INDEPENDENT EXPERT ADVISORY PANEL FOR MINING

Moolarben Coal Stage 1:

Review of UG4 LW401, LW402, LW403 End of Panel Report – Groundwater Monitoring

February 2024

Report No: IEAPM 202402-1

EXECUTIVE SUMMARY

On 24 January 2024, the new NSW Department of Planning, Housing and Infrastructure (DPHI ('the Department')) (formally the Department of Planning and Environment (DPE)) requested advice from the Independent Expert Advisory Panel for Mining (IEAPM), ('the Panel'), based on a review of the following (undated) report: *"Moolarben Coal Operations UG4 LW401, LW402, LW403 – End of Panel Report"* (MCO 2023c). This End of Panel (EoP) report is a summary of groundwater responses after the completion of LW403 and complements the revised groundwater report completed by Australasian Groundwater and Environmental Consultants in August 2023 (AGE 2023).

The EoP report has been prepared to satisfy the additional management and monitoring measures committed to by Moorlarben Coal Operations (MCO) in response to the Independent Advisory Panel for Underground Mining (IAPUM) advice in July 2022 (IAPUM 2022).

The Department requested that the Panel review the EoP report:

- with regard to observed groundwater impacts against modelled predictions and advise if there are any concerns at this time, and
- to provide any other advice it considers would assist the Department in reviewing the EoP report.

The Panel has concluded that currently:

- the observed drawdown in the Triassic sandstone groundwater system across the LW401-408 area is comparable with the numerical model maximum drawdown prediction in AGE 2023,
- there is minimal observed drawdown in the Triassic sandstone groundwater system towards the Goulburn River and 'The Drip' and this agrees with the current model drawdown predictions,
- there is no evidence that private groundwater users or 'The Drip' have been affected by mining-induced groundwater impacts from the extraction of LWs401-403,
- there is poor correlation between observed and maximum predicted drawdowns in the Permian overburden groundwater system, as there is far greater observed drawdown in the northern area extending towards the Goulburn River than predicted in the numerical model,
- there is insufficient data to confirm the mine inflow contribution from LWs401-403. However it is agreed that based on model predictions, most inflows are likely to originate from groundwater draining from the Triassic sandstone and Permian overburden groundwater systems in the LW401-408 area, and
- there are no apparent water quality changes in the Triassic sandstone groundwater system that are mining-induced.

The Panel recommends that:

- the conditional approval of MCO's Extraction Plan (EP) for UG4 area (LW401-LW408) be amended to include a condition requiring a comprehensive EoP report after the extraction of LW407 (and before the completion of LW408).

And that MCO be requested to:

- confirm that PZ235A has been replaced by PZ235C,

- clarify the Triassic sandstone water level trends at PZ235A/C and PZ236A (located north of proposed LW408),
- closely monitor drawdown in the Triassic sandstone and Permian overburden groundwater systems north of LW408 to minimise dewatering in this sensitive area, so as to maintain hydraulic gradients from/to the Goulburn River,
- closely monitor surface water-groundwater connectivity north of LW408 to identify any unacceptable mining-induced impacts,
- report and focus on these shallow groundwater and surface water trends in future annual reports,
- prepare historical (annual) water balances since 2020/21 that can be quoted in future reports and used for future model verification/recalibration, and
- update the Water Management Plan to describe the expanded water monitoring network and include additional Triassic sandstone monitoring sites as water level trigger locations to protect the Triassic sandstone groundwater system close to the Goulburn River and 'The Drip'.

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1.0 INTRODUCTION

On 24 January 2024, the new NSW Department of Planning, Housing and Infrastructure (DPHI ('the Department')) (formally the Department of Planning and Environment (DPE)) requested advice from the Independent Expert Advisory Panel for Mining (IEAPM) of the following (undated) report: *"Moolarben Coal Operations UG4 LW401, LW402, LW403 – End of Panel Report"* (MCO 2023c). This End of Panel (EoP) report is a summary of groundwater responses after the completion of LW403 and complements the revised groundwater report completed by Australasian Groundwater and Environmental Consultants in August 2023 (AGE 2023). A detailed technical review of this groundwater report was completed by the IEAPM in October 2023 (IEAPM 2023).

The EoP report has been prepared to satisfy the additional management and monitoring measures committed to by Moorlarben Coal Operations (MCO) in response to the Independent Advisory Panel for Underground Mining (IAPUM) advice in July 2022 (IAPUM 2022).

In addition to the EoP report, the following technical documents were also supplied by the Department as background information:

- Moolarben Coal UG4 Longwalls 401 to 408 Extraction Plan (MCO 2023a)
- Moolarben Coal UG4 Longwalls 401 to 408 Extraction Plan – Appendix A Water Management Plan (MCO 2023b)
- Moolarben Coal UG4 Longwalls 401 to 408 Extraction Plan – Technical Report 2 – Groundwater Technical Report (AGE 2023)

The detailed technical review completed by the IEAPM in October 2023 (IEAPM 2023) of the AGE 2023 report was also referenced in writing this advice.

The Department requested that the Panel review the EoP report:

- with regard to observed groundwater impacts against modelled predictions and advise if there are any concerns at this time, and
- to provide any other advice it considers would assist the Department in reviewing the EoP report.

2.0 BACKGROUND

2.1. DPE EXTRACTION PLAN APPROVAL

DPE provided conditional approval of MCO's Extraction Plan (EP) for UG4 area (LW401-LW408) in July 2022 (DPE 2022). The important condition in the EP approval that is relevant to this advice is:

Condition 3

Prior to the commencement of longwall mining of LW404 or as otherwise agreed by the Secretary, the Proponent must update the numerical groundwater model and predictions to the satisfaction of the Secretary, including:

a) review and update the model conceptualisation for the leakage between the Triassic sandstones and the Permian overburden;

b) review and update the model conceptualisation of surface water – groundwater connectivity;

c) reassess aquifer drawdown predictions and water balance estimates particularly mine water inflow volumes and groundwater baseflow losses to the Goulburn River;

d) reassess the predicted groundwater take;

e) complete an independent peer review of the current and updated model by a technical expert endorsed by the Secretary

f) consideration of the Final Geological Structural Analysis in Condition 4;

g) provide revised predictions based on the updated numerical model including a detailed technical report on:

(i) predicted cumulative impacts from approved mining; and

(ii) predicted impacts of only the LW401-408 panels.

While the conditional approval did not explicitly request EoP reporting after the completion of LW403, the initial IAPUM advice (IAPUM 2022) recommended that DPE:

12. Consider a hold point at the completion of LW403 (anticipated to be August 2023) to allow the Panel to provide further advice to the Department as to whether any additional EP conditions are required, prior to the commencement of LW404

MCO has confirmed the extraction schedule in Table 1 of the EoP report which suggests that LW403 was completed in December 2023/January 2024 with the extraction of LW404 about to commence.

3.0 GROUNDWATER MONITORING – OBSERVED IMPACTS

The current groundwater monitoring network is summarised in the EoP report (Table 2) which has been extracted from the current version of the Water Management Plan for UG4 (MCO 2023b, Table 6). The monitoring network described in Table 2 of the EoP is the most recent and reliable list as it is noted that standpipes PZ102A and PZ103A have now been decommissioned and replaced by VWP sensors at PZ103D, and one new site (PZ235C) is listed. The groundwater monitoring network map shown in Figure 1 of this advice (taken from AGE 2023) is slightly more comprehensive than the network map presented in the EoP report (Figure 4).

Groundwater level triggers apply to the Triassic sandstone groundwater system at standpipes PZ101C and PZ105C, and the uppermost VWP sensor in PZ129 at 35m (MCO 2023b). Triggers do not apply to the deeper groundwater systems as these are being dewatered to enable mining of the target Ulan Seam.

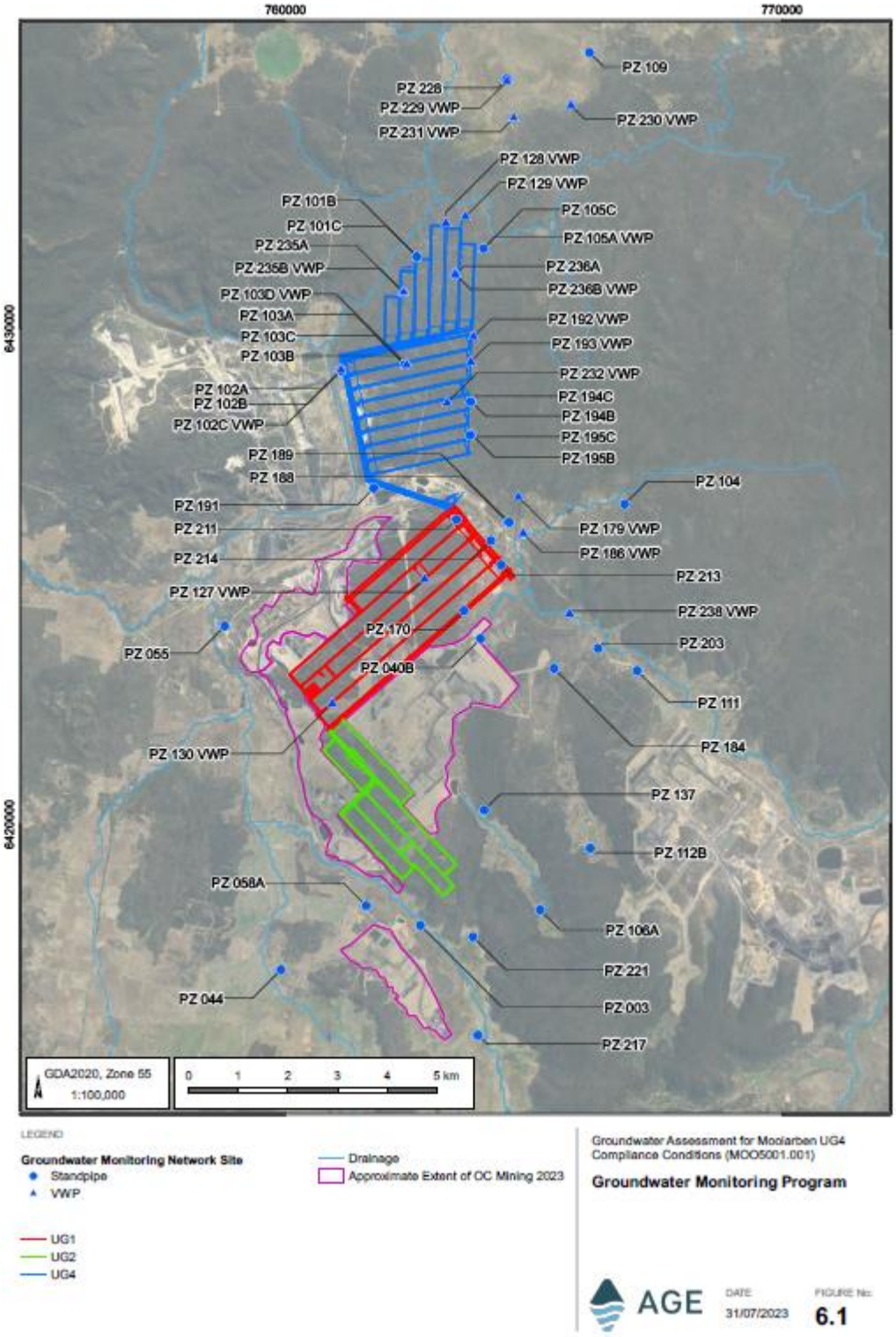

Figure 1: Groundwater Monitoring Network (Figure 6.1 from AGE 2023)

3.1. WATER LEVEL TRENDS

One of the main objectives of the groundwater monitoring network is to assess mining-induced water level declines in the Triassic sandstone groundwater system as this aquifer provides baseflow to the Goulburn River to the north, sustains perched groundwater at 'The Drip' and is the beneficial aquifer tapped by the only water supply bore in the immediate area.

Figure 5 in the EoP report provides the composite hydrographs of most monitoring bores tracking Triassic sandstone water levels in the UG4 LW401 to 408 area. Individual water level trends are hard to differentiate in this Figure, so reference was also made to the individual hydrographs in Appendix A of AGE 2023. Mining-induced water level declines are evident at:

- PZ103C (standpipe) since the commencement of LW401 (less than 0.5m)
- PZ192 (VWP 68m sensor) since the commencement of LW402 (approx. 2m)
- PZ193 (VWP 80m sensor) since the commencement of LW402 (approx. 6m)
- PZ194B (standpipe) since the commencement of LW401 (approx. 11m)
- PZ194 (VWP 78m sensor) since the commencement of LW401 (approx. 12m)
- PZ195B (standpipe) since the commencement of LW401 (approx. 12m)
- PZ232 (VWP 45m sensor) since the commencement of LW401 (less than 1m)
- PZ232 (VWP 75m sensor) since the commencement of LW401 (approx. 6m)
- Potentially PZ236A (standpipe) since the commencement of LW402 (less than 2m)

Most of these sites are located within or adjacent to mined LWs401 to 403. The northernmost site where there is an observed drawdown in the Triassic sandstone is PZ192 (eastern boundary of LW408). The slight drawdown at PZ236A (LW413) could potentially be climatic. There is minimal drawdown in the Triassic strata to the north beyond LW408 towards the Goulburn River and 'The Drip' (based on data from five sites). No groundwater level investigations were triggered at the three nominated trigger locations in the Water Management Plan (MCO 2023b) during the extraction of LWs401-403.

The descriptive text in Sections 2.1.1 (LW401). 2.1.2 (LW402) and 2.1.3 (LW403) of the EoP report does not adequately describe the hydrographic trends in Figure 5. The text focuses on VWP sensors while there are confirmed declines in several standpipe locations as well. A spatial appreciation of the observed drawdowns in the Triassic strata since the commencement of LW401 would have provided an improved understanding of shallow groundwater impacts to date.

The composite hydrographs for the deeper UG4 Permian overburden and UG4 Ulan coal seam are presented in Figures 6 and 7 respectively of the EoP report. Again, water level trends are hard to differentiate in these composite Figures, so reference was also made to the individual hydrographs in Appendix A of AGE 2023. There are water level and pressure declines across most monitored standpipes and VWP sensors. Within and adjacent to the LW401 to 403 area since early 2021, there have been water level declines of 25-35m in both the Permian overburden and Ulan Coal seam groundwater systems and up to 60m of drawdown since 2014. Further north towards the Goulburn River and "The Drip' there are measurable declines of up to 10m in the Permian overburden (standpipe PZ101B and VWP sensors at PZ105A, PZ128 and PZ129) and up to 25m in the Ulan Coal seam (deep sensors at PZ105A).

3.1.1. Comparison with modelled predictions

There are no model predictions referenced in the EoP report, nor is there any discussion of observed versus modelled water level predictions. There are also no model hydrographs included in the revised groundwater technical report (AGE 2023) to obtain an appreciation of current and predicted drawdowns at any individual site.

However, a useful comparison can be made between the composite hydrographic traces in the EoP and the maximum predicted drawdown contours due to just the extraction of UG4 LWs401-408 panels presented in Section 8.2.1 of AGE 2023. It should be noted that a direct comparison is not possible as the maximum predicted drawdown contours for just the extraction of UG4 LWs401-408:

- do not include wider cumulative impacts, and
- are for the whole of LW401-408, and not for the early panels LW401-403.

The most useful plots for comparison purposes are:

- the base of the Triassic lithic sandstone (Layer 9) – left side plot of Figure 8.6, and
- the base of the Permian overburden (Layer 14) – left side plot of Figure 8.7.

For the Triassic sandstone, where current observed drawdowns are up to 10m (i.e. along the eastern starting faces of LWs401-408), the model predicts drawdowns in excess of 20m at the end of mining these eight panels) which would fully dewater the Triassic sandstones in this area. There is minimal drawdown observed towards the Goulburn River and 'The Drip' and this agrees with the current model drawdown predictions. That is, there is reasonable correlation between the observed and maximum predicted drawdown across the UG4 domain for the Triassic sandstone groundwater system.

For the Permian overburden, there is a poor correlation between observed and maximum predicted drawdowns. The hydrographs clearly demonstrate extensive drawdown to the north of LWs401-408 which is the direct result of the extraction of LWs401-403. The model is only predicting between 2 and 5m of drawdown at the base of the Permian overburden north of LW408 which is substantially less the current observed drawdowns which are in excess of 20m.

With increasing drawdown north of LW408 in the deep groundwater systems, there is the potential that the Triassic sandstone groundwater system beneath the remaining panels (i.e. LWs404-408) will drain quicker than predicted and drawdowns will extend further north into the proposed LW409-414 area. The potential consequences are:

- hydraulic gradients from the Goulburn River to the sandstone aquifer could steepen and there could be increased water losses from the river, and
- the gaining river section downstream of 'The Drip' could potentially reverse from gaining to losing.

Closer monitoring of Triassic sandstone and Permian overburden water levels and surface water-groundwater connectivity north of LW408 is required to provide early identification of unacceptable mining-induced impacts.

3.2. GROUNDWATER INFLOWS

The Panel agrees with the EoP statement that *estimating mine inflows onsite is a complex process* and segregating just the inflows from LWs401 to 403 is even more difficult.

The EoP states that;

> *During the Extraction of LW401, LW402, and LW403 the average daily dewatering of underground mining operations (UG1 and UG4 combined) ranged from approximately 120L/s to 310L/s, including water supply, inflows, and recirculation.*

And that:

> *Groundwater inflows estimated during extraction of LW401, LW402, and LW403 were generally greater than modelled during the extraction of LW401 and LW402, as a result of above average rainfall observed during 2022 and increased volumes of water stored in open cut voids adjacent to UG mining operations during this time period. Inflows into UG mining operations continued to reduce during 2023 as rainfall eased and open cut voids were dewatered. Observed inflows during extraction of LW403 were only marginally above predictions (AGE, 2023).*

3.2.1. Comparison with modelled predictions

There is no specific data on locations, pumped volumes, usage and stream discharge volumes in the EoP or the detailed technical report (AGE 2023) to verify whether current pumped volumes across the mine site correlate with model predictions.

The maximum predicted mine water inflow volume for 2023/24 is 3826 or 3719 ML/yr (slightly conflicting data in Table 8.2 and Table 8.5 of AGE 2023). This is about the same as the average (minimum) daily dewatering volume quoted in the EoP for recent years (120 L/s equates to 3790 ML/yr for a full year). Actual annual mine inflow volumes since mid-2022 (the commencement of LW401) have not been included in the EoP but appear to be significantly higher than model predictions because of unseasonably wet conditions in recent years. This point is recognised in Section 2.1.4 of the EoP report.

Details of the predicted direct take (i.e. predominantly groundwater inflows to the mine and dewatering volumes) for the current and future water years are reproduced from AGE 2023 (Table 8.5) in Table 1.

Table 1: Predicted direct take from the Sydney Basin-North Coast Groundwater Source

Water Year	Licence Entitlement (including carry-over)	Moolarben Take (ML)	LW401 to LW408 Take (ML)
2023/24	5,422	3719	3471
2024/25	4,195	3910	3626
2025/26	2,991	2779	1552

These predictions confirm that most of the pumped groundwater is removed from the Triassic sandstone and Permian overburden groundwater systems in the UG4 LW401-408 area. The large reduction in take in 2025/26 suggests that the Triassic sandstones in this area will be dewatered in the next 24 months.

When the numerical model is next reviewed and updated, as part of any recalibration, a historical 'whole of mine site' water balances should be compiled and compared to the mine inflow predictions.

3.3. WATER QUALITY

The tabulated data in Table 3 of the EoP report fails to provide sufficient information to enable identification of temporal water quality trends since the commencement of LW401. A graphical representation of (at least) salinity and pH would have been useful to include.

Three locations in the Triassic sandstone are nominated as groundwater trigger locations for salinity and pH in the Water Management Plan (MCO 2023b) – PZ101C, PZ103C and

PZ105C. PZ103C is located between LW407 and LW408 while the remaining two standpipes are located further north towards the Goulburn River (see Figure 1). Water quality was relatively unchanged at each of these three sites except for the last sampling event in October 2023 when there was a slight increase in salinity at each of the three sites. This is interpreted to be the result of drier conditions that have prevailed since mid-2023 and the trend is not considered to be mining induced. No groundwater quality investigations were triggered at these sites during the extraction of LWs401-403.

There are several other Triassic sandstone sites monitored within the UG4 area that are not nominated as trigger locations (PZ194B, PZ195B and PZ236A). Again, a slight increase in salinity was observed at PZ194B, however there was an anomalous decrease at PZ195B and a larger than expected increase at PZ236A. Even though mining-induced drawdowns were observed at each of these three sites, more monitoring data is required to determine if these water quality trends are mining induced.

3.4. OTHER REVIEW COMMENTS

The Panel agrees that there is no evidence in this EoP report that private groundwater users or 'The Drip' have been affected by mining-induced impacts from the extraction of LWs401-403.

The current Water Management Plan (MCO 2023b) does not accurately describe the current water monitoring network. Additional Triassic sandstone sites need to be included as trigger locations to protect the Triassic groundwater systems close to the Goulburn River and 'The Drip'. This document should be updated once the new surface water and groundwater monitoring locations (as recommended in IEAPM 2023 advice) are installed.

4.0 CONCLUSIONS

The EoP report (MCO 2023c) is a brief status report that focuses on groundwater impacts identified during the extraction of LWs401 to 403. The Panel has concluded that currently:

- the observed drawdown in the Triassic sandstone groundwater system across the LW401-408 area is comparable with the numerical model maximum drawdown prediction in AGE 2023,
- there is minimal observed drawdown in the Triassic sandstone groundwater system towards the Goulburn River and 'The Drip', and this agrees with the current model drawdown predictions,
- there is no evidence that private groundwater users or 'The Drip' have been affected by mining-induced impacts from the extraction of LWs401-403,
- there is poor correlation between observed and maximum predicted drawdowns in the Permian overburden groundwater system, as there is far greater observed drawdown in the northern area extending towards the Goulburn River than predicted in the numerical model,
- there is insufficient data to confirm the mine inflow contribution from LWs401-403. However it is agreed that based on model predictions, most inflows are likely to originate from groundwater draining from the Triassic sandstone and Permian overburden groundwater systems in the LW401-408 area, and
- there are no apparent water quality changes in the Triassic sandstone groundwater system that are mining-induced.

Apart from greater than expected drawdowns in the deeper groundwater systems north of the UG4 LW401-408 area, there are no major concerns regarding groundwater impacts at this time. However, with increasing drawdown north of LW408 in these groundwater systems, there is the potential for the shallow Triassic sandstone groundwater system to drain faster than predicted over a wider area.

5.0 RECOMMENDATIONS

Based on a review of the groundwater data and trends presented in the EoP report and the significance of environmental receptors to the north, the Panel recommends that the conditional approval of MCO's Extraction Plan (EP) for UG4 area (LW401-LW408) be amended to include a condition requiring a comprehensive EoP report after the extraction of LW407 (and before the completion of LW408). This EoP report should include:

- an assessment of subsidence predictions and actual impacts,
- data and trends for all underlying groundwater systems, and an assessment of impacts to the Triassic sandstone aquifer and its environmental and cultural assets adjacent to and downstream of the UG4 area,
- surface water data and trends for the Goulburn River adjacent to and downstream of the UG4 area, and
- an assessment of cultural heritage impacts.

In addition, the Panel recommends that MCO:

- confirm that PZ235A has been replaced by PZ235C,
- clarify the Triassic sandstone water level trends at PZ235A/C and PZ236A,
- closely monitor drawdown in the Triassic sandstone and Permian overburden groundwater systems north of LW408 to minimise dewatering in this sensitive area, so as to maintain hydraulic gradients from/to the Goulburn River,
- closely monitor surface water-groundwater connectivity north of LW408 to identify any unacceptable mining-induced impacts,
- report and focus on these shallow groundwater and surface water trends in future annual reports,
- prepare historical (annual) water balances since 2020/21 that can be quoted in future reports and used for future model verification/recalibration, and
- update the Water Management Plan to describe the expanded water monitoring network and include additional Triassic sandstone monitoring sites as water level trigger locations to protect the Triassic groundwater system close to the Goulburn River and 'The Drip'.

These actions complement those recommendations in the last IEAPM advice (IEAPM, 2023). These 2023 recommendations are reproduced in Appendix A of this advice.

REFERENCES

AGE (2023). *UG4 LW401-408 Extraction Plan Revised Groundwater Technical Report.* V2.02 dated 31 August 2023.

DPE (2022). Approval Letter - *Moolarben Coal Stage 1 – Underground 4 Extraction Plan (LW401-LW408).* Dated 14 July 2022.

IAPUM (2022). *Advice Re: Moolarben Coal Complex UG4 Longwalls 401-408 Extraction Plan.* Dated April 2022.

IEAPM (2023). *Advice Re: Moolarben Coal Mine: Panel Technical Review – UG4 LW401-408 Extraction Plan Revised Groundwater Technical Report (AGE 2023).* IEAPM Report 202310-4 dated October 2023.

MCO (2023a) *UG4 Longwalls 401 to 408 Extraction Plan.* Document MCO_UG4_LW401-408_EP Version 2 dated October 2023.

MCO (2023b) *UG4 Longwalls 401 to 408 Water Management Plan.* Document MCO_UG4_LW401-408_WMP Version 2 dated October 2023.

MCO (2023c) *Moolarben Coal Operations UG4 LW401, LW402, LW403 – End of Panel Report* Undated.

APPENDIX A – RECOMMENDATIONS FROM PREVIOUS ADVICE (IEAPM 2023)

The following recommendations are still outstanding from the IAPUM 2022 advice or are additional after reviewing this groundwater report. Moolarben Coal should:

- Confirm that drawdown in the Triassic sandstone aquifer has commenced across the LW401 to 408 area and provide a time estimate as to when this shallow groundwater system will be dewatered.
- Provide an explanation as to why cumulative drawdown in excess of 5m (in the Triassic sandstone aquifer) due to all approved mining extends north to the Goulburn River beneath the proposed UG4 LW409-414 area.
- Improve the groundwater baseflow estimates to the Goulburn River downstream of proposed LW410 by committing to the installation of gauging stations upstream and downstream of 'The Drip' within the next 6 months.
- Validate the nature of the local inferred fault that straddles LW406 and LW407 once mining intersects it.
- Install nested triple standpipes close to the Goulburn River (two sites) (monitoring alluvium if present, Triassic sandstone, and Permian ICM overburden) north of PZ101 and west of PZ128 in the vicinity of SW02, and at a second location near or downstream of SW01 (subject to suitable site access and appropriate approvals from National Parks).

  The installation of these standpipes (and two new nearby gauging stations as recommended above) is a priority; essential to establish the current 'baseline' conditions before the drawdowns within the UG4 area start affecting water table gradients in the Triassic sandstone south of the Goulburn River.

- Install new shallow standpipes into the Triassic sandstone in the area immediately north of 'The Drip' (subject to assess constraints) to confirm the separation of perched and regional water tables feeding 'The Drip' and the Goulburn River respectively.
- Replace standpipe PZ235A (Triassic sandstone) as soon as practicable if it is deemed unreliable.
- Install standpipe PZ-A as committed to in the current Water Management Plan for LWs401-408 to monitor shallow groundwater west of LW409.