation considered during Stage 1A of the Victorian Constraints Measures Program. Table 2 and Table 3 list all the flows hydraulically modelled for the Goulburn River and River Murray respectively.

In Table 2 the M and the L labels denote the operational constraint in the mid-Goulburn and lower Goulburn intended to be represented by the flows that were hydraulically modelled. The same applies in Table 3, where the Y and D labels denote the operational constraint at Yarrawonga Weir and Doctors Point intended to be represented by the flows that were hydraulically modelled for the nine River Murray zones. For example, M10L17 is shorthand for a scenario where the mid-Goulburn operational constraint is 10,000 ML/d and the lower Goulburn operational constraint is 17,000 ML/d. Y30D30 is shorthand for a scenario where the operational constraint is 30,000 ML/d at both Yarrawonga Weir and Doctors Point.

On the Goulburn River and for zones 7 and 8 of the River Murray, the steady-state flows simulated in the hydraulic models matched the existing and potentially relaxed operational constraints used in the hydrology modelling. For example:

- In the mid-Goulburn, the steady-state flows simulated were 10,000 ML/d, 12,000 ML/d and 14,000 ML/d, and these matched the existing and potentially relaxed operational constraint at Molesworth that was included in the hydrology modelling for the Goulburn River.
- In the lower-Goulburn, the steady-state flows simulated were 10,000 ML/d, 17,000 ML/d, 21,000 ML/d and 25,000 ML/d, and these matched the existing and potentially relaxed operational constraints at Murchison and Shepparton that were included in the hydrology modelling for the Goulburn River.
- In zone 7 of the River Murray (Hume to Yarrawonga Weir), the steady-state flows were modelled in 5,000 ML/d increments between 25,000 ML/d and 40,000 ML/d. These thresholds matched the existing and potentially relaxed operational constraint at Doctors Point that was included in the hydrology modelling for the River Murray.
- In zones 8 and 1 of the River Murray, the steady-state flows were modelled in 5,000 ML/d increments between 15,000 ML/d and 50,000 ML/d. These thresholds matched the existing and potentially relaxed operational constraint downstream of Yarrawonga Weir that was included in the hydrology modelling for the River Murray.

Table 2: Scenarios hydraulically modelled for the Goulburn River

River – Reach	Reference gauges	Steady-state flow (ML/d) at reference gauges for given constraint scenario				
		Current	M10L17	M10L21	M12L21	M14L25
Goulburn River – mid-Goulburn* (Eildon to Goulburn Weir pool)	Goulburn River at Eildon	10,000	10,000	10,000	12,000	14,000
	Goulburn River at Trawool	10,000	10,000	10,000	12,000	14,000
	Goulburn River at Seymour	10,000	10,000	10,000	12,000	14,000
Goulburn River – lower Goulburn^ (Goulburn Weir to River Murray)	Goulburn River at Murchison	10,000	17,000	21,000	21,000	25,000
	Goulburn River at Shepparton	10,000	17,000	21,000	21,000	25,000
	Goulburn River at McCoys Bridge	10,000	17,000	21,000	21,000	25,000

* A 17,000 ML/d scenario was also modelled for the mid-Goulburn for internal project team purposes

For the Goulburn Weir pool between the mid-Goulburn and lower Goulburn hydraulic model extents, the inundated area was represented in all scenarios using the full supply level (FSL) of 124.24 m AHD. This is because for the range of operational constraint relaxation considered in the mid-Goulburn (10,000 ML/d – 14,000 ML/d) the operation of Goulburn Weir controls the area inundated within the weir pool, rather than the flow rate. For context, the minor flood level for the Goulburn River at Goulburn Weir is defined in the Nagambie Flood Emergency Plan (https://www.strathbogie.vic.gov.au/images/Emergency_Management/Flood-Emergency-Management-Plan-2020.pdf) as corresponding with a flow of 36,700 ML/d.

For the River Murray zones downstream of zone 1 (zones 2-6 and 9), the steady-state flows that best corresponded with steady-state flows of varying magnitude downstream of Yarrawonga Weir were estimated by the NSW Department of Planning and Environment (DPE).

These estimates were informed by consideration of:

- Modelled outflows from the hydraulic model in the zone upstream.
- Flow peak to flow peak and/or flow volume to flow peak correlations observed in the historic records available for the reference gauges.
- Results from the hydrology modelling done using the Source Murray Model; i.e. the flows expected at reference gauges following environmental water deliveries to downstream of Yarrawonga Weir.

Table 3 lists the steady-state flows adopted at the reference gauges within the River Murray zones 2-6 and 9 for each operational constraint scenario simulated in the hydraulic models.

For Zone 3, three additional steady-state flow scenarios were also simulated by the MDBA, in anticipation that these results will be useful for potential future constraint relaxation investigations. These scenarios were 17,500 ML/d, 22,500 ML/d (requested by Victoria) and 25,000 ML/d (requested by NSW) for the River Murray downstream of Torrumbarry Weir.

Table 3: Scenarios hydraulically modelled for the River Murray zones.

River – Reach	Reference Gauge	Steady-state flow (ML/d) at reference gauge for given constraint scenario						
		Y15D25	Y25D25	Y30D30	Y35D35*	Y40D40	Y45D40*	Y50D40
River Murray – Hume to Yarrawonga (Zone 7)	River Murray at Doctors Point	25,000	25,000	30,000	35,000	40,000	40,000	40,000
River Murray – Yarrawonga to Tocumwal (Zone 8)	River Murray downstream of Yarrawonga Weir	15,000	25,000	30,000	35,000	40,000	45,000	50,000
River Murray – Barmah-Millewa (Zone 1)	River Murray at Tocumwal	15,000	25,000	30,000	35,000	40,000	45,000	50,000
River Murray – Barmah to Torrumbarry (Zone 9)	River Murray at Barmah	12,000	19,000	21,000	23,000	a) 25,000 b) 25,000	26,000	a) 27,000 b) 27,000
	Goulburn River at McCoys Bridge	9,500	17,000	17,000	17,000	a) 17,000 b) 21,000	17,000	a) 20,000 b) 25,000
	Campaspe River at Rochester	1,400	1,400	1,400	1,400	a) 1,400 b) 1,400	1,400	a) 1,400 b) 1,400
River Murray – Koondrook-Perricoota (Zone 3)	River Murray downstream of Torrumbarry Weir	20,000	30,000	35,000	35,000#	40,000	40,000#	45,000
River Murray – Wakool River reach (Zone 2)	River Murray at Barham	19,320	24,450	25,630	26,940	28,250	29,150	30,050
	Barbers Creek downstream of Koondrook-Perricoota forest	90	1,390	1,860	2,080	2,300	2,505	2,710
	Cow Creek downstream of Koondrook-Perricoota forest	50	630	1,400	2,150	2,900	3,805	4,710
	Calf Creek downstream of Koondrook-Perricoota forest	-	-	-	-	-	-	20
	Thule Creek downstream of Koondrook-Perricoota forest	-	1,450	2,480	2,890	3,300	3,525	3,750
	Wakool River at Offtake	100	550	870	1,135	1,400	1,600	1,800
	Yallakool River at Offtake	610	1,300	1,500	1,700	1,900	2,050	2,200
	Niemur River at Mallan School	1,100	2,500	3,200	3,700	4,200	4,800	5,400
	Little Murray River at Little Murray Weir	5,300	8,600	10,000	11,000	12,000	13,000	14,000
	Merran Creek at Franklin Bridge	440	620	700	750	800	840	880

River – Reach	Reference Gauge	Steady-state flow (ML/d) at reference gauge for given constraint scenario						
		Y15D25	Y25D25	Y30D30	Y35D35*	Y40D40	Y45D40*	Y50D40
River Murray – Niemur-Murray-Boundary Bend (Zone 5)	River Murray at Swan Hill	19,000	23,000	24,500	25,250	26,000	26,500	27,000
	Wakool River at Stoney Crossing	3,200	11,000	16,000	19,000	22,000	25,000	28,000
	Edward River at Liewah	4,000	7,000	8,000	8,500	9,000	9,500	10,000
	Murrumbidgee River at Balranald	8,000	10,000	11,000	11,500	12,000	12,000	12,000

* values interpolated as midpoint between values in adjacent columns

Instead of re-running the Zone 3 hydraulic model, results for these two scenarios were estimated using outputs available from the NSW Reconnecting River Country project for the most similar flow rate

2.3 Comparison to previous work

Goulburn River

The key differences between the Goulburn River hydraulic modelling for Stage 1A of the Victorian Constraints Measures Program and the previous work reviewed by Wilson et al. (2019) was that:

- Additional bathymetry datasets (depth soundings and cross-section surveys) for the mid-Goulburn were incorporated into the digital elevation model used in the hydraulic model.
- The hydraulic modelling results were produced using 2 m grid cells, rather than 10 m grid cells. This means the information is more meaningful at the scales that property owners and public land managers are most interested in.
- The steady-state flows simulated for the mid-Goulburn (10,000 – 14,000 ML/d) and lower Goulburn (10,000 – 25,000 ML/d) were generally lower than the range of flows modelled by Water Technology (2016) for the previous constraint relaxation business cases.

River Murray

Compared with the hydraulic modelling that informed previous business cases for constraints relaxation along the River Murray, the information available from the hydraulic models developed by the MDBA and MHL for the nine zones between Hume Dam and the Wakool Junction are a step-change improvement.

This is because the 1D/2D and fully 2D hydraulic models developed by the MDBA and MHL simulate the movement of water through the river channels and floodplain, and these models have been calibrated to flow data and aerial imagery available for recent flow events. In contrast, the previous estimates of inundation extents along the River Murray were based on the RiM-FIM approach (Sims et al., 2014), which estimated a static water level for a given flow threshold by interpolating between historical inundation extents that were linked to corresponding flows at discrete gauged locations. The estimates of inundation extents available from the MDBA and MHL hydraulic models are therefore more defensible, particularly for river reaches with no or very few streamflow gauges.

3. Example results

The hydraulic model estimates of water level, and hence inundation area and depth, were converted to GIS grids of 1-2 m and displayed in a web-based viewer available to DELWP and the project team via https://coffeygis.tetratech.com/arcgis/apps/webappviewer/index.html?id=732405d98c4f482080f7df3836de07ee#.

For the River Murray, the hydraulic model results for the 25,000 ML/d, 30,000 ML/d and 40,000 ML/d flow at Doctors Point scenarios, and for the 15,000 ML/d, 25,000 ML/d, 30,000 ML/d and 40,000 ML/d flow at Yarrawonga Weir scenarios were also displayed as 'upper limit' inundation extents in the public Reconnecting River Country portal (https://caportal.com.au/dpe/rrc).

Figure 3 and Figure 4 provide examples of the types of GIS grids produced from the hydraulic model results, and how they were displayed in the web-based viewer. Figure 3 is for a 12,000 ML/d flow at Thornton in the mid-Goulburn, and Figure 4 is for a 30,000 ML/d flow at Corowa. The darkness of the blue in the areas inundated indicates the modelled water depth, and the yellow labels show the modelled water level (in m AHD).

The use of steady-state hydraulic model scenarios to develop maps such as Figure 3 and Figure 4 means that the predicted water levels and depths are for total flows at that particular location. For example, the water levels and depths in Figure 4 are for a flow of 30,000 ML/d at Corowa, regardless of whether the 30,000 ML/d is comprised solely of releases from Hume Dam, or is combination of releases from Hume Dam and inflows from tributaries such as the Kiewa River. Table 2 and Table 3 list all the steady-state scenarios that were hydraulically modelled for the Goulburn River and River Murray respectively.

The influence of Goulburn River and River Murray flows on tributary creeks and rivers was hydraulically modelled by simulating no or low tributary inflows, and allowing the main stem water levels to 'back-up' the tributaries. This approach will have estimated the maximum distance over which main stem flows will influence tributary water levels, by magnifying the difference between the Goulburn River / River Murray flows and the tributary inflows. Further background information on main stem and tributary interactions along the Goulburn River is provided in Appendix I.

Figure 3: An example of the water level (in m AHD), water depth (in m) and inundation extents simulated by the hydraulic model of the mid-Goulburn. This example shows a section of the Goulburn River upstream of Thornton, at a flow of 12,000 ML/d.

Figure 4: An example of the water level (in m AHD), water depth (in m) and inundation extents simulated by the hydraulic model of the River Murray (Zone 7; Hume to Yarrawonga). This example shows a section of the River Murray upstream of Corowa, at a flow of 30,000 ML/d.

4. Key outcomes

The key outcomes from the hydraulic modelling completed for Stage 1A of the Victorian Constraints Measures were:

- The development and calibration of hydraulic models tailored to simulate flow magnitudes relevant to constraint relaxation investigations for the mid-Goulburn, lower Goulburn and nine zones of the River Murray (Table 1).
- The use of these hydraulic models to simulate steady-state flows at intervals of 2,000 ML/d – 5,000 ML/d between current operational constraints and potentially relaxed constraints for the Goulburn River (Table 2) and River Murray (Table 3).
- The conversion of the hydraulic modelling results to high-resolution GIS grids of predicted water level, inundation area and water depth along the Goulburn River (e.g. Figure 3) and River Murray (e.g. Figure 4) corresponding with the steady-state flows simulated. For the Goulburn River scenarios, the hydraulic model was also used to produce GIS grids of bed shear stress.

These outcomes are consistent with recommendations made and deliverables proposed in the Stocktake Review (Sequana Partners, 2022) for Stage 1A of the Victorian Constraints Measures Program. Outputs from the hydraulic modelling task have been used to inform the assessment of the environmental benefits of constraint relaxation along the Goulburn River and River Murray, and the evaluation of potential impacts on private property and public assets.

The expected frequency, duration and timing of flows at the thresholds simulated in the hydraulic models was represented in the hydrology modelling completed for Stage 1A of the Victorian Constraint Measures. The outcomes of this hydrology modelling are included in a separate companion report (HARC, 2023b).

5. Future work

The model development reports in Appendix A – Appendix H, and the comparison of model results with aerial imagery of Goulburn River inundation extents (Appendix J), include commentary on potential future improvements to the hydraulic models. In summary:

Goulburn River

Rather than further refining the hydraulic models of the Goulburn River in potential subsequent stages of the Victorian Constraint Measures Program, it is recommended that:

- The aerial imagery captured in October 2022 be used alongside the hydraulic model results during landholder consultations and communications with the wider community.
- If an appropriate opportunity arises, aerial imagery for other sections of the Goulburn River from Trawool to Shepparton be captured when flows are in or near the range of interest.
- In areas where there is contention about the areas subject to inundation during flows within the range of relaxed constraints being considered for the Goulburn River, smaller site-specific hydraulic models be developed, in which refinements can be made to simulated landscape elevations and/or roughness coefficients without influencing model results for regions upstream or downstream.

River Murray

The hydraulic model for Zone 2 of the River Murray does not include the Little Murray River or the confluence of the Loddon River. A priority therefore in future work would be to include these areas in the Zone 2 hydraulic model, and simulate the expected water level, inundation area and water depth during the scenarios considered in Stage 1A of the Victorian Constraints Measures Program.

Ground-truthing

During Stage 1A of the Victorian Constraints Measures Program there was limited opportunity for landholders to review the modelled inundation extents for the mid-Goulburn and lower Goulburn, and for Victorian government agencies or Victorian landholders to review the modelled inundation extents for the nine zones of the River Murray. Therefore, there is an opportunity as part of further work for the Victorian Constraints Measures Program to obtain additional review of the modelled inundation extents by those who live along the Goulburn River and River Murray and those involved in managing the river systems. NSW DPE are developing a GIS-based system for collating feedback on modelled inundation extents in a systematic way, and this approach could be replicated in Victoria if the Constraints Measures Program continues beyond Stage 1A.

6. References

HARC (2023a), *Goulburn River hydraulic modelling – comparison with aerial photography*. Memo for Stage 1A of Victorian Constraints Measures Program, August 2023 [included as Appendix J].

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Appendix A Goulburn River hydraulic modelling

Appendix B River Murray hydraulic modelling – Hume to Yarrawonga

Appendix C River Murray hydraulic modelling – Yarrawonga to Tocumwal

Appendix D River Murray hydraulic modelling – Barmah-Millewa

Appendix E River Murray hydraulic modelling – Barmah to Torrumbarry

Appendix F River Murray hydraulic modelling – Koondrook-Perricoota

Appendix G River Murray hydraulic modelling – Wakool River reach

Appendix H River Murray hydraulic modelling – Niemur-Murray-Boundary Bend

Appendix I Main stem and tributary interactions

During the community consultation meetings for Stage 1A of the Victorian Constraints Measures Program, questions were asked about the effects that raised water levels in the Goulburn River and River Murray will have on water levels in tributary creeks and rivers. In the previous hydraulic modelling completed for Goulburn River constraints relaxation investigations (Water Technology, 2016), the difference in tributary water levels attributable to main stem flows was modelled for the Acheron River (Section 6.1) and Yea River (Section 6.2). This demonstrated that the influence of 12,500 ML/d mid-Goulburn River flows on water levels in the Acheron River is expected to extend up to ~1.3 km upstream of the Goulburn – Acheron confluence and up to ~800 m upstream of the Goulburn – Yea confluence.

To complement the work done in 2016, water level data recorded continuously near the Goulburn – Yea confluence was analysed to test whether increases in Goulburn River levels prevent the 'draining' of the Yea River into the Goulburn (this was a particular concern for the community consultative committee). The water level data was downloaded on an hourly time-step from www.data.water.vic.gov.au for the:

- Goulburn River at Ghin Ghin (405310)
- Yea River at Goulburn Valley Water (GVW) pumping station (405235)
- Yea River at Devlins Bridge (405217)

Figure I-1 shows the location of the Ghin Ghin and GVW pumping station gauges.

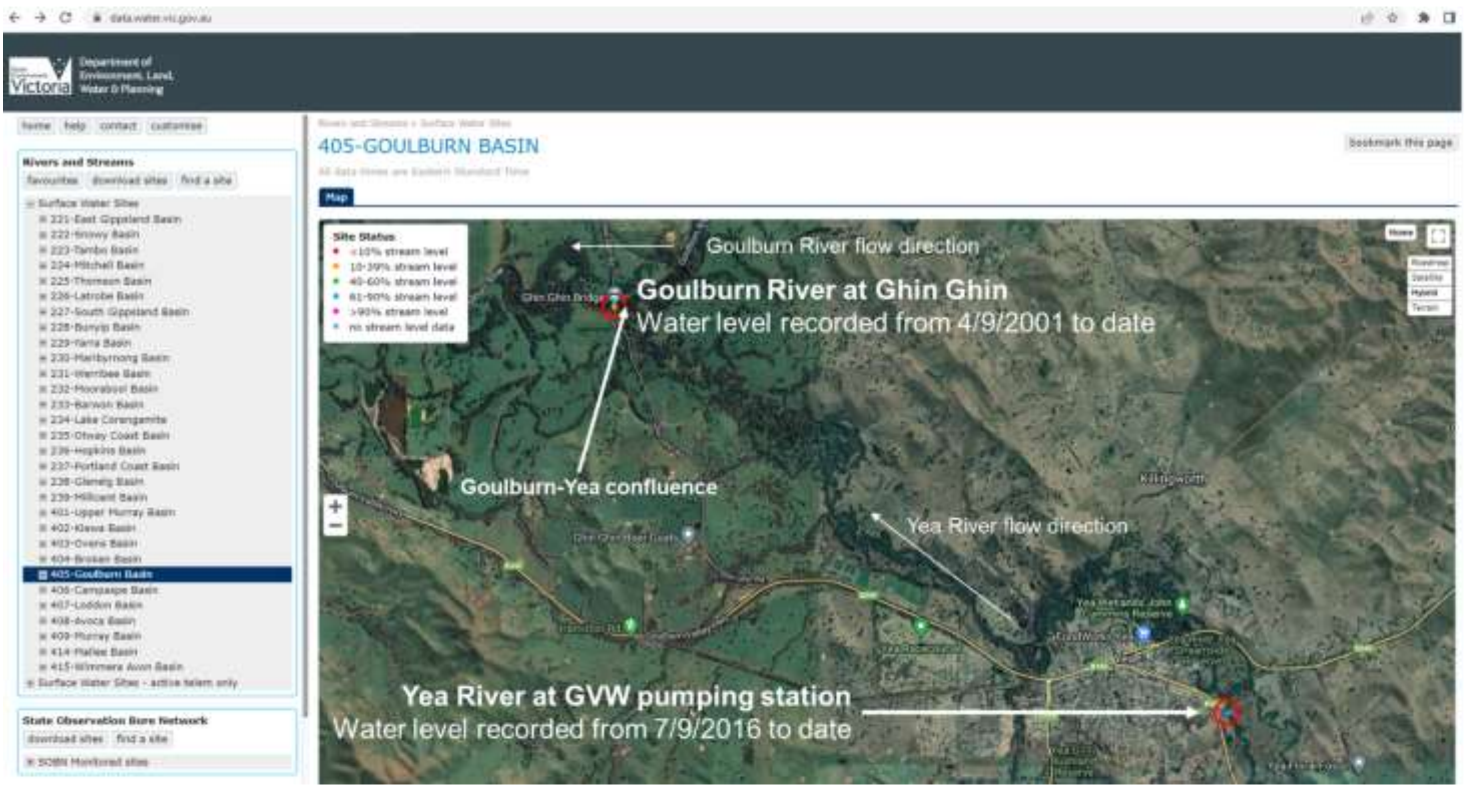

Figure I-1: A screen shot from www.data.water.gov.au showing the location of water level gauges near the Goulburn River – Yea River confluence, and the available period of record.

The Yea River at Devlins Bridge gauge is a further 20+ km upstream of the GVW pumping station gauge.

Figure 1-2 shows the concurrent water level readings for the three gauges since the most recently established gauge (405235) began recording. The response of the Goulburn River and Yea River to rainfall-runoff is apparent in the water level spikes. The increase in the Yea River base flow and hence water levels during winter/spring and wet years (i.e. 2020 and 2021) is also apparent in the 405235 gauge record. The Goulburn River at Ghin Ghin water levels are less influenced by seasonal and climate conditions because of the river regulation resulting from the operation of Eildon Dam.

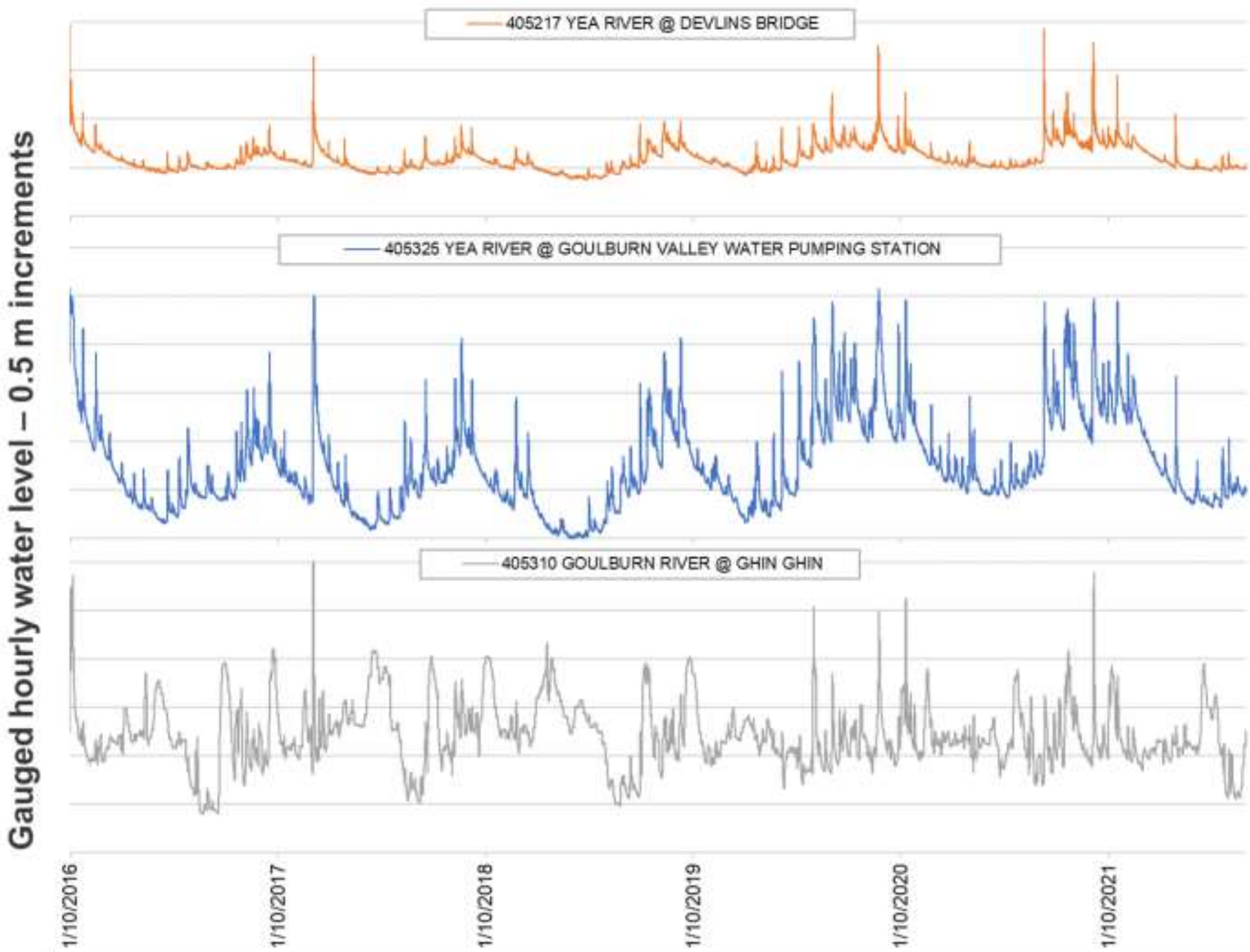

Figure I-2: Concurrent water level readings available for the Yea River at Devlins Bridge (405217), the Yea River at the Goulburn Valley Water pumping station (405325) and the Goulburn River at Ghin Ghin (405310).

Figure I-3 plots the water levels recorded at the three gauges during 2021. In this figure, two events are highlighted – one in early September, and one in early October. In the first event water levels at Ghin Ghin, the GVW pumping station and Devlins Bridge rise at the same time. After the peak passes, the water level at Ghin Ghin drops quicker than water levels in the Yea River. If only looking at this one event, it could be surmised that water levels in the Yea River will not decrease until the Goulburn River level decreases; however, the second event highlighted in Figure I-3 demonstrates this conclusion is not correct.

In early October 2021 the water level in the Goulburn River at Ghin Ghin increased by approximately 1 m, and remained elevated for approximately 1 week. During this time, the Yea River water levels at Devlins Bridge and the GVW pumping station decreased. Therefore, in this case the Goulburn River water level did not need to drop for the Yea River water levels to drop.

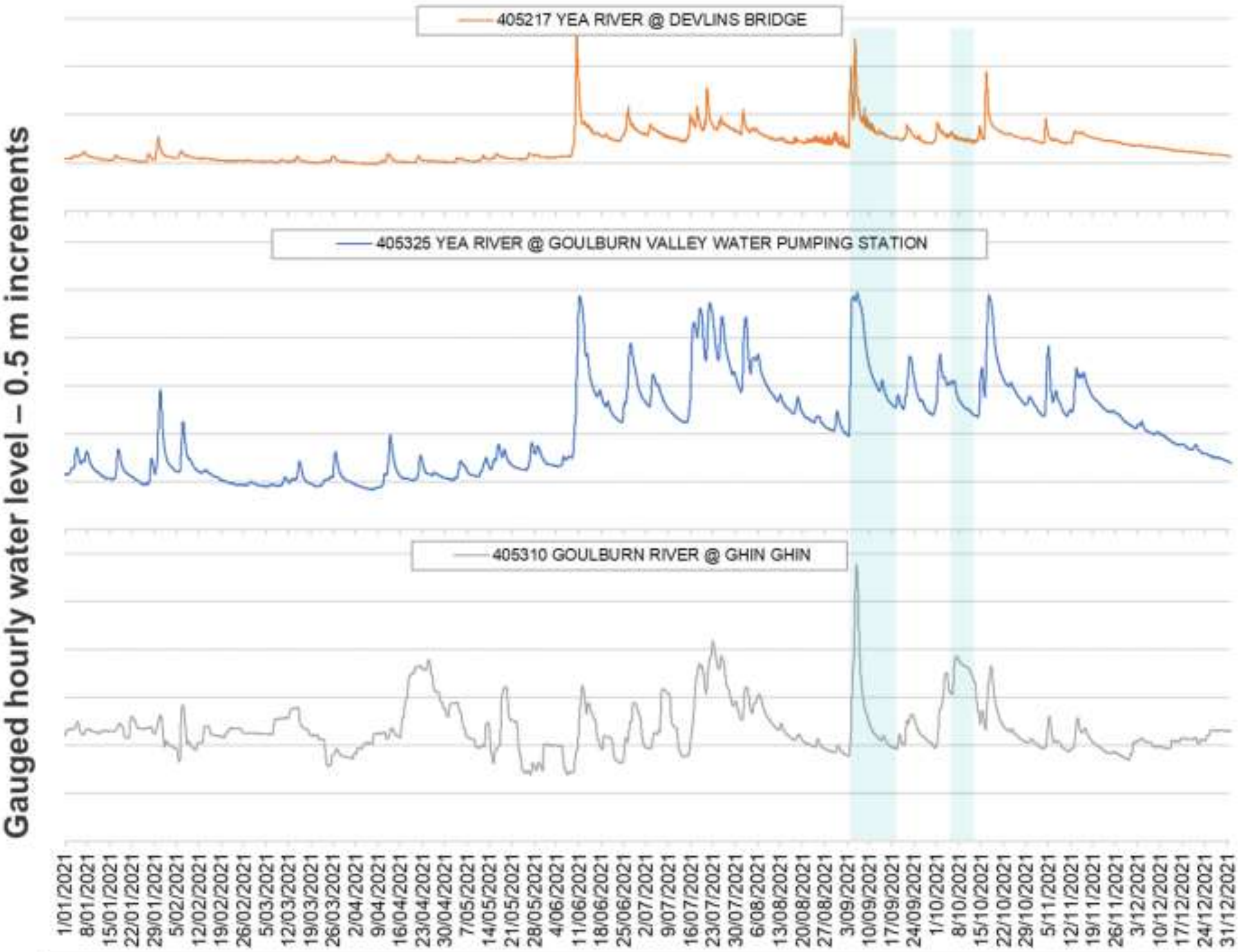

Figure I-3: Concurrent water level readings available for 2021 at gauges 405217, 405325 and 405310. In the first highlighted event the Goulburn River at Ghin Ghin water level drops before the Yea River water levels drop. In the second highlighted event the Yea River water levels drop even though the Goulburn River at Ghin Ghin water level has increased.

The difference between the water level behaviour between September 2021 and October 2021 suggests that Goulburn River and Yea River water levels will increase / decrease concurrently in response to rain that falls across both catchments, but this does not mean that increasing Goulburn River water levels – e.g. via water deliveries to consumptive users or the environment – will change water levels in the Yea River beyond the distances stated by Water Technology (2016). To further demonstrate this, Figure I-4 and Figure I-5 show the water levels recorded during March 2022 and an environmental water delivery in July 2022.

In March 2022, the Goulburn River flow – as estimated at the downstream Trawool gauge (405201) – increased from approximately 3,000 ML/d to 8,500 ML/d during the period highlighted in Figure I-4. This raised the Ghin Ghin water level by 1 m, but no material difference in water level was observed at the GVW pumping station gauge on the Yea River.

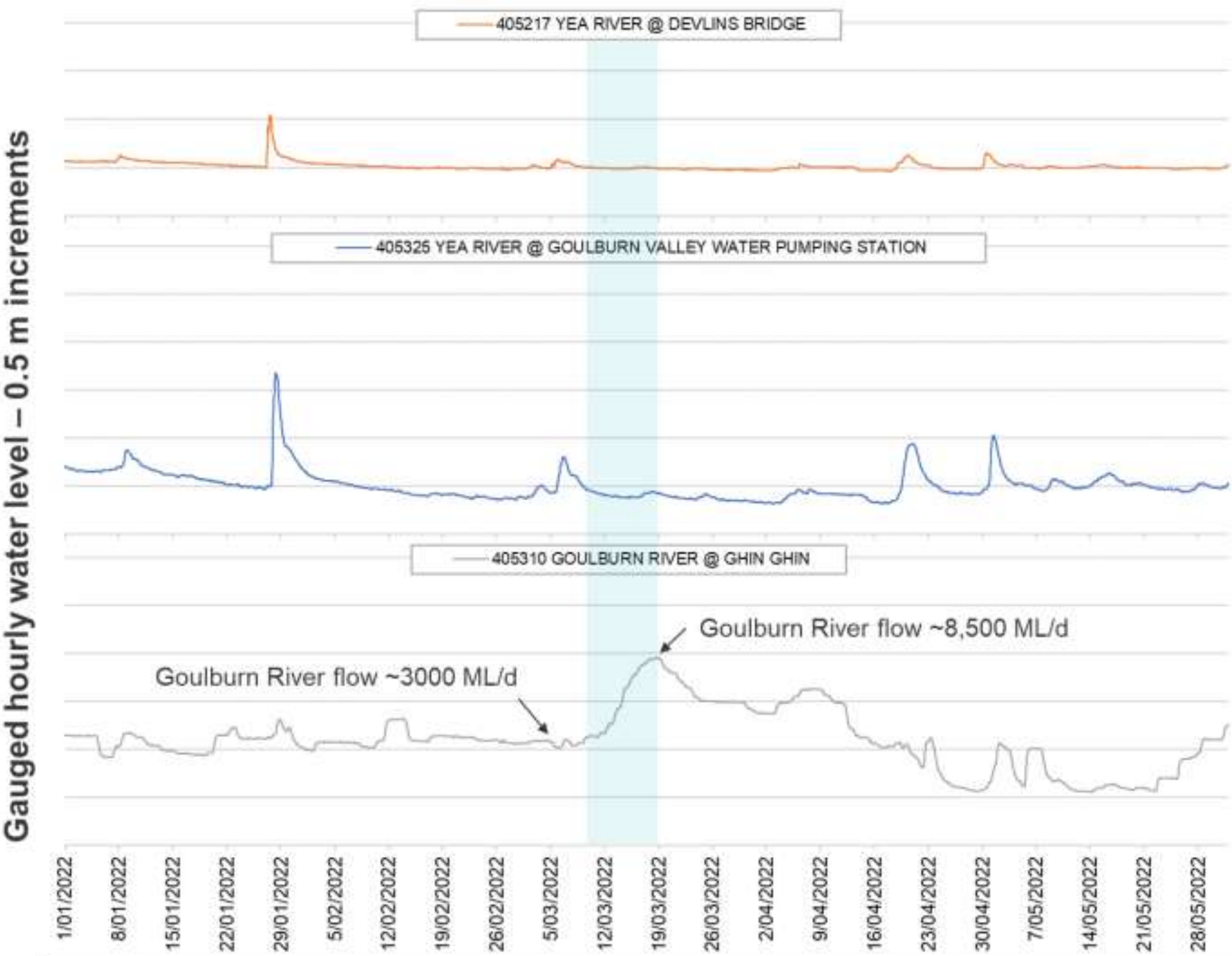

Figure I-4: Concurrent water level readings available for January – May 2022 at gauges 405217, 405325 and 405310.

During the July 2022 environmental water delivery along the Goulburn River, the flow – again estimated at the Trawool gauge – increased from approximately 2,200 ML/d to 8,800 ML/d (Figure I-5). The water level at Ghin Ghin increased by ~1m in response, and remained elevated above the pre-delivery level for approximately 2 weeks. During this same period – highlighted in blue below – the Yea River water level at the GVW pumping station responded to rainfall but returned to a relatively steady level when the rain ceased.

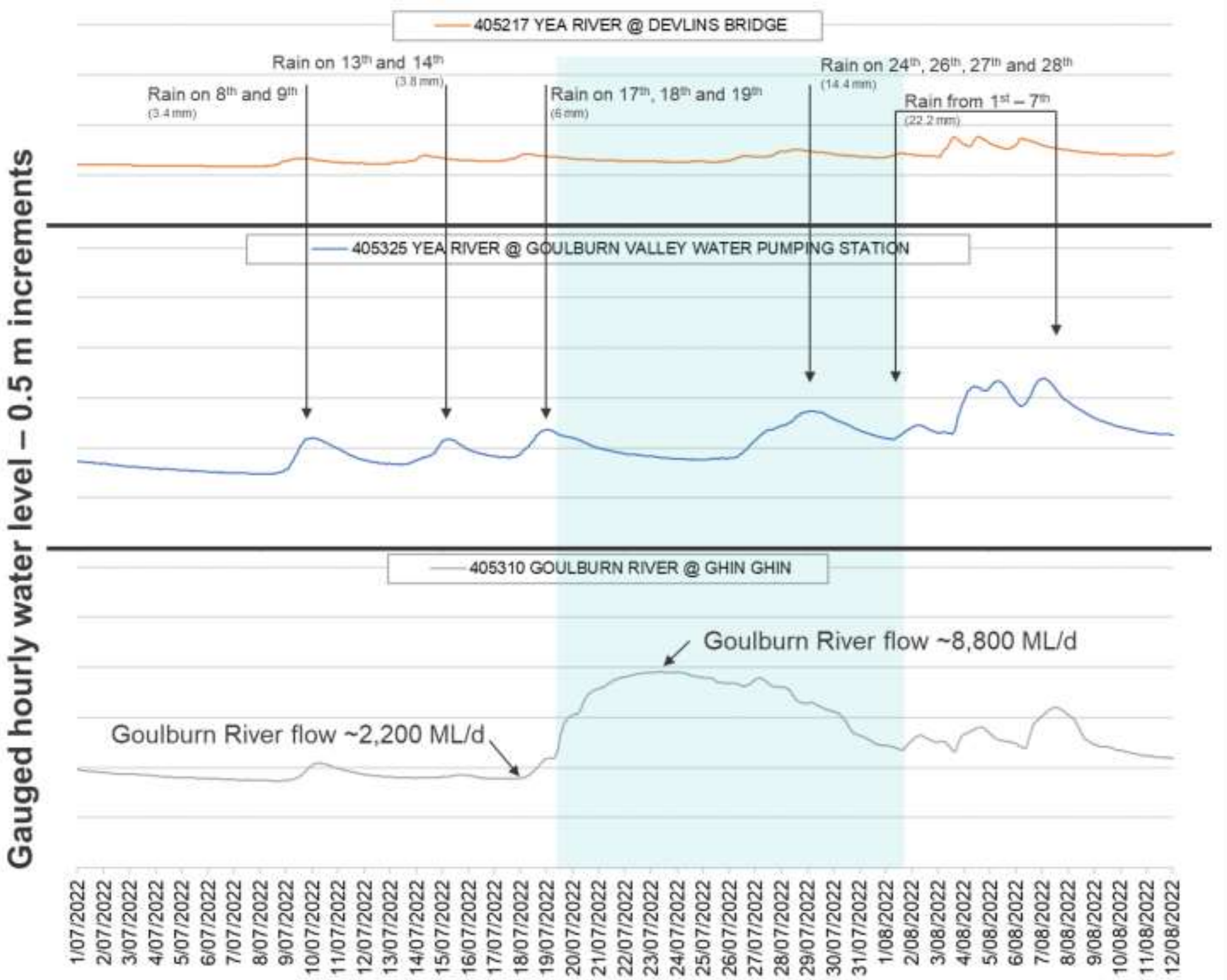

Figure I-5: Concurrent water level readings for gauges 405217, 405325 and 405310 during a July 2022 environmental water delivery. The rainfall depths for Yea were taken from www.farmonlineweather.com.au.

The physical reason for this independence between the response of the Goulburn River and Yea River water levels to historical environmental water deliveries is shown in Figure I-6. As part of Stage 1A of the Victorian Constraints Measures Program, the gauge zero datum of the Ghin Ghin and GVW pumping station gauges was surveyed by ALS to be:

- 164.58 m AHD for the Yea River at the GVM pumping station
- 150.0 m AHD for the Goulburn River at Ghin Ghin

This means that there is a >10 m difference in elevation between typical water levels at the two locations, and confirms that Goulburn River water level changes associated with environmental water deliveries up to relaxed constraints of 10,000 ML/d – 14,000 ML/d (in the mid-Goulburn) are not going to influence Yea River water levels beyond distances stated by Water Technology (2016).

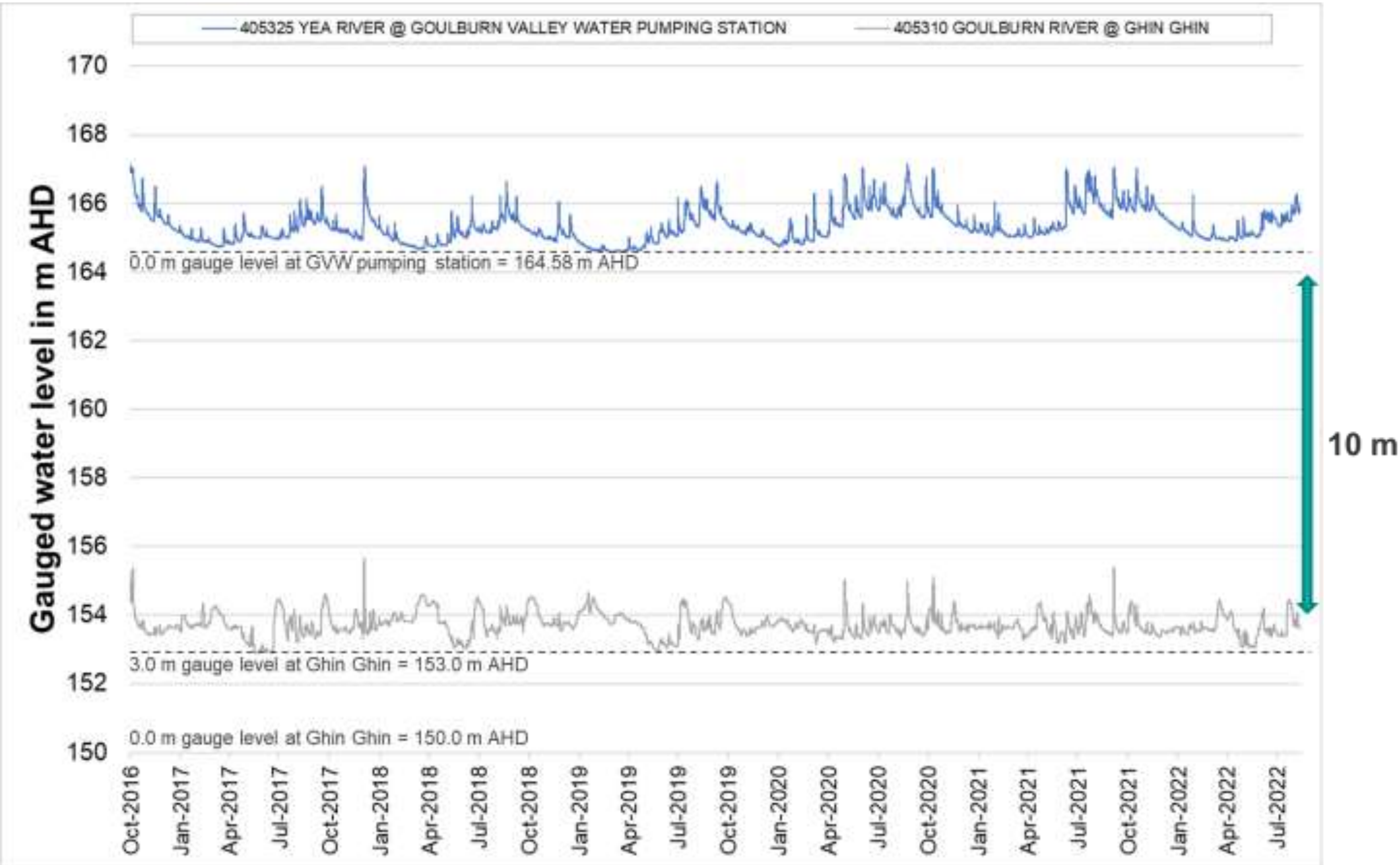

Figure I-6: Gauged water levels for the Yea River at the GVW pumping station and the Goulburn River at Ghin Ghin converted to m AHD. This shows that that there is a >10 m difference in elevation between typical water levels at the two locations.

Appendix J Goulburn River hydraulic modelling – comparison with aerial photography