INDEPENDENT EXPERT ADVISORY PANEL FOR MINING

MOOLARBEN COAL COMPLEX

UG4 EXTRACTION PLAN FOR LONGWALLS 409-414 (MP05_0117)

15 AUGUST 2025

ADVICE NO: IEAPM 202508-01

EXECUTIVE SUMMARY

The Moolarben Coal Complex (MCC) is an open-cut and underground coal mine located approximately 40 kilometres (km) north of Mudgee, owned and operated by Moolarben Coal Operations (MCO), a subsidiary of Yancoal Australia Limited (Yancoal). The complex lies directly between two other mining operations, the Ulan Coal Complex to the north-west and Wilpinjong Mine to the south-east.

The existing approved MCC comprises four open-cut (OC1, OC2, OC3 and OC4) and three underground mining areas (UG1, UG2 and UG4), as well other mining-related infrastructure including coal processing and transport facilities.

The Extraction Plan proposed relates to the northern section of the UG4 mining area, where extraction of longwall panels LW409 to LW414 is planned. Previous extraction plan approval was granted for panels LW401 to LW408 in UG4 and these longwall panels are currently being mined.

On 21 January 2025, the NSW Department of Planning, Housing and Infrastructure (DPHI) requested advice from the Independent Expert Advisory Panel for Mining (IEAPM – the 'Panel') in relation to the proposed MCO Extraction Plan for UG4. DPHI requested targeted advice from the Panel with respect to subsidence, water-related impacts and the existing applicable performance measures, with particular focus on key water features in the vicinity of the Extraction Plan area, including The Drip, the Corner Gorge and the Goulburn River. In addition, the Panel was requested to comment on potential subsidence impacts to Aboriginal Heritage sites within the Extraction Plan area and the adequacy of the proposed MCC Trigger Action Response Plans.

Overarching Advice

On the basis of the currently available information and the draft UG4 monitoring and management plan, the Panel has some concerns regarding the ability of the Applicant to meet the performance measures.

The Panel's conclusions and recommendations are summarised below under the four distinct headings – subsidence, groundwater, surface water and biodiversity. Detailed presentation of these conclusions and recommendations, together with the Panel's supporting review discussion, is provided in each of the subsequent relevant sections of this report under these same headings.

Principal Conclusions

With respect to subsidence, the Panel concludes that:

1. The predicted levels and nature of conventional subsidence behaviour directly above the mining study area of UG4 are based on a reasonable and appropriate prediction method resulting in upper-bound predicted scale of subsidence effects and impacts.
2. The Goulburn River Gorge lies outside the range of conventional subsidence effects but could be subject to non-conventional effects and impacts that need to be carefully managed in view of the potential susceptibility of the natural features to low levels of subsidence impacts.
3. The Panel believes that the likelihood of adverse impacts occurring in the Goulburn River Gorge because of the proposed Extraction Plan is very low but remains a possibility and therefore a precautionary monitoring and management approach should be adopted. This will require further improvements to the Applicant's draft monitoring and management plan (and associated TARPs), as outlined in the recommendations below.
4. With appropriate improvements and a rigorous implementation of the enhanced management plan, the Panel believes that there is a very high likelihood that the performance measures of nil impact on The Drip and Corner Gorge, and negligible impact on the Goulburn River can be achieved – with respect to direct subsidence impacts. (The ability to comply with the performance measures regarding the subsequent environmental consequences associated with groundwater and surface water are discussed separately – see below).
5. In regard to Aboriginal heritage sites above and adjacent to the UG4 study area, the Panel is satisfied that likelihood of any subsidence damage is low, consistent with the specified performance measure and that site S1MC287 in particular is adequately protected, but should still be subject to ongoing monitoring, as proposed by the applicant, as extraction of each of the adjacent longwall panels approach.

With respect to groundwater, the Panel concludes that:

6. The regional water table in the Triassic sandstone aquifer will decline and it will be extensively dewatered south of the Goulburn River. There are uncertain regional water table impacts north of the Goulburn River.
7. The perched groundwater discharging to the upper cliff faces at The Drip from the Triassic sandstone should not be impacted based on the subsidence predictions that non-conventional impacts are unlikely at distance.
8. Seepage discharges from the Triassic sandstone at the base of the cliff face at The Drip could be impacted by a declining regional water table.
9. Baseflow impacts to the Goulburn River are expected as the regional water table declines south of the Goulburn River and the river changes from a connected gaining stream to a losing stream. Intercepted groundwater and streamflow losses could be more than negligible between stream gauges SW2 and SW22.
10. Current mine water discharges occurring from both UMC and MCC are masking natural groundwater baseflows. These high flows will make it difficult to measure and identify any streamflow losses to groundwater.
11. The current groundwater model adopts lateral general head boundary conditions that are not clearly consistent with the available water at the model boundary. This may have

introduced bias into the calibration of the model and reduced the reliability of the model for long term predictions. The boundary conditions require further evaluation.

12. The lack of a model uncertainty analysis of groundwater conditions at The Drip and the impacts to baseflows for the period of mining limits the value of the modelling in assessing future environmental consequences resulting from a declining regional water table and groundwater depressurisation.
13. When the groundwater monitoring network is complete, it is expected to provide an appropriate quantum of data to monitor the groundwater impacts arising from the extraction of LW409 to LW414.
14. The 'open hole' completion for the monitoring bore located immediately north of The Drip is inappropriate as it is likely to drain perched groundwater and could have the unintended consequence of impacting and draining seepage flows migrating towards The Drip.
15. The frequency of monitoring both groundwater levels and groundwater quality is adequate.
16. The groundwater triggers in The Drip and Corner Gorge, and Goulburn River TARPS do not provide useful management measures to ensure nil impact or environmental consequences to The Drip and Goulburn River Gorge or negligible impact or environmental consequences to the baseflow in the Goulburn River.
17. The nominated trigger locations in the TARPs are reasonable except:
    i. There is limited value in nominating triggers for the southern sites PZ128 SP2 and PZ129 SP2.
    ii. A northern monitoring site is required to monitor both the perched and regional water table level trends immediately north of The Drip.

With respect to surface water, the Panel concludes that:

18. The upper Goulburn River is heavily influenced by historical and ongoing mining activities that have already caused non-negligible impacts on river geomorphology, flows and water quality. The Panel's current consideration is the incremental impacts of LW409 to LW414.
19. It is likely that there will be more than "negligible impact or consequences" to baseflows in the Goulburn River.
20. Activating the contingency plans associated with the TARPs is unlikely to stop or reverse impacts on baseflows. This is because of the time-lag between groundwater depressurisation at the mine void and the change in hydraulic gradient between the groundwater and the river.
21. The surface water TARPs (water quality, flow and shallow groundwater) could not be fully assessed by the Panel because their trigger levels were not defined in the last seen version of the TARP tables.
22. The monitoring and TARPs are designed to assess the Goulburn River impacts of LW409 to LW414 rather than the impacts of "the project" (as defined in the Consent). This is related to lack of long-term baseline data and cannot now be resolved.
23. The Goulburn River TARPs use a single trigger that leaves little room for meaningful action before determination of whether the performance measure is exceeded.
24. There are no quantitative performance indicators that will support the determination of whether a consequence is negligible or not. This puts weight on the judgements of the Technical Committee, DPHI and agencies.
25. The TARPS are potentially confusing with respect to their dual use of "negligible" and "material".

With respect to biodiversity, the Panel concludes that:

26. The majority of the biodiversity values in the LW409 to LW414 study area are considered to be at minimal risk of negative environmental consequences from mining-induced impacts.
27. Impact predictions for microbats in the Biodiversity Management Plan (Yancoal 2025f) do not reflect the impact predictions from the environmental assessment (Moolarben Biota 2006) including no net loss of roosting habitat and no impacts to breeding caves. There is potential for impacts to minor cliffs. However, surveys have not been undertaken to determine the potential for these minor cliff lines to support roosting or breeding habitat. Thus, it cannot be determined whether proposed monitoring can satisfactorily identify subsidence impacts and related environmental consequences.
28. Monitoring proposed for microbats is insufficient to reliably assess performance against the performance indicator (changes in abundance) and is also insufficient to determine whether impacts are in accordance with the environmental assessment (no net loss of roosting features and no impacts to caves of particular value).
29. There is potential for reductions in baseflow, increased salinity, and increased frequency and periods of no to very low flow to impact on aquatic ecosystems and stream health; this will be exacerbated following cessation of mining.
30. Drawdown of groundwater in the Triassic sandstone and underlying Permian may impact on GDEs, including riparian vegetation along the Goulburn River and potentially lower sections of The Drip. These impacts have not been assessed.
31. The performance indicators and TARPs proposed do not ensure that impacts are in accordance with the impact predictions in the environmental assessment.
32. Subject to the recommendations below, the proposed aquatic monitoring program is considered sufficient to document changes in stream health.

Recommendations

The Panel acknowledges that during the various discussion and review sessions held with the Applicant there has been significant progress and positive enhancements made to the overall proposed monitoring and management program. The Panel believes that a number of further actions and improvements are still required, together with additional supporting information to increase the likelihood of being able to meet the performance measures. However, in some instances, there may still be deficiencies in the ability to achieve all of the performance measures.

The recommended additional measures are summarised below:

With respect to subsidence, the Panel recommends that:

1. Monitoring and management of any potential impacts on the natural features of the Goulburn River Gorge and the Goulburn River itself should always adopt a comprehensive approach addressing all relevant TARPs collectively, rather than in isolation, i.e. subsidence, groundwater and surface water TARPs should be considered together on each occasion.
2. Regarding far-field movement in the vicinity of the Gorge, some level of movement is expected, but is not likely to cause adverse impacts at the levels involved. The Applicant's

subsidence consultant, MSEC, has made predictions based on the database established from GNSS monitoring stations at Moolarben. The relevant far-field movement TARPs should be informed by a tabulated list of offset distances (between the extremity of mining extraction and the natural features) and the predicted level of far-field movement – for each longwall panel in the UG4 extraction plan.

3. An additional TARP should be added relating to far-field movement associated with the mining of each longwall panel. Any movement more than the current predictions made by MSEC should result in a TARP trigger that results in a further review of MSEC predictions for all non-conventional effects and impacts.
4. The valley closure TARP should be triggered as soon as any measurable closure, i.e. more than the GNSS monitoring system accuracy (understood to be $\pm$ 5mm), is detected. Such a trigger should lead to an immediate pause in mining while other monitoring systems and TARPs are reviewed. If there is no indication of any adverse impacts, then a period of reduced rate extraction could re-commence under a careful and regular monitoring regime which needs to be specified in an improved TARP. However, if there are any other indications of actual or potential adverse impact, then the alternative adaptive management strategies should be enacted, involving a stop to mining at that location and a potential relocation of the mining face further away from the Gorge.
5. Monitoring in relation to valley closure should be supplemented by installation of sub-surface monitoring to detect any potential bedding plane shear in the sub-surface rock strata on the mining side of each of The Drip and Corner Gorge. Such additional monitoring should be used to inform any decision regarding potential impact on the base of the Gorge which could adversely affect surface water, groundwater or stability of the Drip itself.
6. The location of the Goulburn River, where it passes close to the proposed mining extraction (e.g. the inbye corners of LW409, LW410 and LW412) should also be subject to valley closure monitoring and a specific TARP introduced to trigger a review of predictions and possible further actions if the predicted values of closure are exceeded.

With respect to groundwater, the Panel recommends that:

7. Full re-appraisal of the modelled general head boundary conditions is prioritised and the model recalibrated to the satisfaction of the Department, prior to commencement of extraction of LW410 as part of modelling improvements to increase the reliability of the long-term predictions of mining impacts on the environment.
8. Formal uncertainty analysis is undertaken as part of the proposed review and updating of the model with specific attention paid to areas of environmental concern including the Goulburn River and the Drip.
9. The examination of possible options for mitigation of impacts to The Drip, not only if performance measures are exceeded but also when groundwater impacts become apparent that are likely to result in performance measures being exceeded.
10. The proposed additions to the groundwater monitoring network be installed and fully operational by the end of Q3 2025.
11. The ‘open hole’ completion specification for the monitoring bore located immediately north of The Drip be revised to monitor perched water table and regional water table in separate standpipes with appropriate isolation of aquifer zones and be based on a robust environmental risk assessment.
12. The groundwater trigger in the draft TARP for the Goulburn River be revised by:
    i. Setting trigger water levels and objective management measures for the two nested sites located near SW2 and SW22 (PZ237A and PZ234A respectively) to coincide

with when the surface water-groundwater connectivity changes from connected gaining to connected losing, and

ii. Identifying all other standpipe sites (such as PZ105C, PZ128 SP1, PZ129 SP1, and PZ-G) that would assist with assessing baseflow impacts and determining appropriate management measures.

13. The water supply and groundwater triggers in the draft TARP for The Drip and Corner Gorge be expanded by nominating appropriate standpipe sites (such as the nested locations north of The Drip) and by including objective management measures to ensure nil impact or environmental consequences to the water supply to The Drip.

With respect to surface water, the Panel recommends that:

14. The trigger levels for flow, water quality and riparian groundwater (PZ124/127) should be independently reviewed, to the satisfaction of the Department, after they are proposed and before start of extraction of LW409.
15. Quantitative performance indicators for flow loss, water quality and groundwater decline at PZ234/237 should be proposed and embedded in the TARP tables.
16. The dual use of "negligible" and "material" in the Goulburn River TARPs and "nil" and "material" in other TARPs should be avoided, for example by referring instead more generally to the "performance conditions".
17. The performance condition stated in the header of the Goulburn River (water quality flows and PZ234/237) TARP tables should be checked for accuracy.

With respect to biodiversity, the Panel recommends that:

18. Impact predictions for microbats in the Biodiversity Management Plan (Yancoal 2025f) are updated to reflect the impact predictions from the environmental assessment (Moolarben Biota 2006) including no net loss of roosting habitat and no impacts to breeding caves.
19. Baseline surveys of cliff lines within and adjacent to the study area are undertaken prior to commencement of mining to determine whether the study area supports roosting or breeding habitat for microbats.
20. The results of this baseline survey should inform management measures and revisions to the monitoring program, with identified roosting and breeding habitat subject to monitoring to ensure environmental consequences are in accordance with the predictions in the environmental assessment:
    i. if breeding and roosting habitat is not identified, monitoring could be removed from the monitoring program.
    ii. if breeding and roosting habitat is identified more targeted monitoring of these locations would be required to ensure impacts are in accordance with the environmental assessment and determine whether mining results in environmental consequences for microbats.
15. A baseline assessment is undertaken prior to mining to identify and map aquatic ecosystems and GDEs, along with a baseline assessment of their current condition and health and an assessment of the potential impacts to aquatic ecosystems and GDEs arising from loss of baseflow to the Goulburn River.
21. The results of this assessment should inform the development of a monitoring program to detect changes in identified GDEs. The monitoring program would require further assessment after trends in the groundwater monitoring data show that drawdown has

occurred in the Triassic sandstone to be below river level, and that the Goulburn River is potentially a losing stream. Periodic monitoring of GDEs and aquatic ecosystems would be required thereafter to record impacts to aquatic ecosystems and GDEs. Any monitoring program should focus on use of reliable metrics for assessment of changes in vegetation condition; this may include remote sensing.

22. The results of this assessment should inform the development of a monitoring program to detect changes in identified GDEs. Any monitoring program should focus on use of reliable metrics for assessment of changes in vegetation condition; this may include remote sensing.
23. If MCO wishes to undertake monitoring of native vegetation, remote sensing may provide more suitable methods for detecting large-scale changes in water usage by vegetation above longwall mining areas. If the use of floristic plots is used to monitor changes, it is recommended that a minimum of two years baseline survey is required and that monitoring continue until mining is beyond the 26° angle of draw and that a monitoring plot is unlikely to experience and further conventional subsidence.
24. The monitoring program and TARP for threatened flora should be updated to include monitoring of any plants translocated into new habitat resulting from a Level 1 trigger and require biodiversity offsets if a Level 2 trigger occurs.

Contents

1. SCOPE OF WORKS

1.1. PROJECT BACKGROUND

The Moolarben Coal Complex (MCC) is an open-cut and underground coal mine located approximately 40 kilometres (km) north of Mudgee. The complex lies directly between two other mining operations, the Ulan Coal Complex (UCC) to the north-west and Wilpinjong Mine to the south-east. The existing approved MCC comprises four open-cut (OC1, OC2, OC3 and OC4) and three underground mining areas (UG1, UG2 and UG4), as well other mining related infrastructure including coal processing and transport facilities (see Figure 1).

Moolarben Coal Operations Pty Ltd (MCO) is the operator of the Moolarben Coal Complex on behalf of the Moolarben Joint Venture (Moolarben Coal Mines Pty Ltd [MCM], Yancoal Moolarben Pty Ltd [YM] and a consortium of Korean power companies). MCO, MCM and YM are wholly owned subsidiaries of Yancoal Australia Limited (Yancoal). The Moolarben Coal Complex comprises of the Moolarben Coal Project Stage 1 and the Moolarben Coal Project Stage 2.

MCC operates under two integrated Development Consents known as 'Stage 1' (05_0117) and 'Stage 2' (08_0135). The current UG4 Extraction Plan under consideration is a post-approval matter involving proposed longwall extraction in six panels – LW409 to LW414 - located in the north of the UG4 area and is covered by the existing Stage 1 Development Consent. An Extraction Plan for the southern region of the UG4 area has previously been approved and mining is currently taking place (LW401 to LW408).

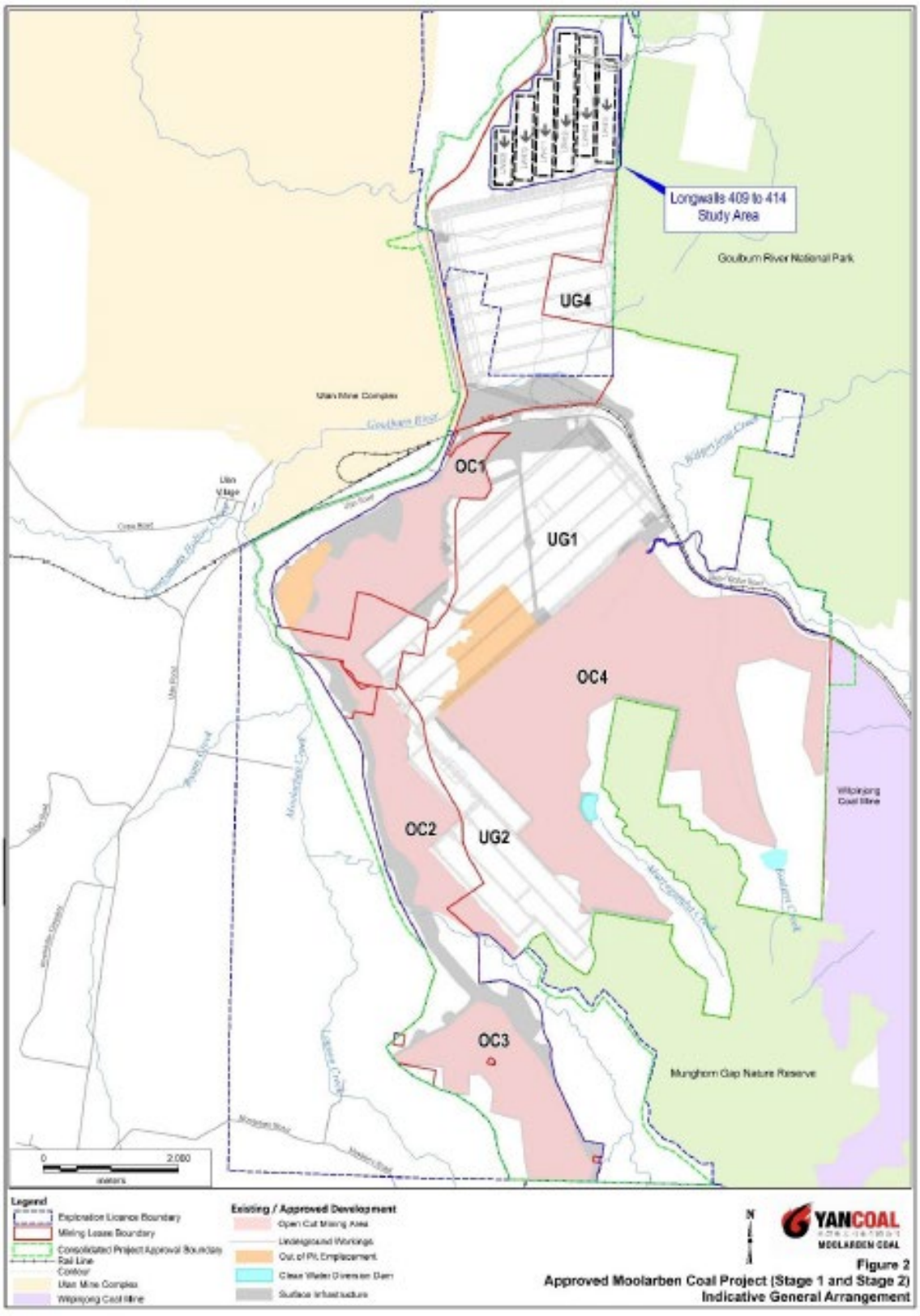

Figure 1: Existing and proposed mining areas

Figure 2 shows the combined UG4 mine plans together with the relevant natural features in the area. Figure 3 shows the built features and identified heritage sites, relative to the UG4 mine plans.

The key natural features of interest for the Panel's consideration, as marked on Figure 2, are The Drip, the Corner Gorge and the Goulburn River. The Drip and the Corner Gorge are located immediately to the north of UG4, while the Goulburn River passes along the west of the UG4 area and then across the north.

The identified heritage sites marked on Figure 3 are located both above the extraction area, and also beyond the study area boundary (marked as a black line defined by the limiting angle of draw for conventional subsidence).

Relevant mine plan geometry details for the proposed northern area of UG4 (LW409 to LW414) are as follows:

- Seam being mined: Ulan Seam
- Depth: 120m (near commencing end of LW412) to 215m (near finishing end of LW414)
- Panel widths: 260m (total void)
- Panel lengths: LW409 – 787m
  LW410 – 1,241m
  LW411 – 1,411m
  LW412 – 2,022m
  LW413 – 1,750m
  LW414 – 1,509m
- Extraction height: 3.0m
- Retreat direction: north to south
- Closest mining proximity to Goulburn River: 180m (LW409)
- Closest mining proximity to The Drip: 645m (LW413)
- Closest mining proximity to the Corner Gorge: 450m (LW414)

Development for LW409 panel commenced in June 2025.

Proposed longwall mining start date for LW409 is March 2026.

Proposed finish date for LW414 is March 2028.

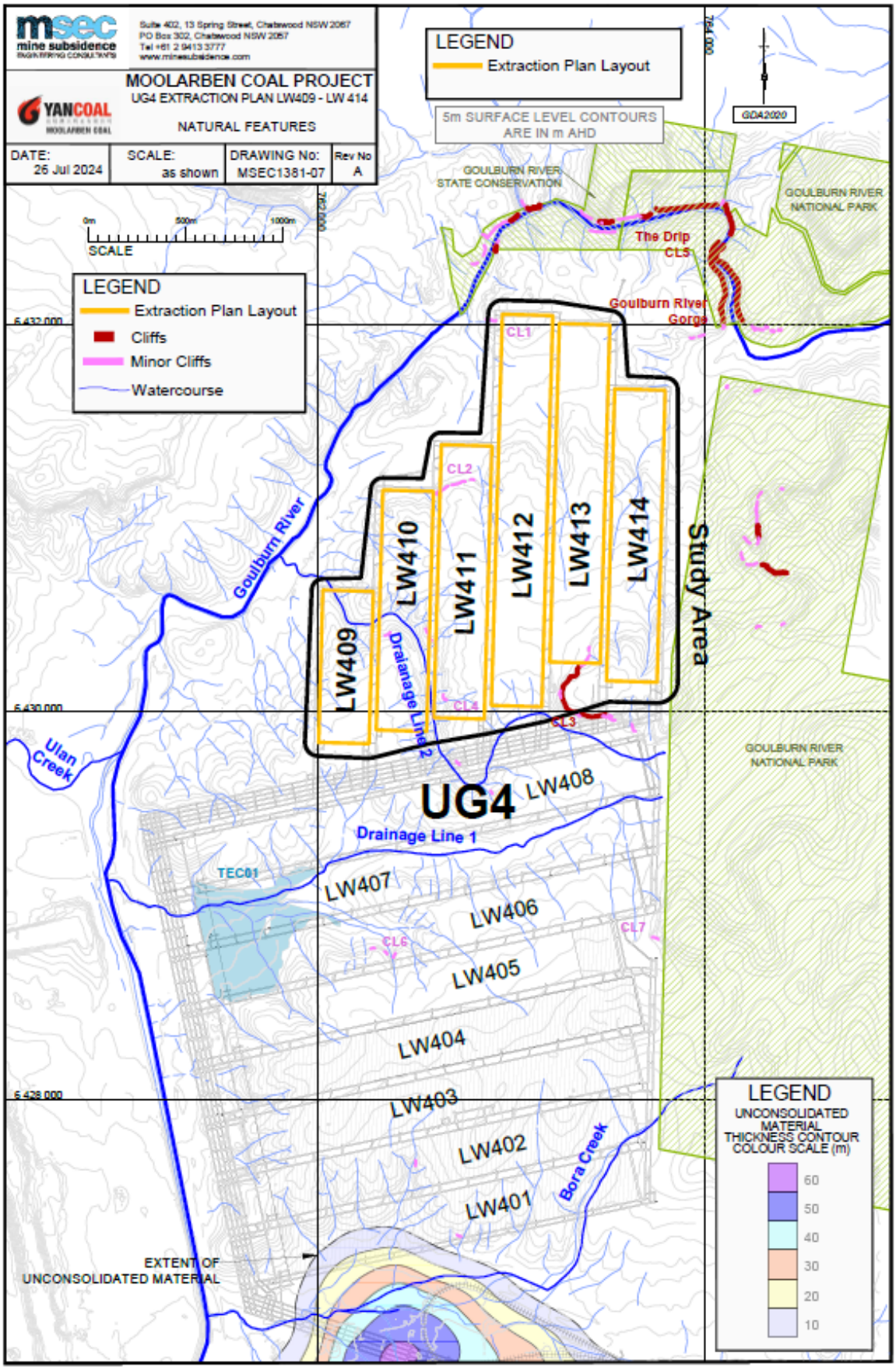

Figure 2: UG4 mining area and relevant natural features in the vicinity (*source: MSEC, 2024*)

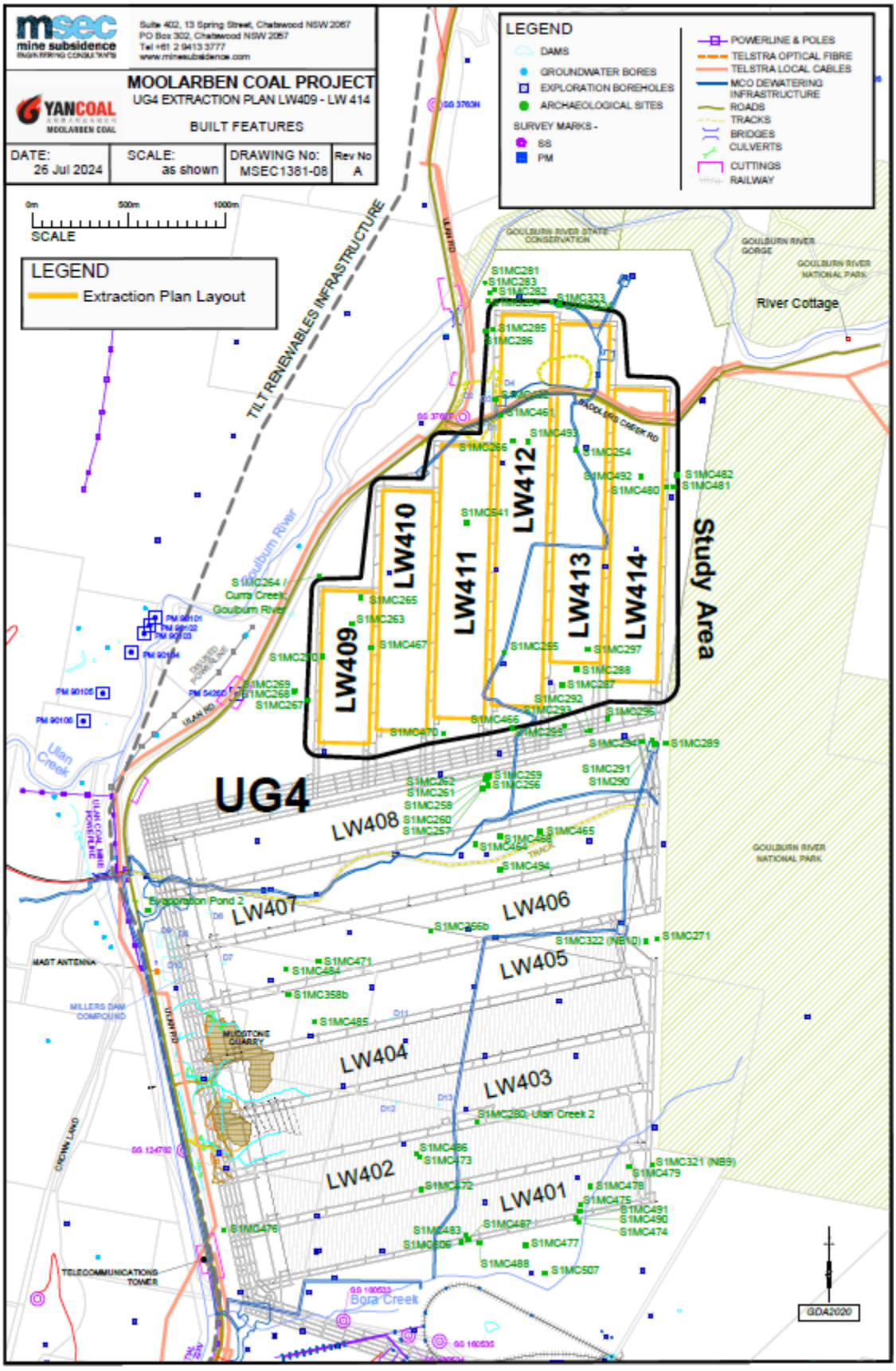

Figure 3: UG4 mining area and relevant built features and heritage sites (*source: MSEC, 2024*)

The Subsidence Impact Performance Measures (PM) relating to the currently proposed UG4 Extraction Plan in regard to natural and heritage features are listed below in Table 1, together with a summary response against each PM as provided by MCO in the Extraction Plan documentation.

Table 1: UG4 Extraction Plan Performance Measures (*source: UG4 Extraction Plan, Table 6*)

Table 6: Subsidence Impact Performance Measures – Natural and Heritage Features

Subsidence Impact Performance Measure		Relevance to LW409-414 Extraction Plan
Special Feature		
The Drip and Goulburn River Gorge	*Nil impact or environmental consequences*	The Drip is located approximately 645 m from LW413 and is approximately 770 m from LW412. The Corner Gorge is located approximately 450 m from LW414 and is approximately 575 m from LW413 and mining-related impacts to the Drip and Corner Gorge due to the extraction of LW409-414 are considered unlikely to occur.
Water Resources		
Goulburn River and the bed of the Goulburn River	*Negligible impact or environmental consequences.* *Remain outside the zone of recorded subsidence damage for longwall mining.*	The Goulburn River is located on the north-western side of LW409-412 at distances of 180 m to 440 m from the longwall commencing ends, and to the north and north-east of LW412-414 at distances of 460 m to 500 m and may experience horizontal movements at a valley location; however, it is considered unlikely that fracturing of the bed of the Goulburn River would occur.
Land		
CL3	*Minimise subsidence damage*	CL3 is located adjacent to the finishing end of LW413 and is over 165 m to the north of LW408. The length of LW413 has been reduced by 125 m for the Extraction Layout compared to the Approved Layout to reduce the predicted impacts at CL3. The maximum predicted conventional subsidence parameters based on the Extraction Plan Layout are less than those for the Approved Layout.
Heritage Sites		
Aboriginal heritage sites 264, 282, 283, 286 and 287	*Reduce the likelihood of subsidence damage to low.*	Aboriginal heritage site 264, 282, 283, 284[3], 286 and 287 are located outside the 20 mm subsidence contour and subsidence impacts to these sites are considered unlikely to occur.
Aboriginal Heritage Site 280	*Reduce the likelihood of subsidence damage to moderate.*	Aboriginal heritage site S1MC280 is located within the LW401-408 Study Area (south of the LW409-414 Study Area) and the likelihood of subsidence impacts to this feature from LW409-414 is considered to be very low. S1MC280 is not discussed further in the LW409-414 Extraction Plan.
Historic heritage sites	*No greater subsidence impact or environmental consequences than predicted in the EA[4]*	There are no historic heritage sites within the Study Area or within the vicinity of the Study Area.

Mine workings		
First workings under an approved Extraction Plan beneath any feature where performance measures in this table require negligible impacts, negligible consequences or negligible loss	*To remain long-term stable and non-subsiding.*	First workings have been designed to meet the requirements of Condition 79, Schedule 3 of Project Approval (05_0117). RR confirmed their satisfaction of first workings for UG4 on 8 July 2019.
Second workings	*To be carried out only within the longwall mining domains, in accordance with an approved Extraction Plan.*	Second workings will be carried out in accordance with an approved Extraction Plan (this Extraction Plan).

1.2. AGENCY ADVICE

As part of the preparation of the EP, MCO consulted with agencies to assist with the preparation of the Extraction Plan. The Panel was provided with the following agency advice, post submission of the EP:

- NSW Environment Protection Authority (EPA)
- Heritage NSW
- NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) - Water Group
- DCCEEW - Conservation Programs, Heritage and Regulations Group (CPHR) and NSW National Parks and Wildlife Services (NPWS) (Joint Response)

The catalyst for requesting the Panel's advice involved some concerns raised by several agencies and community groups regarding potential impacts to Goulburn River National Park, and the installation of monitoring bores proximal to The Drip.

1.3. DEPARTMENT REQUEST FOR ADVICE

The NSW Department of Planning, Housing and Infrastructure (DPHI – the Department) has established the Independent Expert Advisory Panel for Mining (IEAPM – the Panel) to give DPHI access to specialist knowledge and expert advice when assessing mining proposals under the *Environmental Planning and Assessment Act 1979*.

On 21 January 2025 the Department requested advice from the Panel.

The Department requested that the Panel provide advice targeting the following:

- *the scale and likelihood of potential subsidence, water-related impacts and environmental consequences on key water features in the vicinity of the Extraction Plan area, including the Drip gorge, Corner Gorge and the Goulburn River;*
- *whether is it reasonable to conclude that existing subsidence performance measures could be met;*
- *the scale and likelihood of potential subsidence impacts to Aboriginal Heritage sites within the Extraction Plan area, including SM1C287; and*

- *whether the proposed monitoring program and Trigger Action Response Plans are adequate to satisfactorily identify subsidence impacts and related environmental consequences.*

The Chair of the Panel (Em. Professor Jim Galvin) nominated the following members of the Panel to prepare the advice on the Moolarben UG4 Extraction Plan, based on their nominated areas of expertise:

- Em. Professor Bruce Hebblewhite (Moolarben UG4 Panel Convenor) – Mining and geotechnical (subsidence)
- Em. Professor Jim Galvin – Mining and geotechnical (subsidence)
- Neil Alston – Mining and geotechnical (subsidence)
- John Ross – Groundwater
- Rae Mackay – Groundwater
- Neil McIntyre – Surface Water
- Nathan Garvey – Biodiversity

2. METHOD OF OPERATION

2.1. DOCUMENTATION

The Panel convened by videoconference during the preparation of its advice and was administratively supported by Secretariat staff provided by the Department's Major Projects and Resource Assessments teams.

A wide range of documents was provided for review by the Panel in preparing this advice, the principal documents are summarised in Table 2.

During the course of the Panel's deliberations, the Panel sourced additional documentation from the Applicant, via the Department, in response to a number of questions and requests for further information. These were addressed by way of additional documentation provided on 8 April 2025, 23 May 2025, 6 June 2025 and 17 June 2025. A record of these responses is listed below in Table 2.

Table 2: Key Documents reviewed by the Panel

Document Reference	Document Name
Initial supply of documentation from MCO	**UG4 Longwalls 409-414 Extraction Plan** • Attachment 1: Statutory Requirements • Attachment 2: Relevant Consultation Records • Attachment 3: Program to Collect Baseline Data for Future Extraction Plans • Attachment 4: Key Contact Register • Appendix A: Water Management Plan • Appendix B: Land Management Plan • Appendix C: Biodiversity Management Plan • Appendix D: Heritage Management Plan • Appendix F: Public Safety Management Plan • Appendix G: Subsidence Monitoring Program (Plans 1-7) • Technical Report 1: Subsidence Report • Technical Report 2: Groundwater Technical Report • Technical Report 3: Surface Water Technical Report • Technical Report 4: Biodiversity Technical Report • Technical Report 5: Aboriginal Cultural Heritage Technical Report • Letter Response to Agency Feedback – 17 January 2025
Site Visit documents from MCO – dated 18 February 2025	• Location of SW02-PZ237 • Site Visit Itinerary • Briefing Presentation
Information from MCO following site visit Request for Information (dated 21	• Letter Response to Request for Information – 7 April 2025 o Enclosure 1 Response Table o Enclosure 2 The Drip, Corner Gorge, Goulburn River Monitoring and Reporting Program

Feb 2025) – received 8 April 2025	• Niche Longwall 401-408 Monitoring Program Spring 2023 – 12 February 2024 • Niche Longwalls 401-408 Monitoring Program Spring 2024 – 12 December 2024
Information from MCO following further Request for Information (dated 17 April 2025)– received 23 May 2025	• Letter dated 23 May 2025, plus attachment o Response to public submissions (provided separately)
Information from MCO following further Request for Information (dated 29 April 2025)– received 6 June 2025	• Letter dated 6 June 2025, plus attachments o SCT letter dated 2 June 2025 o MSEC letter dated 20 May 2025 o Encl. 3 – Summary of MCO responses to queries o Revised monitoring and reporting program (incl. TARPs)
Agency Advice provided by DPHI – Resource Assessments	• EPA • Heritage NSW • NSW DCCEEW (Water Group) • NSW DCCEEW (Conservation Programs Heritage Regulation (CPHR) and NPWS) (Joint Response)
Information from MCO in response to queries raised during briefing on 13 June 2025- received 17 June 2025	• Email and baseline visual inspection photographs provided by MCO in response to questions re Goulburn River monitoring and groundwater modelling.
Information from NSW DCCEEW NPWS (dated 30 June 2025) – received 10 July 2025	• Email, plus attachments in response to the Panel's request for data o Email clarifying the location and status of two alluvium piezometers close to The Drip o Monitoring data dated September 2024

2.2. SITE VISIT

On 18 February 2025, the Panel undertook a site inspection. The inspection involved a briefing at the MCC by the Applicant followed by inspection of the extraction area over the UG4 location and surrounding topography. Figure 4 shows the route taken by the Panel during the site inspection. The Panel was accompanied by the Applicant and its relevant consultants, plus Department representatives, during its inspection.

The Panel also independently visited the Goulburn River Gorge and The Drip, on the same day, immediately prior to meeting with MCO representatives for the site visit.

Figure 5 and Figure 6 are photographs taken by Panel members during these site visits on 18 February, showing The Drip (looking east and west, respectively). Figure 7 shows the Goulburn River passing through the Corner Gorge and Figure 8 shows an example of the overhanging cliffs on the southern side of the Corner Gorge.

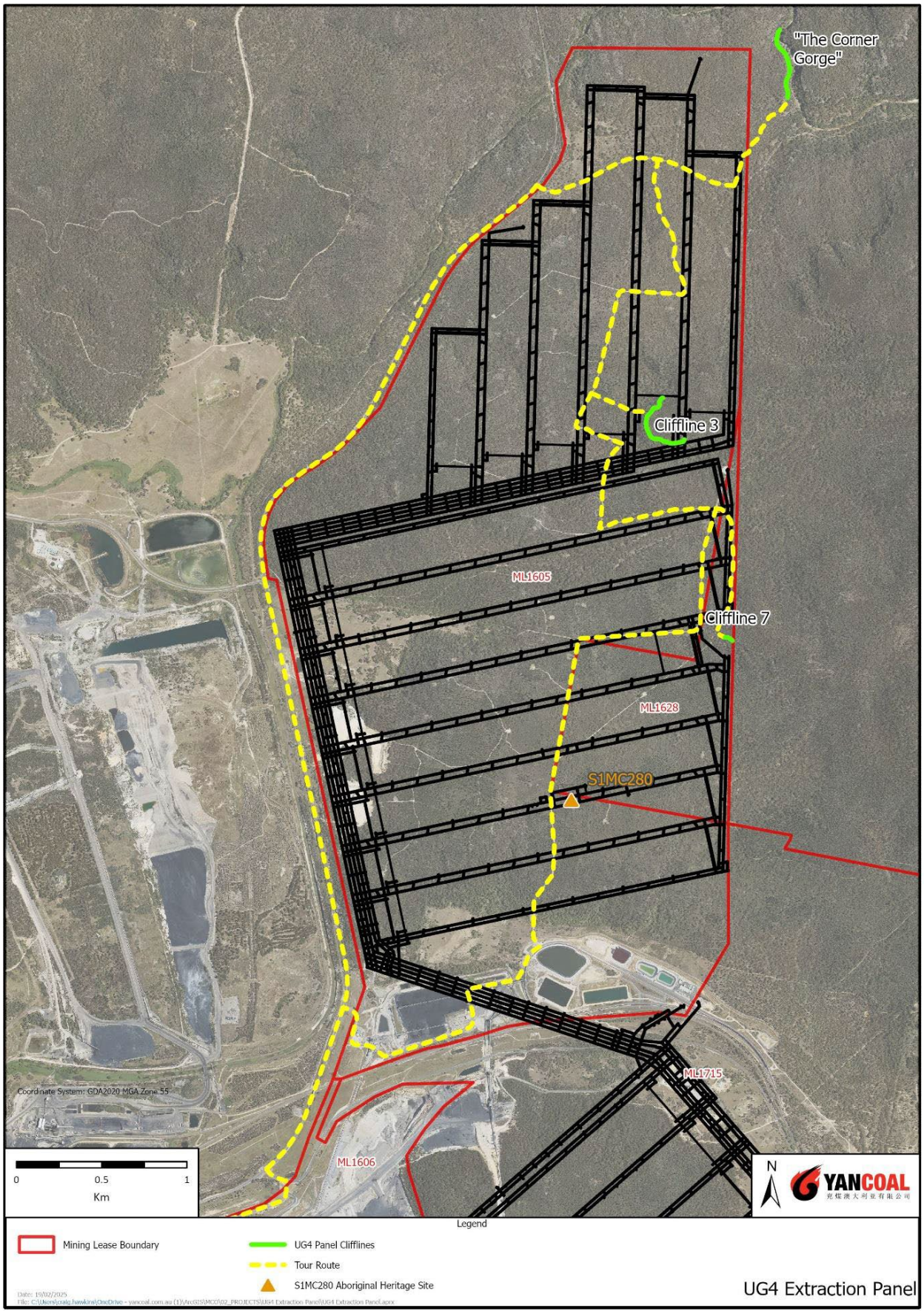

Figure 4: Site visit route (18 February 2025) – (*source: Site visit itinerary provided by MCO*)

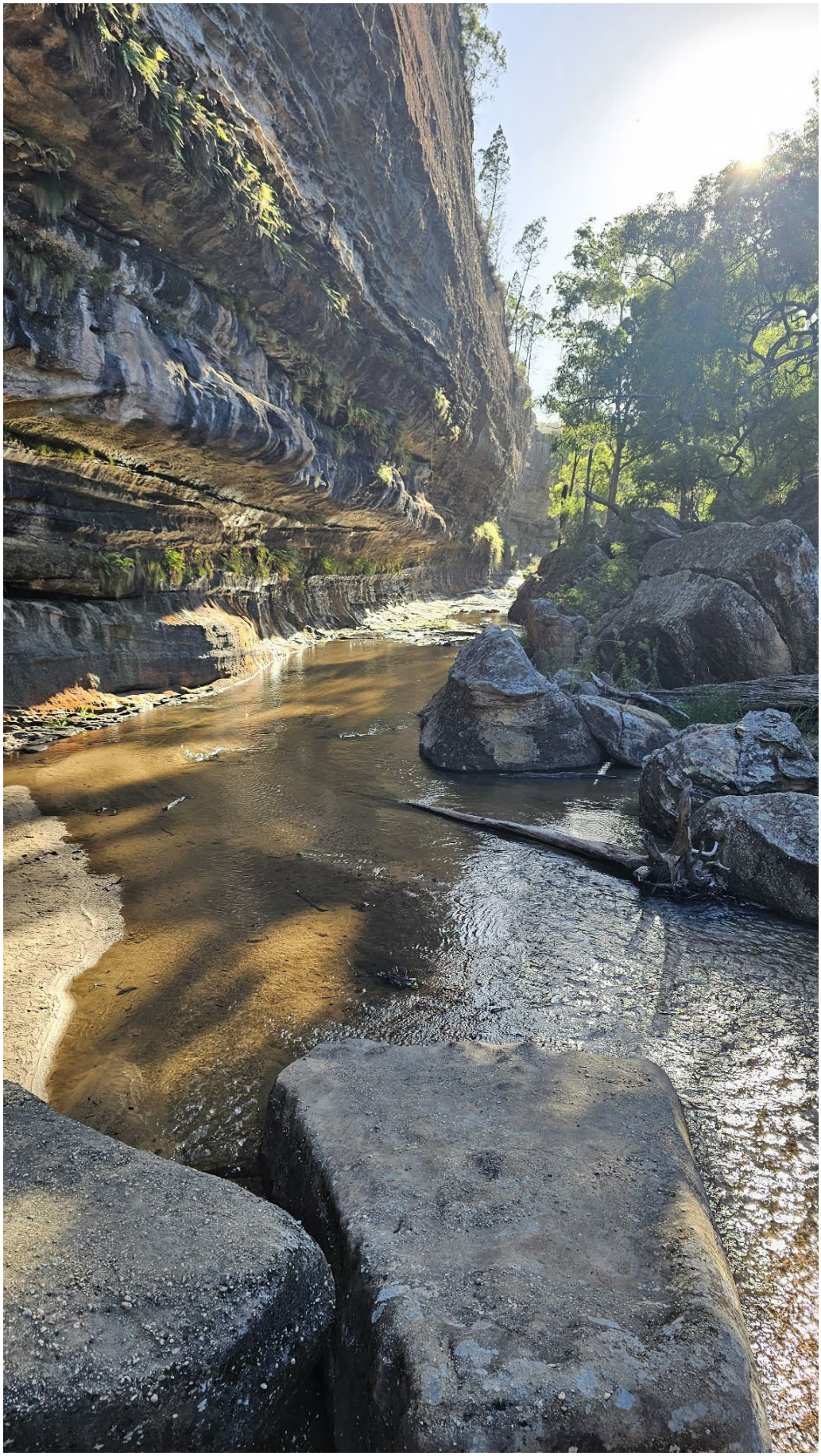

Figure 5: The Drip – Goulburn River Gorge (looking east)

Figure 6: The Drip – Goulburn River Gorge (looking west)

Figure 7: Goulburn River – passing through the Corner Gorge (looking west)

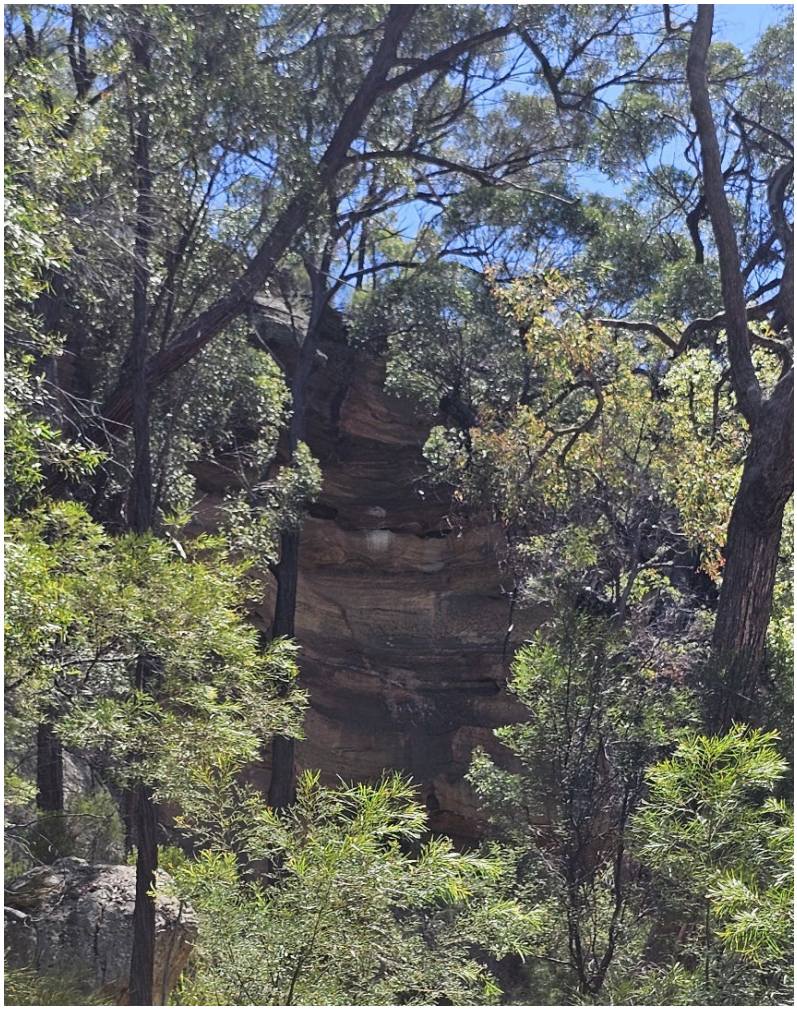

Figure 8: Cliff overhangs on the southern side of the Corner Gorge

2.3. MEETINGS

The Panel convened several times over the course of preparing its advice. Table 3 lists the meetings held by the Panel.

Table 3: Panel Meetings

Meeting Date	Meeting Information
5/02/2025	Panel briefing with NSW Resource Assessments
18/02/2025	Site visit including briefing by MCO
15/04/2025	Panel discussion relevant to request for information response
13/06/2025	Further briefing by MCO in relation to 6 June 2025 responses
1/07/2025	Panel discussion to review draft Panel report
15/07/2025	Panel briefing with NSW Resource Assessments
17/07/2025	Panel discussion to review draft Panel report

3. PRIMARY FOCUS OF THIS ADVICE

The Panel has been asked to review the Moolarben UG4 Extraction Plan (*"the Extraction Plan"*) and other supporting documentation provided, as a post-approval matter. As noted in section 1.3 of this report, above, the Panel was specifically tasked with consideration of the subsidence effects associated with the proposed UG4 extraction and the subsidence impact together with water-related impacts (surface and groundwater) and associated environmental consequences on the Goulburn River Gorge, including The Drip and the Corner Gorge, and the Goulburn River itself.

The Panel has particularly been requested to consider whether the prescribed performance measures in relation to protection of these natural features can be achieved, and whether the monitoring program and Trigger Action Response Plans (TARPs) are considered adequate to identify and manage the impacts of mining to within the limits of these performance measures.

The performance measures were listed in Table 1 and require:

- *Nil impact or environmental consequences* – in regard to the Goulburn River Gorge and specifically The Drip and the Corner Gorge; and
- *Negligible impact or environmental consequences* – in regard to the Goulburn River and the bed of the Goulburn River.

The Panel has also been requested to consider the scale and likelihood of subsidence impacts to Aboriginal heritage sites within the Extraction Plan area, and in particular, site SM1C287. In regard to these sites, the performance measures require:

- *Reduce the likelihood of subsidence damage to low* – with respect to Aboriginal heritage sites 264, 282, 283, 284, 286 and 287.
- *Minimise subsidence damage* – with respect to cliff line CL3 (to the south of LW412), where site SM1C287 is located.

The following Panel review and advice is structured under the headings of:

- Subsidence
- Groundwater
- Surface Water
- Biodiversity

Discussion under these broad headings includes potential subsidence impacts, in particular due to non-conventional subsidence behaviour associated with the Goulburn River Gorge and the Goulburn River itself, together with subsidence impact on Aboriginal heritage sites (under Subsidence); and under the groundwater and surface water headings, discussion includes groundwater-surface water interaction, modelling and monitoring.

4. SUBSIDENCE

4.1. SUBSIDENCE TERMINOLOGY

It is important that consistent terminology is used in this discussion to avoid confusion and potential misinterpretation of the type of subsidence behaviour under consideration. For this reason, a brief summary of appropriate subsidence terminology is included below.

The independent 2008 Southern Coalfield Inquiry (NSW Dept of Planning, 2008) conducted on behalf of the NSW government provided the following definitions of important terms that are now widely accepted by the industry and the geotechnical/mining professions.

The Southern Coalfield Inquiry defined two primary modes of systematic subsidence behaviour[1], as follows:

- *Conventional Subsidence* - Subsidence behaviour that follows reasonably predictable systematic behaviour in accordance with well- and long-established behaviour models, normally associated with relatively flat surface topography.
- *Non-Conventional Subsidence* - Subsidence behaviour that follows a form of behaviour that differs from conventional behaviour - normally associated with irregular surface topography - resulting in subsidence effects and impacts that can still be systematic in nature, but are not defined by conventional subsidence models, and include non-conventional effects and impacts of far-field movements[2], valley closure[3] and valley-floor upsidence[4].

Conventional subsidence behaviour is generally restricted to mining-induced ground movements contained within a surface footprint defined by an angle of draw that is typically between about 26^0 to 35^0 from a vertical projection above the perimeter of mining extraction.

Moolarben's subsidence consultant, MSEC, has used an angle of draw` of 26.5^0 to define the Study Area boundary around the extraction area to contain the extent of conventional subsidence, coinciding with the predicted contour line of a total 20mm of vertical subsidence (20mm is widely accepted as a reasonable limit to distinguish between mining-induced subsidence and natural ground movements).

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[1] Systematic subsidence - A generic, high-level term to describe subsidence behaviour that can be defined by reasonably consistent and predictable models – either conventional or as non-conventional subsidence. The opposite of systematic subsidence is anomalous subsidence, which is essentially unpredictable, and usually quite discrete or localised behaviour (IESC, 2022).

[2] Far-field movement - This term is used to describe usually lower levels of surface horizontal movement as a result of mining, which occurs well outside the bounds of the angle of draw and is considered to be a non-conventional subsidence effect.

[3] Valley closure - A subsidence impact defined by non-conventional subsidence behaviour, whereby the sides of valleys above an extraction area, and to a lesser extent, adjacent to an extraction area, exhibit horizontal closure, linked to the buckling effects of valley floor impact.

[4] Upsidence - Upsidence is localised incremental uplift resulting from the dilation or buckling of near-surface valley floor strata. It is defined as the difference in observed or predicted subsidence of a valley floor region by comparison to the expected downward vertical subsidence if the area was a flat terrain, as predicted by conventional subsidence behaviour, i.e., if a point of ground above a mining extraction area was predicted to subside by 600 mm under conventional subsidence theory, but being in the floor of a valley, has actually only subsided by 450 mm, it is said to have undergone 150 mm of "upsidence", reflecting the impact of the subsidence behaviour on the structure of the near-surface valley floor strata.

In contrast to the above two forms of systematic subsidence behaviour that can be reasonably well-defined and amenable to predictive modelling, a third form of subsidence is referred to as anomalous behaviour (IESC, 2022):

- *Anomalous Subsidence* - Subsidence behaviour that does not follow any of the accepted normal systematic behavioural models – often associated with localised anomalous geological structural features such as faults, dykes or joint swarms. Anomalous subsidence is usually quite a discrete behavioural event, occurring in localised areas only.

The above classifications of subsidence behaviour are summarised in a hierarchy presented graphically in Figure 9. Unfortunately, there are still some differences in the use of these terms for subsidence behaviour across the industry and even amongst subsidence consultants. However, the Panel has adopted the terminology described here, to minimise confusion and inappropriate interpretation.

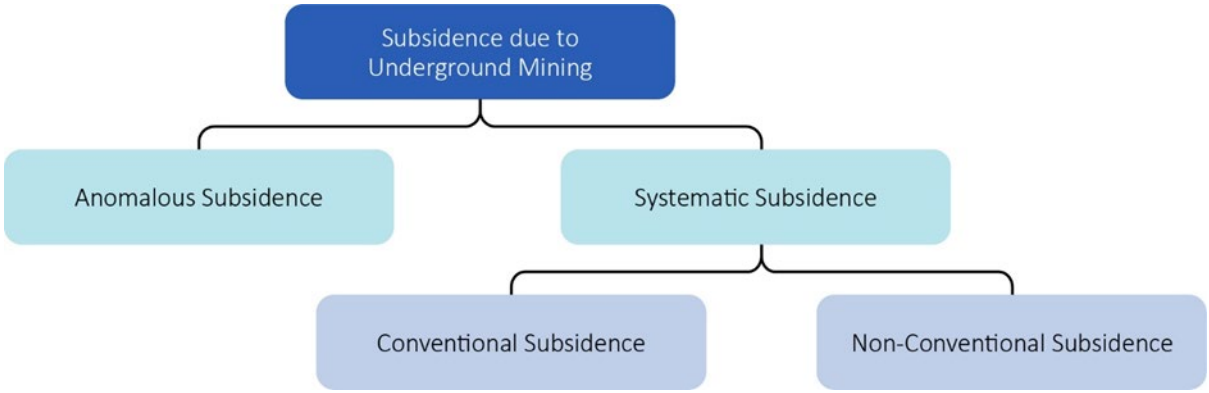

Figure 9: Hierarchy of subsidence behaviour models

The Southern Coalfield Inquiry further defined the following terms, as follows:

- The term *subsidence effects* was used to describe subsidence itself – i.e., deformation of the ground mass caused by mining, including all mining-induced ground movements such as vertical and horizontal displacements and curvature as measured by tilts and strains.
- The term *subsidence impacts* was used to describe the physical changes to the ground and its surface caused by these subsidence effects. These impacts are principally tensile and shear cracking of the rock mass and localised buckling of strata caused by valley closure and upsidence but also include subsidence depressions or troughs.
- The *environmental consequences* of these impacts can include loss of surface water flows to the subsurface, loss of standing pools, adverse surface, and groundwater quality impacts, development of iron bacterial mats, cliff falls and rock falls, damage to Aboriginal heritage sites, impacts on aquatic ecology, ponding, impacts on upland and valley-infill swamps, ecology etc. (Note: This terminology is an expansion of the common use of the term *"environmental impact"*, as used in an Environmental Impact Statement, for example. Here, the environmental impact is referred to as an environmental consequence of a subsidence impact, as opposed to environmental impacts that might be caused by other non-subsidence related factors).

Returning to the non-conventional subsidence impacts associated with valley closure and upsidence, Figure 10 is a useful schematic diagram that clearly illustrates the type of valley floor fracturing and bedding plane shearing, potential buckling and localised dilation within the sub-surface rock strata that can contribute to both valley closure and upsidence in non-conventional subsidence.

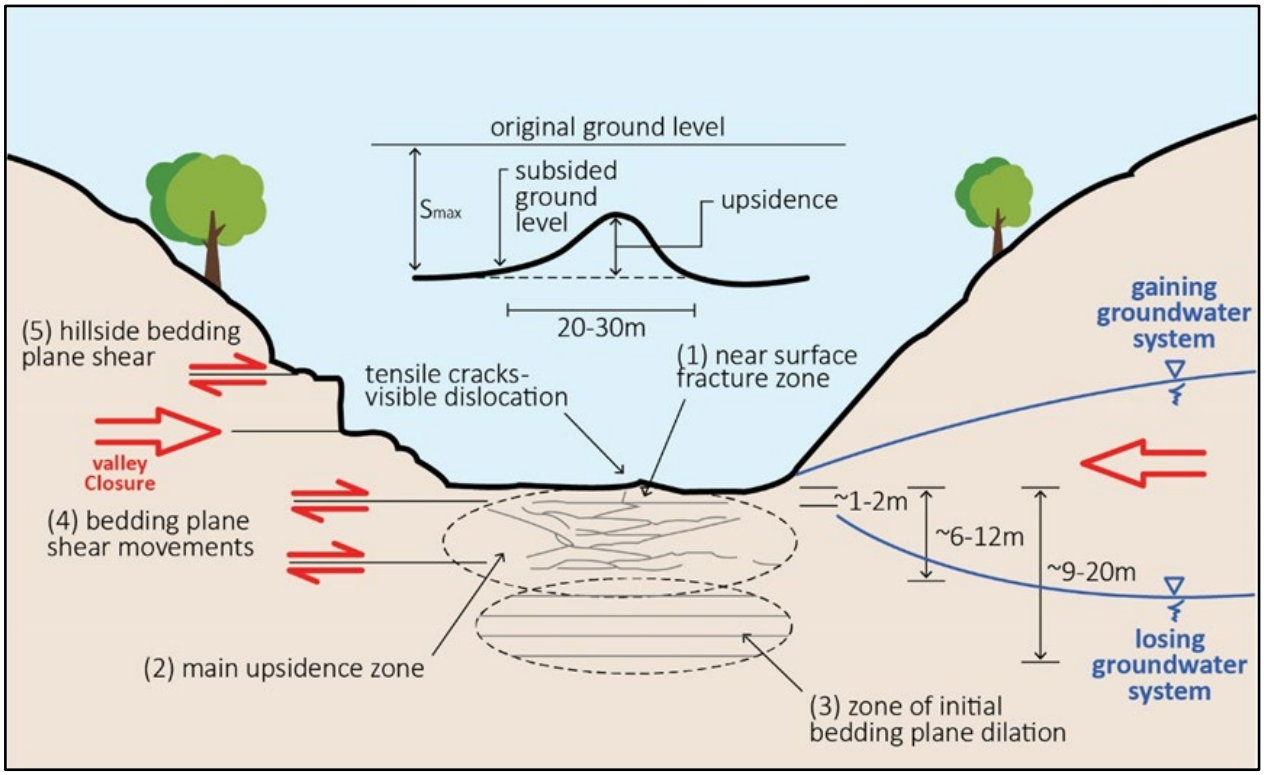

Figure 10: Sketch of conceptual mechanism for valley closure and upsidence *(source: Mills, 2008)*

4.2. UG4 Conventional Subsidence Considerations

The Extraction Plan and supporting documentation provided makes predictions of subsidence effects and impacts on the surface as a result of the mining of LW409 to LW414. The Panel notes the methodology used for such predictions by the Applicant's consultants MSEC, and accepts that the prediction methodology, and hence the initial prediction values, are considered acceptable. However, it is noted by the Panel that the predictions should be reviewed on a panel-by-panel basis against measured behaviour, and recalibrated as required, as subsidence monitoring data is collected and analysed.

In relation to the surface impacts of extraction in the proposed block of six longwall panels, it is noted that the proposed maximum extraction height is nominated as 3.0m (lower than earlier planning proposals that used an extraction height of up to 4.2m in order to reduce any adverse subsidence impacts). This reduction is noted and accepted as an important control measure that must be adhered to during the operational stage of the project.

The depth of cover over the proposed longwall panels ranges from as low as 120m to approximately 215m. At this range of depths, with 260m longwall void widths, the surface subsidence effects will be in the super-critical range, meaning the development of the

maximum vertical subsidence magnitude across the centre of each panel, with reduced subsidence over the lines of chain pillars between the panels, accompanied by inevitable surface tensile cracking above the panel edges and ahead of the mining face in each panel.

It is also likely that at the shallower range of depths, the extent of fracturing and deformation of the overburden above the panels may result in the height of depressurisation due to mining (with respect to any contained groundwater) extending towards and into the near-surface fracture zone. Given the absence of any significant constrained zone to prevent groundwater migration, the regional water table in the Triassic sandstone will decline and, locally, this aquifer zone will be dewatered (see Groundwater Section 5 of this report for further discussion).

4.3. UG4 Non-Conventional Subsidence Considerations

The primary focus of this subsidence review relates to the non-conventional behaviour associated with proximity to the Goulburn River Gorge containing both The Drip and the Corner Gorge natural features. The Goulburn River itself, and the near-surface strata forming the bed of the river – both through the Gorge and elsewhere – is also of interest to the Panel in regard to potential subsidence impacts due to valley closure.

The offset distances between the extent of mining and these various features were listed in section 1.1 of this report.

MSEC has made predictions with respect to these non-conventional subsidence effects and impacts – again based on a quite extensive empirical database developed across NSW and elsewhere. The Panel accepts that the MSEC prediction methodology is appropriate, although noting that the level of confidence in the predictions is not as high as with predictions for conventional subsidence.

The Panel acknowledges that The Drip is a very significant and quite unique natural feature comprising of a layered but relatively massive exposed vertical rock face with a significant overhang, as is visible in the images shown in Figure 5 and Figure 6. Whilst it is clearly subject to long-term natural erosion effects over time, it would also be highly susceptible to any potential adverse mining-induced subsidence impacts such as differential movement, tilting or strain. The size and nature of the overhanging cliffs and rock structures on the southern side of the Corner Gorge are also considered to be of great significance and potentially susceptible to the same forms of mining-induced effects and impacts that might occur in this location.

On the basis of the predictions made by MSEC and the mine plan configuration incorporating significant offset distances from the extent of mining to these critical natural features of The Drip and the Corner Gorge, together with the Goulburn River, the Panel agrees that the likelihood of any adverse impacts on these natural features is very low. However, given the significance and the characteristics of these natural features and the performance measures that require nil impact or environmental consequence, the Panel believes that a precautionary approach needs to be applied to the management strategies in order to ensure compliance with the performance measures.

The Panel notes that the current mine layout (with respect to panel orientation and retreat directions) has already been approved as part of the existing Development Consent. To some degree, this limits the available adaptive management strategies available to MCO to manage compliance with the performance measures. However, since discussions with the Panel commenced, MCO has made several significant enhancements to the proposed monitoring program, TARPs and adaptive management strategies in the most recent draft version of the UG4 Monitoring and Reporting Program (6 June 2025). These enhancements are believed to be at least in part in response to requests from the Panel and they are acknowledged and welcomed.

4.3.1. Adaptive Management Strategies

In particular, the available adaptive management strategies now in place are described by MCO as follows in Yancoal (2025c):

> *To clarify the proposed adaptive management strategies for the Drip and Corner Gorge, MCO has revised the Monitoring Program, including the Drip and Corner Gorge TARP, to specify that any recommendations from the Technical Committee must consider and provide recommendations as to whether monitoring observations require the following interventions/actions:*
>
> > *1. Pause secondary extraction in relevant areas where appropriate and safe to do so.*
> >
> > *2. Depending on outcomes of further investigations, consider whether:*
> > *• longwall extraction of the current and/or future panels should cease prematurely;*
> > *• longwall extraction of the current panel should be relocated further outbye;*
> > *• future panels should commence further outbye than the approved mining layout;*
> > *• the density of cut throughs should be increased within the first portion of extraction of future panels to enable earlier pause and/or cessation of the longwall extraction, if required;*
> > *• retreat speed of future panels should be limited for the first portion of extraction to enable additional time to review/assess monitoring data; and/or*
> > *• no change to the approved mining layout is required.*
>
> *If changes to the approved mining layout are required once a longwall panel has commenced, MCO would prepare a recovery plan to safely recover the longwall equipment to avoid and/or minimise impacts to the Drip and Corner Gorge.*
>
> *Adaptive management would be implemented during mining of LW409-414 under the process outlined below:*
>
> > *1. During secondary extraction of LW409-411, the Technical Committee would review monitoring data against subsidence predictions and TARP trigger levels following the first 300 metres (m) of secondary extraction of each panel.*

- If observed far-field movements are within predictions and the TARP is not triggered, mining of the next panel would continue as proposed.
- If observed far-field movements are greater than predicted and/or the TARP is triggered, the Technical Committee would consider whether any changes to the monitoring program, trigger levels, TARP or mine plan (i.e. as per interventions/actions listed above) are required to maintain compliance with performance measures.
- The Steering Committee would make a decision on any recommendations from the Technical Committee prior to commencement of the next panel.
- Additional review of monitoring data would also occur at the end of each panel.

2. In accordance with Condition 78A, Schedule 3 of the Stage 1 Project Approval (05_0117), prior to commencement of LW412, MCO would prepare a report (with input from independent technical specialists) which summarises reviews undertaken during secondary extraction of LW409-411, confirms subsidence predictions, trigger levels and TARPs and documents whether any changes to the mine plan are required for LW412-414.

3. During secondary extraction of LW412-414, the Technical Committee would review monitoring data against subsidence predictions bi-weekly (i.e. twice a week) during secondary extraction of the first 300 m of each panel.

- *If observed far-field movements are within predictions and the TARP is not triggered, mining of the next panel would continue as proposed.*
- *If observed far-field movements are greater than predicted and/or the TARP is triggered, the Technical Committee would consider whether any changes to the monitoring program, trigger levels, TARP or mine plan (i.e. as per interventions/actions listed above) are required to maintain compliance with performance measures.*
- *The Steering Committee would make a decision on any recommendations from the Technical Committee prior to commencement of the next panel.*
- *Additional review of monitoring data would also occur fortnightly during secondary extraction of the next 500 m of each panel and at the end of each panel.*

In order to comply with nil impact performance measures, control by way of individual TARPs in isolation can be difficult and it is the view of the Panel that all monitoring systems and related TARPs (addressing not only subsidence but groundwater and surface water) should be considered collectively in relation to any potential impacts and consequences on these natural features.

With respect to the key elements of non-conventional subsidence impacts – particularly far-field movements and valley closure (and related valley floor upsidence) – the Panel puts forward the following views and advice with respect to the most appropriate management strategies.

4.3.2. FAR-FIELD MOVEMENTS

Far-field movements represent horizontal deformation of the surface and near-surface strata towards the mining excavation over large distances – often well beyond the extent prescribed by the angle of draw as defined in conventional subsidence. This type of far-field movement is typically characterised by very low levels of differential horizontal movement and negligible vertical movement and hence very low to negligible surface horizontal strains, and no tilts, hence negligible adverse surface impacts. The extent of such movement below the surface is not as well understood but may involve some degree of bedding plane shearing at various strata interfaces below the surface.

In response to the request by the previous Panel that reviewed the proposed LW401 to LW408 area of UG4 (IAPUM, 2022), Moolarben installed an array of very accurate satellite-sensing ground deformation monitoring stations (GNSS units) to measure horizontal deformations, effectively on a continuous basis. These have provided a very good and expanding database, specific to Moolarben, to demonstrate the magnitude and extent of far-field movement away from the current UG4 longwall panels. This GNSS array has more recently been further supplemented with more stations located in the vicinity of the Goulburn River Gorge (with stations on either side of the Gorge). Figure 11 shows the results of this database as provided to the Panel in (MSEC, 2024) in terms of extent of movement relative to distance from the extent of mining extraction.

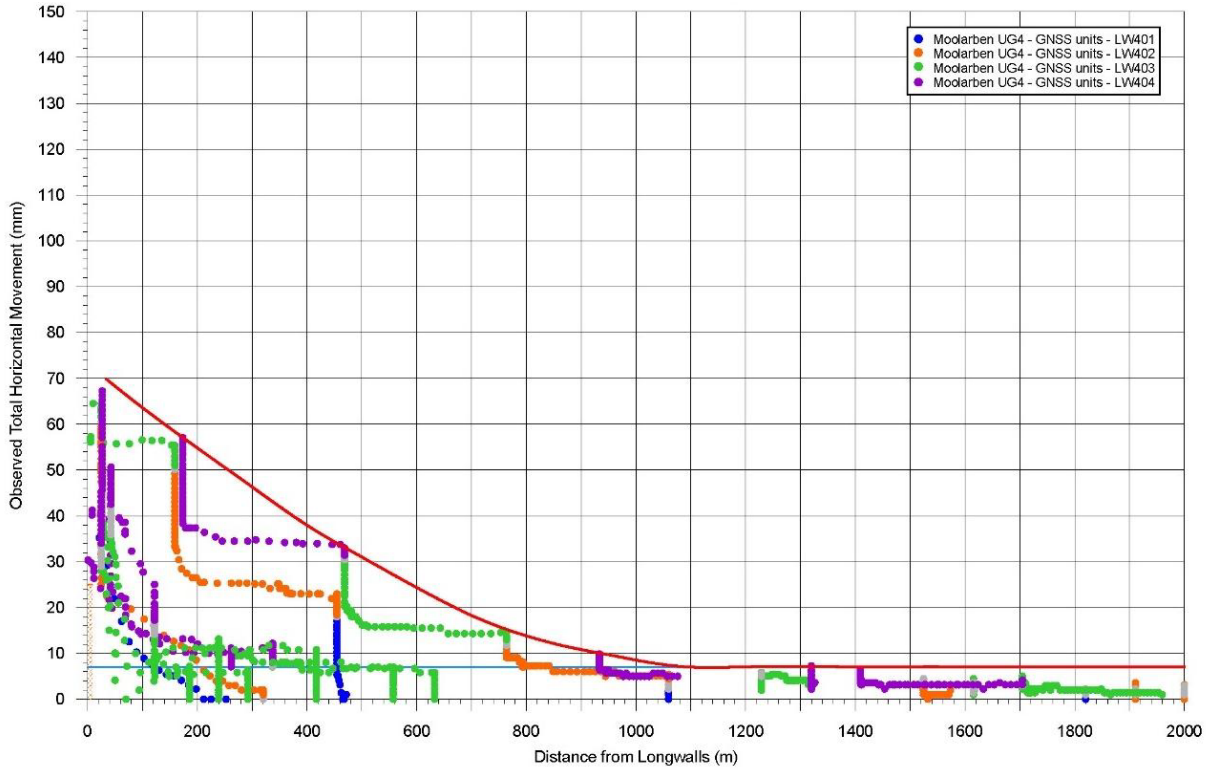

Figure 11: Moolarben far-field movement database (*source: MSEC, 2024*)

These measured results indicate a maximum value for far-field movements of 35mm at a set-back distance of 450m (corresponding to the closest Corner Gorge proximity) and approximately 21mm at 645m (the closest Drip proximity).

This database is being continually updated and the use of any parameters derived from it in the management plans should also be updated accordingly.

One of the recommendations by the Panel during discussions with Moolarben was to use the proximity of each of the initial panels to The Drip, to determine a lower level of far-field movement for the greater offset distances involved, by comparison with the predicted far-field movement indicated by the Figure 11 database. This would provide a useful incremental system of early warning for evaluating the reliability of the far-field distance prediction values and hence the overall subsidence model.

This approach was agreed to by MCO during discussion but does not appear to be reflected directly in the TARPs provided on far-field movement. It is the Panel's recommendation that an additional TARP be inserted in the far-field movement section that lists each panel offset distance and the predicted level of far-field movement associated with that distance. The TARP level descriptions and actions would be as they currently are given for The Drip and Corner Gorge, but the TARPs should be informed by a tabulated list of offset distances and predicted movements to define both the Level 1 and Level 2 triggers and actions in each case.

Once each of the earlier longwall panels has retreated at least 300m from their initial position, the far-field movement at the Goulburn River Gorge monitoring stations should be checked and reported against the documented prediction values listed in this additional TARP. This figure should continue to be monitored as the panels retreat further away to the south and should be reported as part of each end-of-panel report.

The actions listed when stepping up beyond Level 1 for each of the far-field movement TARPs should also include a review of relevant groundwater and Goulburn River monitoring parameters.

4.3.3. VALLEY CLOSURE

Valley closure is of greater concern to the Panel, in terms of the potential for adverse impacts on the natural features, either directly (e.g. rock falls) or indirectly, in terms of groundwater or river impacts. This again is due to the nature of the features involved, as discussed earlier, and their potential susceptibility to even low levels of adverse mining-induced subsidence effects and impacts. Once again, the Panel believes that the likelihood of this occurring is very low, but it is important that the monitoring and management plans in place are as robust as possible to detect any excessive or anomalous behaviour, prior to any adverse impacts occurring.

In particular, one of the major concerns with valley closure is the possibility of strata movement and/or rock failure in the near-surface riverbed strata that could lead to impacts on groundwater or localised loss of river water. Such valley floor impacts could also lead to de-stabilising of the vertical and overhanging cliff faces that make up The Drip and some of the cliffs on the south-western side of the Corner Gorge. Even very small differential movements at the base of these rock structures can be magnified and lead to instability higher in the structures.

The MCO Extraction Plan relies on an MSEC prediction of no measurable valley closure in the Goulburn River Gorge. In response to the Panel's request, a valley closure TARP has now been introduced, whereby any measurable closure (measurable defined elsewhere as >5mm differential movement between GNSS sites across the Gorge) would trigger a TARP level

requiring action. The Panel considers this appropriate. However, given the potential significance of the potential valley closure impact, as soon as such movement is detected, which, by definition, exceeds the MSEC predictions, there should be a mandatory pause of mining extraction while the data is further reviewed, and all other relevant monitoring data is also reviewed.

The outcome of such a review – recognising that valley closure does not stop instantly but can continue after mining ceases, for a period of time – should either be a more permanent mining stoppage or relocation; or a reduced extraction rate for a period of time, as indicated in the available adaptive management strategies.

The Panel also believes that the monitoring program would be significantly enhanced by the installation of some form of sub-surface monitoring of potential bedding plane shear in the strata between the mining area and the river where it passes through the Gorge. This could provide a valuable additional parameter to inform any decision on whether any detected valley closure is impacting the strata near and beneath the riverbed. Previous investigations elsewhere have used inclinometers for such a task, but there may be other simpler techniques which may also be effective for this purpose.

In both TARPs – for far-field movement and valley closure – the Level 3 TARP represents a breach of the nil impact performance measure, meaning that there is only a 2-step TARP process available to prevent breaching the performance measures – hence the need for a greater degree of diligence and the precautionary approach recommended here.

4.3.4. Goulburn River Closure

In addition to the focus on the features within the Goulburn River Gorge, it is recommended that the locations of the Goulburn River which pass close to the proposed mining panel boundaries also be monitored for closure and a TARP introduced accordingly (for the inbye corners of LW409, LW410 and LW412). MSEC has predicted up to 20mm closure across the river valley at the closest point which is 180m from mining (presumably the inbye corner of LW412). The TARP should use any exceedance of this 20mm value as a step up to level 2.

4.4. Aboriginal Heritage Sites

The majority of identified Aboriginal heritage sites lie outside of the mining Study Area (as defined by the conventional subsidence angle of draw boundary) and are not considered to be in danger of any significant adverse impact from mining.

Site SM1C287 is specifically noted in the request for advice provided by the Department to the Panel. This site is located within the region of Cliff Line 3 (CL3) – beyond the southern finish line position of LW413 in a position that is also outside the Study Area boundary (as a result of LW413 being shortened to avoid damage to this cliff line), although the boundary shown on the plans does not accurately reflect this change.
Figure 12 shows the location of SM1C287 on a close-up of the plan of heritage sites, to the south of the LW413 finish line.

The Panel is satisfied that this site should not incur any significant adverse impact, in accordance with the performance measures of low likelihood of damage. However, it is important that the monitoring program includes regular monitoring of this location – both with the approach of the adjacent LW412 and also LW413 and LW414.

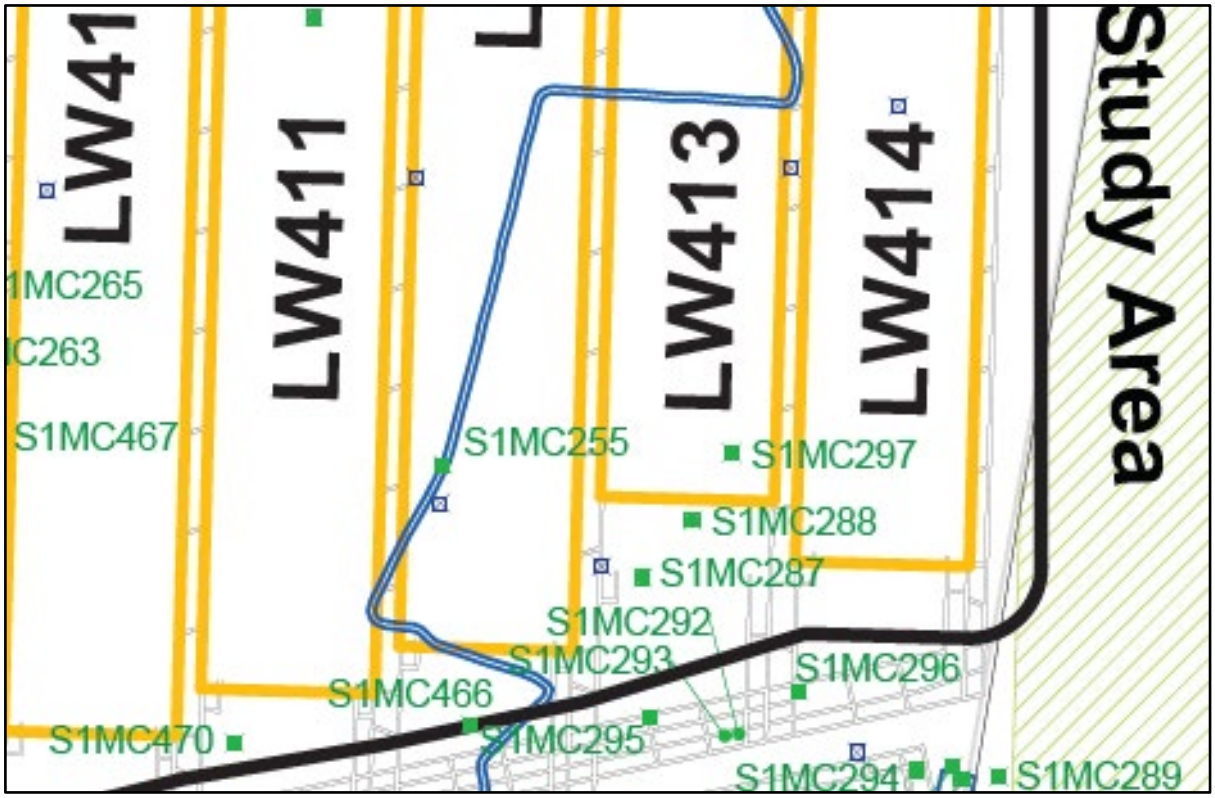

Figure 12: Location of heritage site S1MC287 (*source: MSEC, 2024*)

4.5. SUBSIDENCE CONCLUSIONS

The Panel has reviewed all the documentation provided by MCO including the proposed MCC UG4 Extraction Plan, the subsidence consultant (MSEC) 2024 report attached to the Extraction Plan, and the most recent draft version of the Monitoring and Reporting Program (undated but provided on 6 June 2025 by MCO [Yancoal 2025a]).

The review by the Panel has included a particular focus on The Drip and Corner Gorge in the Goulburn River Gorge, and the Goulburn River, as requested by the Department. The Panel recognises the significance and uniqueness of these natural features – The Drip in particular – and hence the importance in their protection from any mining-induced adverse impacts.

Arising from this review, the Panel has formed the following conclusions:

1. The predicted levels and nature of conventional subsidence behaviour directly above the mining study area of UG4 are based on a reasonable and appropriate prediction method resulting in upper-bound predicted scale of subsidence effects and impacts.
2. The Goulburn River Gorge lies outside the range of conventional subsidence effects but could be subject to non-conventional effects and impacts that need to be carefully managed

in view of the potential susceptibility of the natural features to low levels of subsidence impacts.

3. The Panel believes that the likelihood of adverse impacts occurring in the Goulburn River Gorge because of the proposed Extraction Plan is very low but remains a possibility and therefore a precautionary monitoring and management approach should be adopted. This will require further improvements to the Applicant's draft monitoring and management plan (and associated TARPs), as outlined in the recommendations below.
4. With appropriate improvements and a rigorous implementation of the enhanced management plan, the Panel believes that there is a very high likelihood that the performance measures of nil impact on The Drip and Corner Gorge, and negligible impact on the Goulburn River can be achieved – with respect to direct subsidence impacts. (The ability to comply with the performance measures regarding the subsequent environmental consequences associated with groundwater and surface water are discussed separately – see section 5 and section 6 of this advice below).
5. In regard to Aboriginal heritage sites above and adjacent to the UG4 study area, the Panel is satisfied that likelihood of any subsidence damage is low, consistent with the specified performance measure and that site S1MC287 in particular is adequately protected, but should still be subject to ongoing monitoring, as proposed by the applicant, as extraction of each of the adjacent longwall panels approach.

4.6. SUBSIDENCE RECOMMENDATIONS

As referenced in the summary conclusions above, the Panel makes the following recommendations which are essential elements of an enhanced monitoring and management plan, for the performance measures to be achieved with respect to subsidence impacts:

1. Monitoring and management of any potential impacts on the natural features of the Goulburn River Gorge and the Goulburn River itself should always adopt a comprehensive approach addressing all relevant TARPs collectively, rather than in isolation, i.e. subsidence, groundwater and surface water TARPs should be considered together on each occasion.
2. Regarding far-field movement in the vicinity of the Gorge, some level of movement is expected, but is not likely to cause adverse impacts at the levels involved. The Applicant's subsidence consultant, MSEC, has made predictions based on the database established from GNSS monitoring stations at Moolarben. The relevant far-field movement TARPs should be informed by a tabulated list of offset distances (between the extremity of mining extraction and the natural features) and the predicted level of far-field movement – for each longwall panel in the UG4 extraction plan.
3. An additional TARP should be added relating to far-field movement associated with the mining of each longwall panel. Any movement more than the current MSEC predictions should result in a TARP trigger that results in a further review of MSEC predictions for all non-conventional effects and impacts.
4. The valley closure TARP should be triggered as soon as any measurable closure, i.e. more than the GNSS monitoring system accuracy (understood to be $\pm$ 5mm), is detected. Such a trigger should lead to an immediate pause in mining while other monitoring systems and TARPs are reviewed. If there is no indication of any adverse impacts, then a period of reduced rate extraction could re-commence under a careful and regular monitoring regime which needs to be specified in an improved TARP. However, if there are any other

indications of actual or potential adverse impact, then the alternative adaptive management strategies should be enacted, involving a stop to mining at that location and a potential relocation of the mining face further away from the Gorge.

5. Monitoring in relation to valley closure should be supplemented by installation of sub-surface monitoring to detect any potential bedding plane shear in the sub-surface rock strata on the mining side of each of The Drip and Corner Gorge. Such additional monitoring should be used to inform any decision regarding potential impact on the base of the Gorge which could adversely affect surface water, groundwater or stability of the Drip itself.
6. The location of the Goulburn River, where it passes close to the proposed mining extraction (e.g. the inbye corners of LW409, LW410 and LW412) should also be subject to valley closure monitoring and a specific TARP introduced to trigger a review of predictions and possible further actions if the predicted values of closure are exceeded.

5. GROUNDWATER

The main geological units within and surrounding the MCC include:

- Quaternary alluvium associated with the present-day drainage system.
- Tertiary alluvium associated with a palaeochannel system not related to the present-day drainage.
- Tertiary volcanics comprising remnant flows, plugs, and dykes and sills.
- Jurassic Pilliga Sandstone and Purlewaugh Formation siltstone, consisting of coarse grained quartzose sandstone, lithic sandstone, conglomerates, claystone and shale.
- Triassic Narrabeen Group sandstone consisting of quartzose sandstone and lithic sandstone.
- Permian Illawarra Coal Measures (ICM) a variety of coal measure sediments, which includes the Ulan Seam near the base of the unit.
- Permian Marrangaroo Conglomerate – the basal sedimentary basin unit.
- Palaeozoic Basement – Units that include Carboniferous volcanics and the Ulan Granite.

The main groundwater systems (or hydrostratigraphic) units in the immediate vicinity of the UG4 extraction area can be summarised as:

- Quaternary alluvium (minor aquifer) associated with the Goulburn River.
- Triassic sandstone (perched aquifer (localised)).
- Triassic sandstone (water table aquifer (regional)).
- Permian overburden (aquitard confining layers).
- Permian Ulan seam (confined aquifer).

5.1. CURRENT GROUNDWATER SYSTEM CONCEPTUALISATION

There has been an improved understanding of the groundwater systems, their interaction with surface water, together with natural and mining-induced processes and trends in the UG4 extraction area since the previous Panel's initial advice on LW401 to LW408 in April 2022 (IAPUM 2022).

5.1.1. NATURAL (UNDISTURBED) GROUNDWATER PROCESSES

The natural (undisturbed by mining) groundwater system in the vicinity of the UG4 extraction area has been summarised in many previous reports (AGE 2023, IEAPM 2023). In the immediate vicinity of the Goulburn River, The Drip and Corner Gorge, the shallow groundwater systems (i.e. the alluvium and Triassic sandstone units) and their natural processes are conceptualised as follows:

- Thin and isolated pods of alluvium that are fully saturated when there is permanent streamflow but are less saturated/unsaturated during drought periods when there is minimal or no streamflow.
- North of the Goulburn River:
  - Rainfall recharge sustains perched aquifers in the elevated sandstone landscape.
  - Some of the perched groundwater migrates laterally though porous horizons to seepage faces in the upper cliff faces at The Drip to support this significant environmental feature.

    - A proportion of the rainfall recharge migrates vertically to the regional water table in the deeper Triassic sandstone.
    - The water table aquifer underlying the northern catchment appears to support groundwater seepage at the base of the cliff face at The Drip and provide baseflow to the pods of alluvium and the Goulburn River.
- There are no known seepage faces in the Corner Gorge area supported by perched groundwater, but they may exist in the northern gorge area towards The Drip.
- South of the Goulburn River (where the terrain is less elevated):
    - There appear to be no perched aquifer systems indicating that rainfall recharge percolates to the regional water table in the Triassic sandstone.
    - The water table aquifer underlying the area south of the river contributes to baseflow to the pods of alluvium and the Goulburn River.
- Under natural conditions the Goulburn River is a gaining stream both upstream and downstream of The Drip and the Corner Gorge (i.e. there is a groundwater baseflow contribution from the regional Triassic sandstone aquifer to streamflow).
- Across the whole catchment, a small proportion of rainfall recharge and groundwater stored in the sandstone aquifer migrates into the deeper groundwater systems in the Permian overburden and coal seams.

An appreciation of current surface water-groundwater connectivity is provided in section 5.2.

5.1.2. DISTURBED MINING-INDUCED GROUNDWATER PROCESSES

With the northern progression of panels LW401 to LW408 in the southern UG4 mine area, there are major disruptions to the natural flow and storage characteristics of both deep and shallow groundwater systems. The development of LW 409 to LW414 can be expected to amplify the water level/pressure declines already observed to date in these aquifers across the LW401 to LW408 area. The likely impacts and consequences are:

- Perched aquifers in shallow Triassic sandstone north of the Goulburn River discharging to the upper cliff faces at The Drip should not be impacted based on the subsidence predictions that non-conventional impacts are unlikely.
- North of the Goulburn River:
    - Groundwater in the deeper Permian groundwater systems is likely to be further depressurised but not dewatered. This is in addition to existing depressurisation resulting from former Ulan and Moolarben mine operations.
    - Seepage discharges from the water table in the Triassic sandstone at the base of the cliff face at The Drip could be impacted by depressurisation of the deeper Permian strata.
    - If the regional water table declines, the groundwater baseflow contribution may also reduce from the Triassic sandstone aquifer to the Goulburn River.
    - The northern flank of the Goulburn River should remain connected gaining.
- South of the Goulburn River (overlying the whole UG4 area):
    - Active dewatering will create drawdown in the Ulan Seam, Permian overburden and Triassic sandstone units.
    - The height of fracturing above the mined panels will extend into the Triassic sandstone and impact the regional water table. Consequently, there will be an increased vertical gradient and enhanced drainage from the (regional) Triassic sandstone aquifer to the mine voids in the Ulan seam and the cracked strata in the Permian overburden goaf area above and adjacent to the mined panels.

- The overlying strata will be effectively dewatered above the mined panels (see Figure 13).
- There will be no groundwater baseflow contribution from the Triassic sandstone aquifer to the Goulburn River.
- Hydraulic gradients will reverse and it's likely that the southern flank of the Goulburn River will change from a connected gaining to a connected losing or disconnected losing stream between stream gauges SW02 and SW22.

There are groundwater dependent ecosystems (GDEs) associated with the perched groundwater discharging from the Triassic sandstone (vegetation on the cliff face at The Drip), and the regional water table in the Triassic sandstone (minor riparian vegetation).

Currently there is no clear indication of any drawdown in the regional water table in the Triassic sandstone extending north of LW408 towards the Goulburn River, The Drip and Corner Gorge areas (except for a subtle decline at the PZ234A/B site downstream of Corner Gorge). However, monitoring confirms that depressurisation impacts in the deeper Permian groundwater systems caused by the extraction of LW401 to LW406 already extend to at least the Goulburn River (see PZ129 (53m and 74m) VWP sensors and PZ234C standpipe hydrographs) (AGE 2025 and Yancoal 2025a).

The Panel largely agrees with the updated conceptual model presented in section 4.5 of AGE (2024), with the exception that:

- There is evidence of extensive groundwater drawdown occurring within the Triassic sandstone aquifer and regional water table south of the Goulburn River.
- There is insufficient evidence that seepage at the base of The Drip is not regional water table controlled.

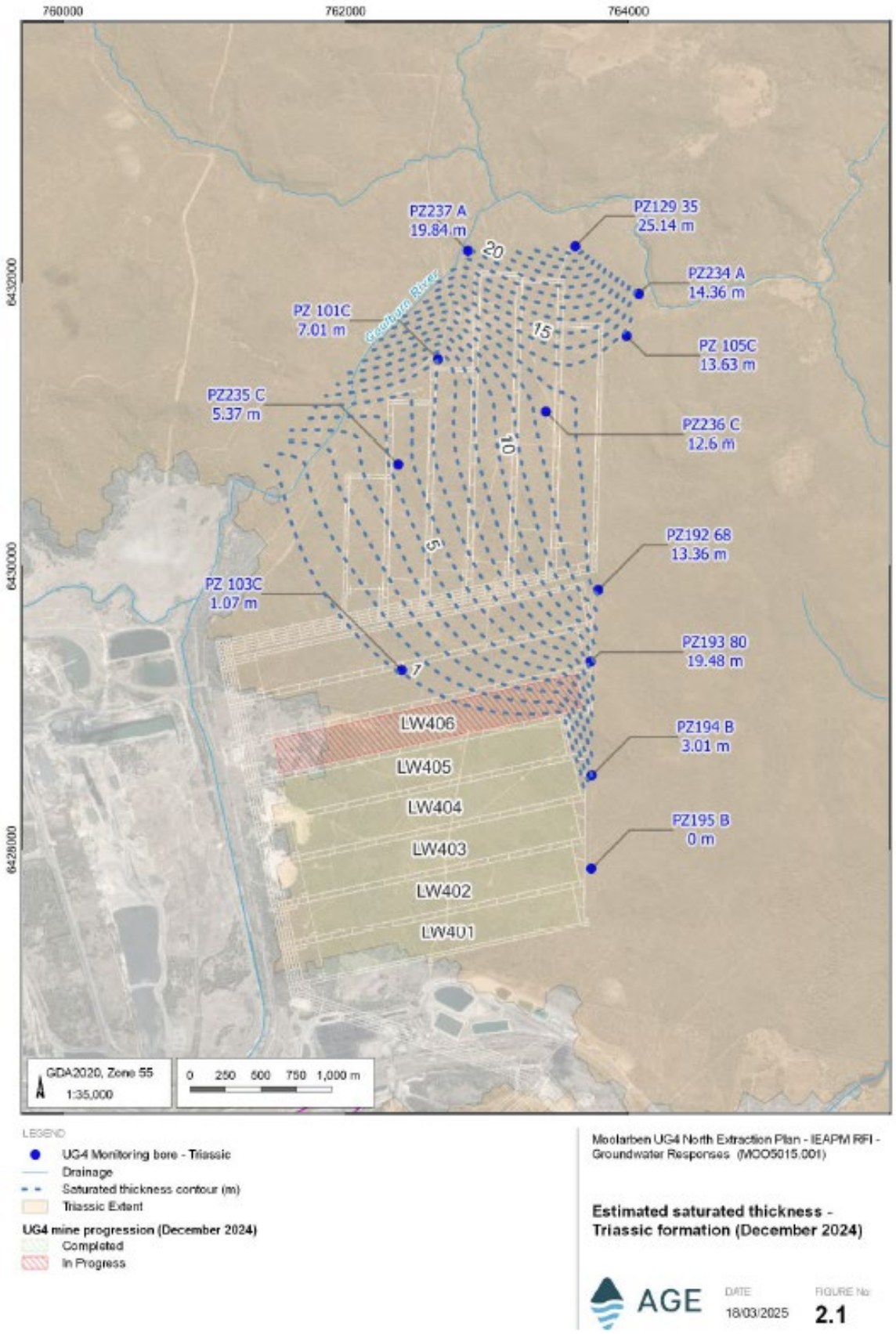

Figure 13: Estimated saturated thickness of the Triassic sandstone strata as at December 2024 showing progressive dewatering above the current UG4 mined panels (*Source: Figure 2.1 from AGE 2025*)

5.2. SURFACE WATER – GROUNDWATER CONNECTIVITY

The Goulburn River in the downstream areas of the MCC is mostly perennial, although anecdotal evidence suggests it has ceased to flow historically through prolonged periods of drought (AGE 2024). There is no baseline data on natural streamflow heights and volumes prior to the commencement of mining. There are approved discharges to Ulan Creek from the Ulan Mine Complex (UMC) and to the Goulburn River from the MCC that are currently maintaining permanent flow downstream.

The approved water discharges to the Goulburn River from UMC of up to 30 ML/day (Environment Protection License [EPL] 394) and MCC of up to 20 ML/day (EPL 12932), will continue during mining of LW409 to LW414 but will cease on completion of all mining which is expected to occur in 2038. MCO reported a 2024 discharge volume of 2,097 ML (Yancoal 2025d) with daily discharge rates typically ranging between 3 and 13 ML/day (i.e. between 35 and 150 L/s) (see Figure 14). UMC reported a 2024 discharge volume of 5,888 ML (Glencore 2025) with a maximum combined discharge rate of 25.1 ML/day (i.e. 290 L/s) in July 2024.

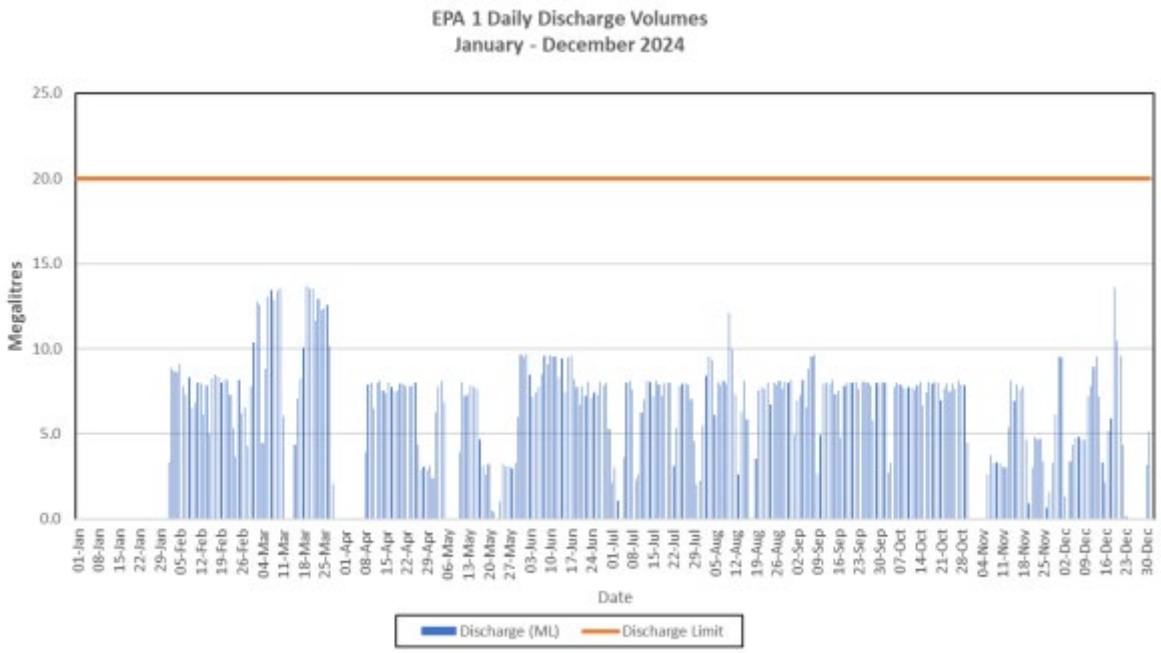

Figure 14: 2024 daily discharges volumes at EPL LDP1 (*source: Figure 10 from Yancoal 2025d*)

In the vicinity the Goulburn River diversion west of LW401 to LW408, the Goulburn River is disconnected losing to the Permian groundwater systems but changes to connected gaining about 2km downstream once the bedrock in the river becomes Triassic sandstone and the river intersects the water table in the sandstone.

With daily mine water discharges typically in the range of 10 to 20 ML/day, stream flows reach a height of between 382.9 and 383.1 mAHD at SW02, while at SW22 the typical heights are between 373.4 and 373.6 mAHD (see Figures 4.6 and 4.7 in AGE 2024). The streamflow 'cease to flows' levels are about 20cm lower than the lowest recorded flows at SW2 and about 40cm lower than the lowest recorded flows at SW22. Water table elevations are higher than current streamflow levels and 'cease to flow' levels at both sites.

The Goulburn River is therefore confirmed as a gaining stream downstream of stream gauge SW02 past The Drip and the Corner Gorge (see hydrographs in Figure 15 (upstream) and Figure 16 (downstream)), and most likely further downstream into the Goulburn River National Park.

The very recent water level trend at the PZ234A site indicates that the regional water table is declining and that the slightly deeper zone in the Triassic sandstone aquifer (PZ234B) may in fact now be below river level.

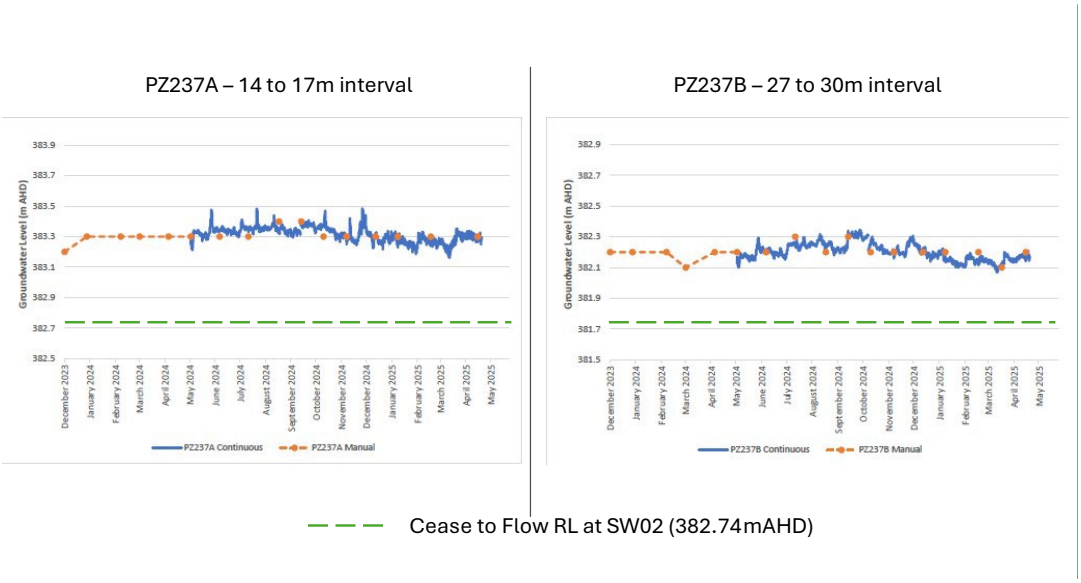

Figure 15: Groundwater and Cease to Flow Reduced Levels at PZ237 and SW02 (upstream of The Drip)

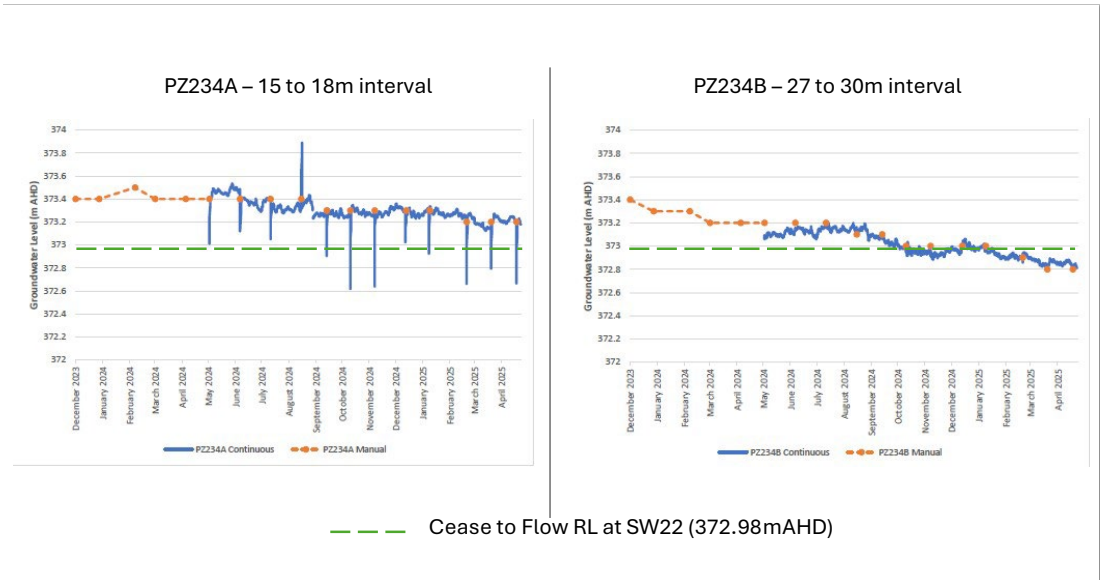

Figure 16: Groundwater and Cease to Flow Reduced Levels at PZ234 and SW22 (downstream of The Drip)[5]

[5] Note that gauging station SW22 is located about 100m upstream of monitoring bores PZ234A/B, and therefore a lower stream water and 'cease to flow' level within the river would be expected immediately adjacent to the nested monitoring bores.

The available monitoring data suggests there is reasonable connectivity between the regional water table in the Triassic sandstone and water levels in the Goulburn River. The model predictions for the baseflow contribution to the Goulburn River in 2025 across the whole model domain (for all approved mining) is of the order of 325 ML/year (Figure 5.20 in AGE 2024). This is predicted to reduce to 310 ML/year by 2036. This volume has not been segmented into the likely contribution and predicted loss between stream gauges SW2 and SW22.

These baseflow estimates appear high and may be a product of the modelling and assumed head boundaries (see section 5.4) Conversely the incremental baseflow loss due to mining of UG4 LW409 to LW414 appears to be low. Model predictions of baseflow loss attributable to UG4 North are less than 1 ML/year (Tables 5.11 and 5.12 in AGE 2024). The Panel assumes this loss is intercepted groundwater that would have otherwise reported to the river as baseflow plus predicted streamflow losses associated with the regional water table decline. The Panel has very low confidence in this baseflow loss estimate.

5.3. ADEQUACY OF THE GROUNDWATER MONITORING NETWORK

Additional groundwater monitoring bores and VWPs are proposed within the northern UG4 extraction area to provide additional water level/pressure coverage as mining progresses from south to north within LWs406-408 and then west to east within LW409 to LW414. There is an increased focus on the Triassic sandstone aquifer.

The groundwater monitoring network in the vicinity of UG4 south of the Goulburn River is shown in Figure 17 with the new additional sites identified in Table 4 (from AGE 2024). The specific details of this monitoring network are best described in AGE 2024 and AGE 2025 (latest compilations are Table 2-1 and Table A5-1 of AGE 2025).

The current and proposed groundwater monitoring programs are best described in:

- The UG4 Longwalls 409 to 414 Water Management Plan (Yancoal 2025b).
- The UG4 Longwall 409 to 414 monitoring and reporting program (Yancoal 2025c).

The frequency of monitoring both water levels and water quality south of the Goulburn River is adequate, and the Panel does not recommend any changes.

Table 4: Additional groundwater monitoring site details (*source: Table 7.1 from AGE 2024*)

Site	Bore ID	Type	Purpose	Hole depth (m)	Target strata	Geology	PVC Screen / VWP sensor depth (mbgl)
PZ-G	PZ-G SP1	Standpipe	Trigger	37	Permian	Weathered Zone	34 - 37
	PZ-G VWP	VWP	Monitoring	130	Permian	Weathered Zone	35
			Monitoring			Irondale Seam	69
			Monitoring			Ulan Overburden	90
			Monitoring			Ulan Seam	112
			Monitoring			Permian Underburden	125
PZ128	PZ128 SP1	Standpipe	Monitoring	30	Triassic	Weathered Zone	27 - 30
	PZ128 SP2	Standpipe	Trigger	45	Triassic	Triassic Lithic	42 - 45
	PZ128 VWP2	VWP	Monitoring	160	Triassic	Triassic Lithic	43
			Monitoring		Permian	Irondale Seam	104
			Monitoring			Ulan Overburden	125
			Monitoring			Ulan Seam	147
			Monitoring			Permian Underburden	155
PZ129	PZ129 SP1	Standpipe	Monitoring	40	Triassic	Weathered Zone	37 - 40
	PZ129 SP2	Standpipe	Trigger	65	Triassic	Triassic Lithic	62 - 65
	PZ129 VWP2	VWP	Monitoring	180	Triassic	Triassic Lithic	63
			Monitoring		Permian	Irondale Seam	123
			Monitoring			Ulan Overburden	143
			Monitoring			Ulan Seam	167
			Monitoring			Permian Underburden	175

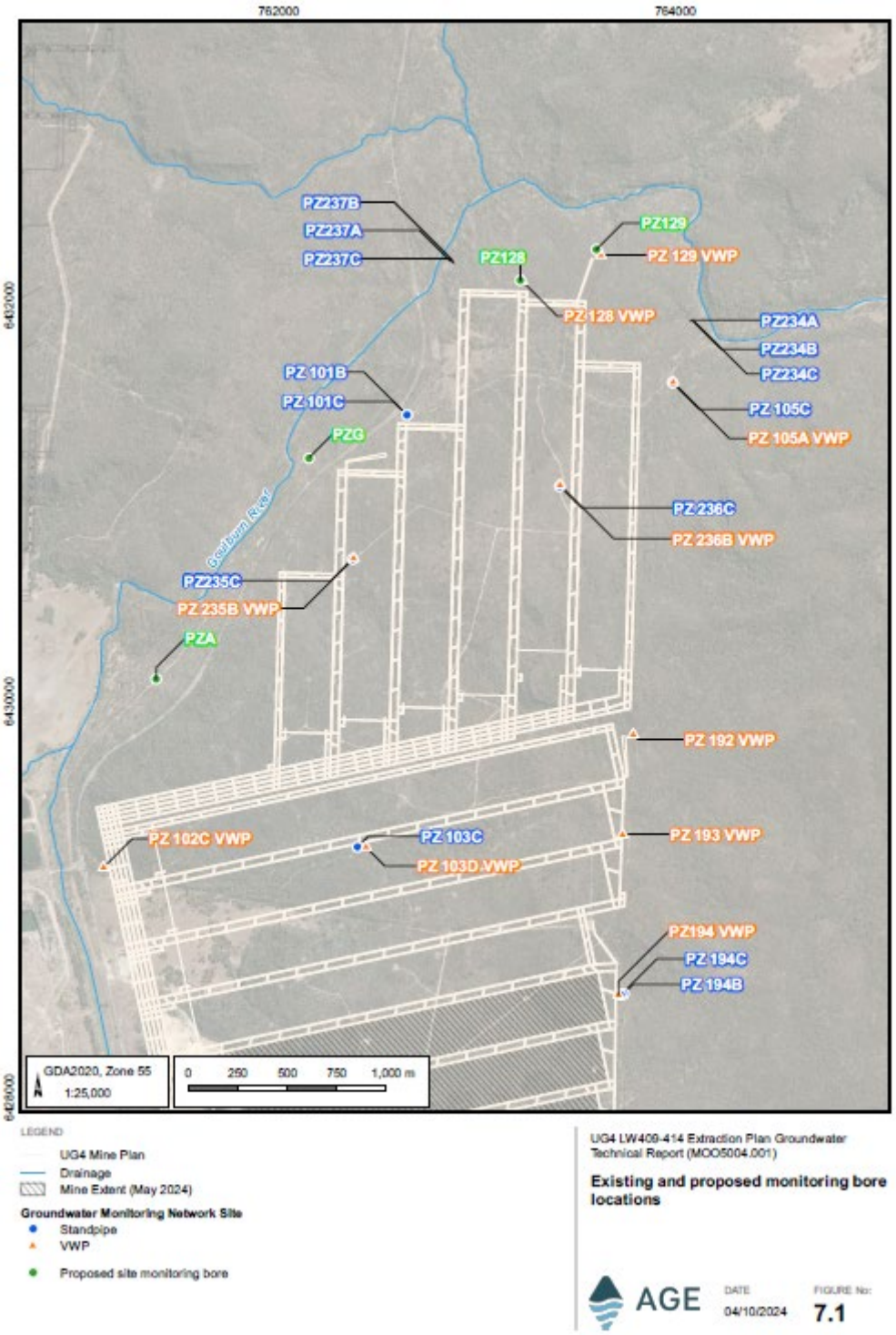

Figure 17: Existing and proposed monitoring bore network (*Source: Figure 7.1 from AGE 2024*)

However additional groundwater monitoring is required north of the Goulburn River. MCO has committed to installing monitoring bores immediately north of The Drip to confirm the nature of the aquifer zones and to monitor water levels within the Triassic sandstone. One site will be a VWP piezometer with an unknown number of sensors, the other site is described as an 'open hole' standpipe. Indicative locations are shown in Figure 18 (AGE 2025). The location closest to The Drip at the slightly lower elevation is preferred for the standpipe location.

The Panel recommends that two (nested) standpipes be completed at the standpipe location rather than a single 'open hole' completion to prove that the first water cut is perched groundwater and that the deeper water cut at river level represents the regional water table. An 'open hole' completion is likely to drain perched groundwater and could have the unintended consequence of draining seepage flows that would have otherwise migrated towards The Drip. The Panel strongly recommends against an open hole completion for this monitoring site.

As a part of the development of the design and installation procedures for these sites the Panel recommends that a risk assessment is undertaken to minimise the likelihood of adverse impacts on the groundwater system and The Drip.

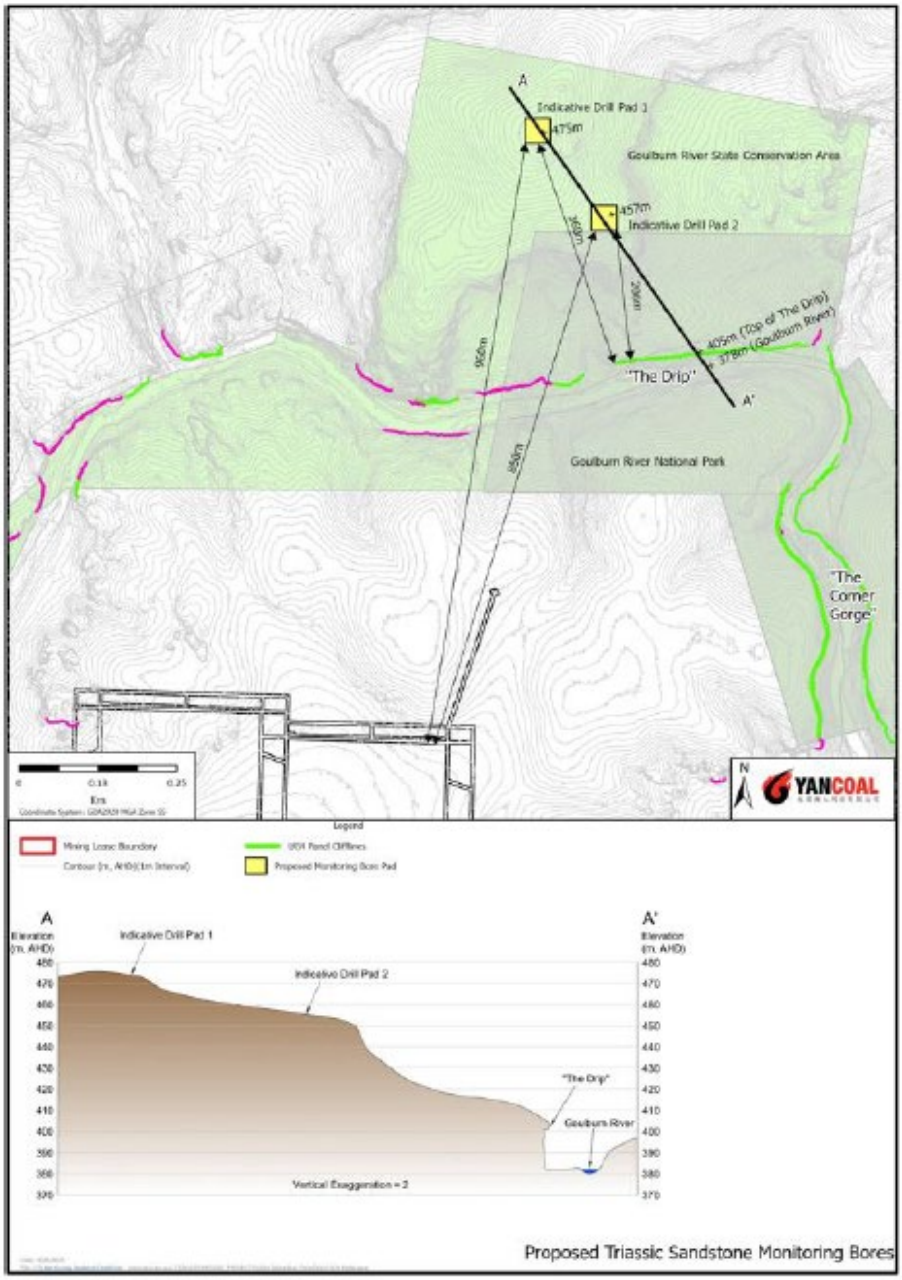

Figure A4-1: Indicative Locations of Groundwater Bores

Figure 18: Indicative monitoring bore locations proposed north of The Drip

When the groundwater monitoring network is complete it is expected to provide an appropriate level of data to monitor the groundwater impacts arising from the extraction of LW409 to LW414. The early completion of the new sites in Q3 2025 and commencement of baseline monitoring is supported by the Panel.

5.4. GROUNDWATER MODELLING AND PREDICTIONS

The current regional groundwater model for the Moolarben Coal Complex detailed for the extraction plan has evolved since 2006 as extensions to mining have taken place. Several model reports were provided to the Panel covering the original modelling (Peter Dundon and Associates, 2006) through to the most recent model developments undertaken by AGE Consultants for UG4 LW409-414 (AGE, 2024). The suite of reports provided are:

- Moolarben Coal Complex UG4 LW409- 414 Extraction Plan Groundwater Technical Report (AGE, 2024).
- Moolarben Coal Complex UG4 LW401-408 Extraction Plan Revised Groundwater Technical Report (AGE, 2023).
- Moolarben Coal Project Groundwater Assessment (Peter Dundon and Associates, 2006).
- Moolarben Coal Complex Extraction Plan Longwalls 104 to 105 Groundwater Technical Report (SLR, 2020).
- Moolarben Coal Complex OC3 Extension Project Groundwater Impact Assessment (AGE, 2022).
- Moolarben Coal Complex UG2 Modification – Groundwater Review (AGE, 2021b).

The current groundwater model encompasses a region that includes the Ulan Coal Complex and the Wilpinjong mine. The model has been built using MODFLOW-USG, a well-regarded and well-tested numerical groundwater modelling package developed by the USGS. It is a multi-layered model, comprised of nineteen layers, that captures the principal hydrogeological formations from the surface to the Permian formations beneath the mined Ulan Coal seam. The model has adopted fine scale spatial refinement of the model grid around all areas of potential interest including the areas of The Drip and the Corner Gorge relevant to the current advice. The extent of the modelled area is approximately 60km north to south by 50km west to east. Natural hydrogeological boundaries with clearly defined hydrogeological conditions are not available for all parts of the model limit and in these locations, notably to the north and east, approximate conditions have been estimated using general head boundaries to simulate groundwater exchange between the modelled area and the surrounding formations.

The Panel notes that explicit descriptions of the parameters adopted for the general head boundaries are not provided except for the values of the applied hydraulic heads. Investigation of the model outputs (Specifically Figures 5.16 and 5.17 of AGE 2024) extracted as Figure 19 and Figure 20 below) suggest that the adopted general head boundaries too closely approximate constant head boundary conditions. Constant head boundaries imply a readily accessible and reliable source of water adjacent to the boundary. In this case the boundary conditions are not apparently consistent with the very limited recharge conditions implied adjacent to the model boundary. The presently imposed boundary conditions are likely to produce a significant overestimate of the water that can enter the modelled area from the external environment due to mining. Consequently, long term predictions using the current model are potentially biased.

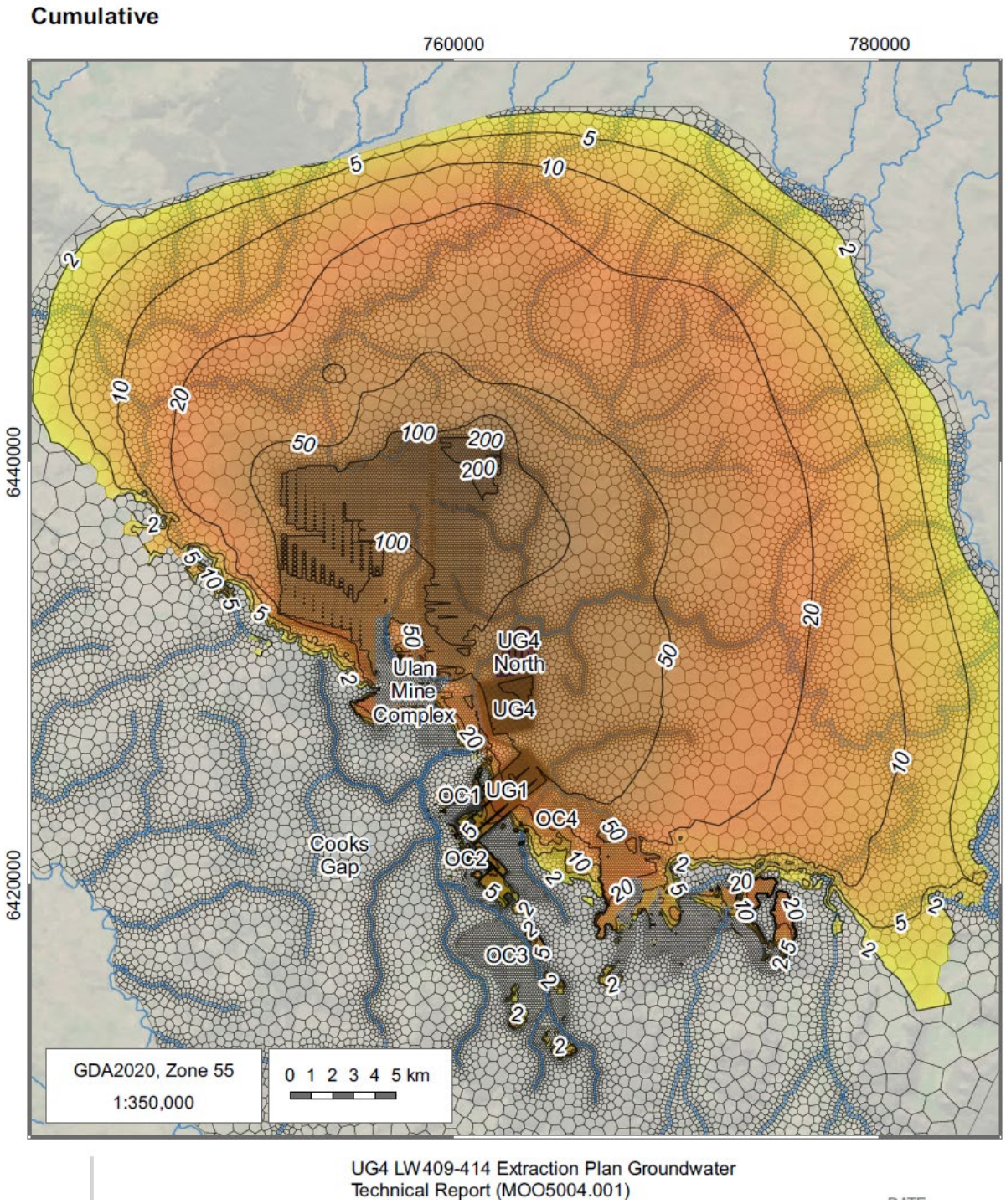

Figure 19: Maximum predicted cumulative drawdown in the base of Permian Overburden until End of Mining (2038) (*Source: Figure 5.16 from AGE 2024*)

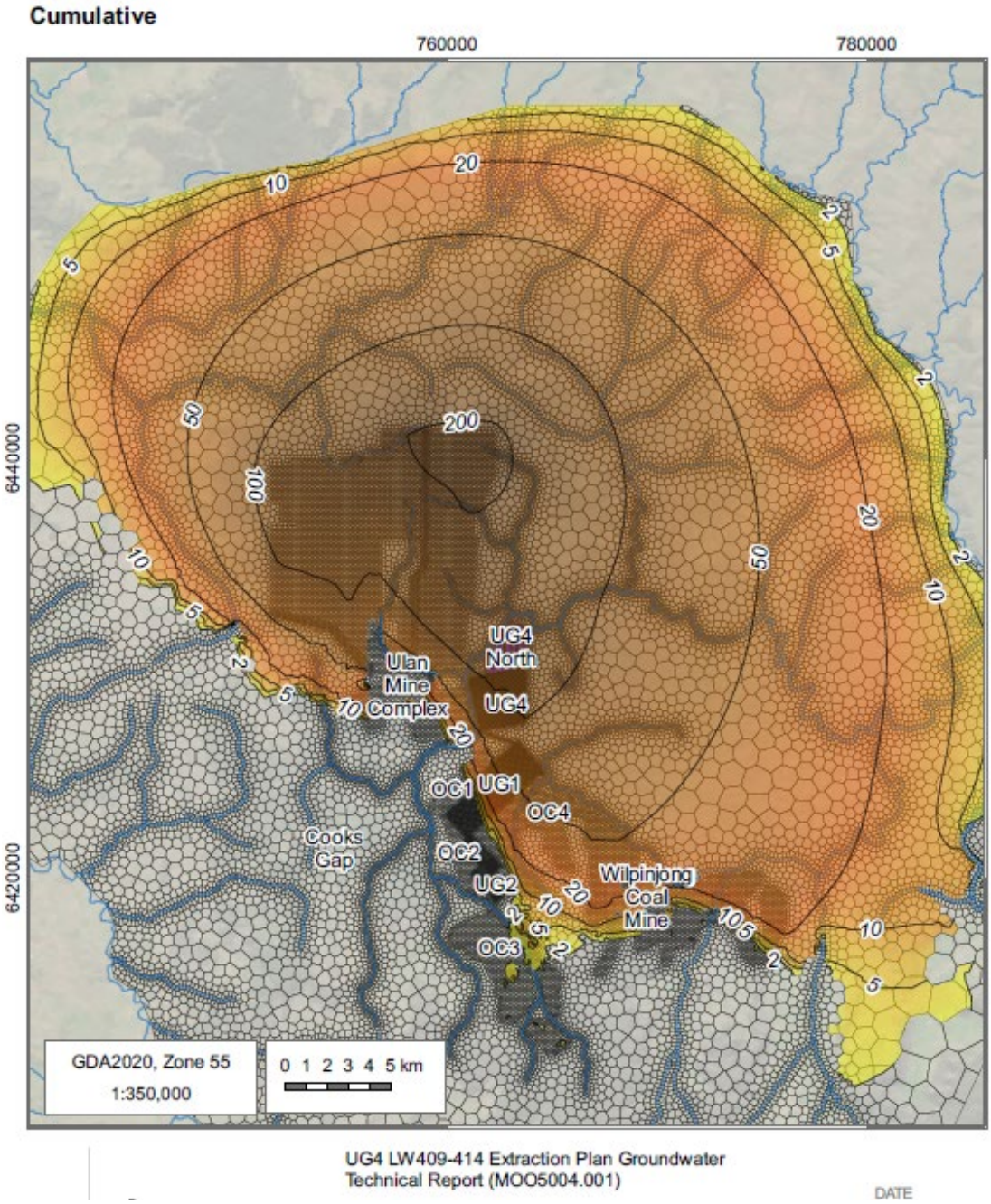

Figure 20: Maximum predicted cumulative drawdown in the Ulan Seam until End of Mining (2038) (*Source: Figure 5.17 of AGE 2024*)

The water budget presented in Table 5.8 (AGE 2024) (Reproduced as Table 5 below) suggests that for the calibration period over 90% of the water discharged from the mines is derived from the boundary flows. This observation suggests that a more realistic general head boundary condition could significantly alter the model calibration and lead to rather different long-term predictions. The Panel recommends that a full re-appraisal of the selected general head boundary condition parameterisation is undertaken prior to the commencement of LW410, and the model recalibrated as part of modelling improvements to increase the reliability of the long-term predictions of mining impacts on the environment.

Table 5: Modelled Water Budget over the Transient calibration period (1984-2023) showing the average fluxes during the calibration period (*Source: Table 5.8 of AGE 2024*).

Parameter	In (ML/day)	Out (ML/day)	In - Out (ML/day)
Storage	21.14	0.66	20.48
Rivers	0.10	25.00	-24.9
Rainfall recharge	23.19	-	23.19
Evapotranspiration	-	1.77	-1.77
General head boundaries (across edge of model domain)	111.05	12.03	99.02
Drains (inflow to mine workings)	-	119.06	-119.06
Total	**155.48**	**158.52**	**-3.04**

The model has been calibrated using the available borehole hydrographic data for the region. As stated in AGE (2023):

> *The groundwater model was calibrated with automated parameterisation software (PEST) (Doherty, 2015) using the latest available MCC groundwater level and flow data. Hydraulic properties and groundwater recharge rates were varied during the model calibration. The pilot point multiplier method was used to represent spatially varying hydraulic properties.*

Nearly all hydraulic model inputs appear to have been allowed to vary in the calibration process. This approach to calibration, although consistent with the data available, highlights the potential predictive uncertainty of such a model. So even though a reasonable set of calibration statistics are provided as an output from the current MCC model these may not provide an appropriate indication of the adequacy of the model for prediction. The discussion of the adequacy of the chosen general head boundary conditions above reinforces this concern. Uncertainty analysis is a normal requirement in these cases.

There appears to have been no significant effort to examine the potential uncertainty in the model predictions on a regional basis and specifically for the Goulburn River region even though the following statement is made in AGE (2023):

> *Groundwater models represent complex environmental systems and processes in a simplified manner. This means that predictions from groundwater models, like other environmental models, are inherently uncertain. When considered in a risk management context, a single calibrated model is insufficient to fully predict the range of potential impacts and their likelihood. A robust uncertainty analysis is therefore important for regulatory decision-making to ensure management options and approaches are appropriate to the level of risk and its likelihood for impact.*

While uncertainty analysis through scenarios for the Open Cut 3 area was undertaken (AGE 2023) it considered only uncertainties related to the properties of the open cut locality and, therefore, is not pertinent to the consideration of the potential impacts on the Goulburn River, The Drip and Corner Gorge.

It is the opinion of the Panel that the lack of an uncertainty analysis reduces the reliability of the interpretations of the model predictions. The Panel recommends that a formal uncertainty analysis is undertaken as part of the proposed review and updating of the model suggested

earlier with specific attention paid to areas of environmental concern including the Goulburn River and The Drip. Further, attention should be paid not only to the period up to the end of mining but also to the period beyond the end of mining when naturalised river flows will be restored and when the impacts of drought will be more evident on the aquifer groundwater interactions.

As discussed in section 5.1.2 of this advice, the Panel does not expect groundwater depressurisation due to mining to impact the perched groundwater that is feeding the water dripping from the overhang at The Drip. However, the seepage at the base of the overhang could be affected if this seepage is an expression of the regional groundwater table. At this stage, it is not clear from the information provided in the reports whether the seepage is controlled by a perched water table or by the regional groundwater table. The Panel therefore agrees with the decision by MCO to predict seepage conditions at The Drip assuming a direct connection to the regional water table. However, MCO's predictions that there will be negligible impact cannot, at this stage, be relied upon based on the considerations of the model boundary conditions and the lack of a specific uncertainty analysis addressing the regional groundwater movements beneath The Drip.

Nevertheless, the predictions provided in AGE (2024) do indicate that the incremental impacts of mining LW409 to LW414 on the groundwater table at The Drip and baseflows to the Goulburn River can be expected to be secondary to the long-term impacts of the mining that has already taken place. There are two provisos to this view.

First, the recent impacts on the Triassic sandstone overlying LW409 to LW414 arising from current mining of LW401 to LW408 are controlled in part by the dewatering of the Triassic sandstone above and adjacent to the mine workings. This is likely to have caused a more muted lateral groundwater response to mining at distance from the workings compared to a condition where full desaturation does not occur adjacent to the mined area. This control on the lateral extent of groundwater table decline may be less pronounced for LW409 to LW414.

Second, if a higher vertical connectivity through the Permian overburden above the Ulan Seam to the overlying Triassic sandstone exists relative to the modelled connectivity, then the timescales for observations of impacts from this groundwater pathway may not yet be visible but could have longer term implications for water table decline in the vicinity of The Drip.

It appears from the current modelling predictions that if the drawdown beneath The Drip exceeds the current predictions, the exceedance would occur even without the planned mining of the current longwalls. This is most easily seen from Figure 5.15 of AGE (2024), reproduced in part in Figure 21 below, which shows the encroachment of drawdowns from the UCC to the west as well as encroachment of drawdowns from the south on the Triassic sandstone beneath the Goulburn River.

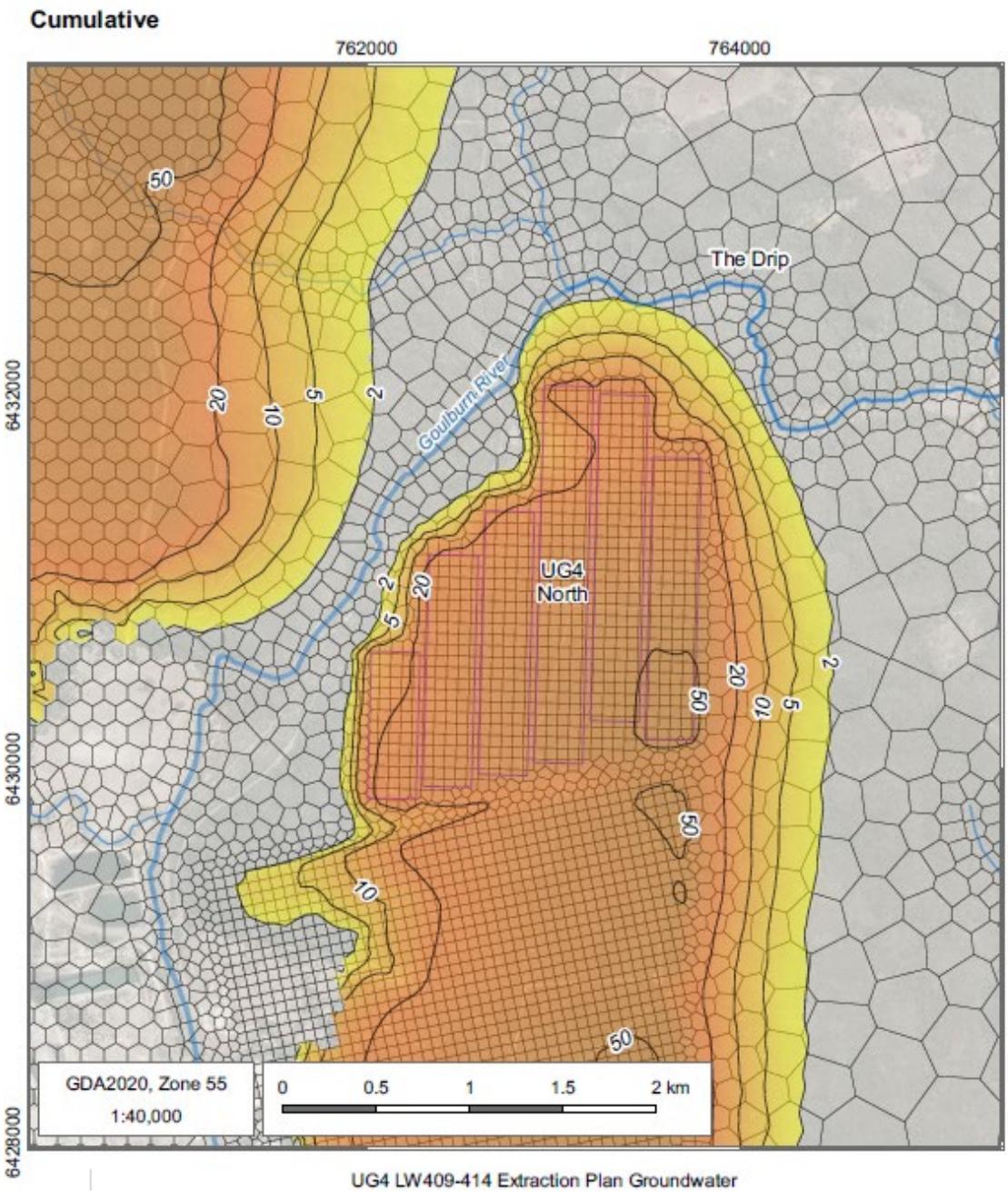

Figure 21: Maximum predicted cumulative drawdown in the Triassic Sandstone local to the Goulburn River in the Triassic sandstone (Lithic) until end of mining (2038) [reproduced from Figure 5.15 (AGE 2024)].

While the Panel has reservations about the adequacy of the current model for long-term predictions, the current modelling does provide evidence that the time for groundwater impacts to be observed is most likely to extend beyond the period of mining of UG4. In this case, adaptive management is not expected to be applicable for management of any longer-term groundwater impacts.

The Panel recommends that MCO examines possible options for mitigation of impacts to The Drip not only if performance measures are exceeded but also when groundwater impacts become apparent that are likely to result in performance measures being exceeded.

5.5. ENVIRONMENTAL CONSEQUENCES OF PREDICTED GROUNDWATER IMPACTS

The predicted groundwater impacts of a declining water table in the regional Triassic sandstone aquifer are likely to be:

- Dewatering of the Triassic sandstone aquifer south of the Goulburn River.
- Loss of groundwater baseflows to the Goulburn River between stream gauges SW2 and SW22.
- Potential loss of streamflow to the underlying groundwater systems.

These impacts could potentially have the following environmental consequences:

- Reduced seepage flows at the base of The Drip that support this ecosystem.
- Loss of shallow groundwater that supports riparian vegetation along the southern bank of the Goulburn River.
- Longer and potentially more frequent periods of no or very low flow in the Goulburn River following cessation of the current mine water discharges.

Impacts and environmental consequences associated with the Goulburn River are going to be difficult to identify in the short-term because of the masking effect of the current mine water discharges from both UMC and MCC.

Finally, environmental consequences could be exacerbated if it is shown that the current model predictions are biased because of the boundary conditions and model parameterisation selected and the predicted drawdowns in the Triassic sandstone are significantly underestimated.

5.6. ADEQUACY OF GROUNDWATER TRIGGERS AND TARPS

5.6.1. TRIGGERS

The nominated salinity and pH investigation triggers at the two Triassic sandstone monitoring sites (Table 8 in Yancoal 2025b) are suitable given there is a very low risk of any impact to the groundwater quality in the Triassic sandstone.

Groundwater level triggers have been nominated at six standpipe locations – PZ105C, PZ128 SP2, PZ129 SP2, PZ234A, PZ237A and PZ-G (three of which are yet to be installed) (Table 9 in Yancoal 2025b). It is essential that the three new locations are constructed and operational in Q3 2025 so as to collect meaningful baseline data on which to base appropriate trigger levels.

The Panel has several issues with the nominated interim trigger levels for two of the three existing sites as described in Table 9 of Yancoal 2025b and Table 6 of Yancoal 2025c:

- The nominated trigger level at PZ237A will be approx. 0.7 m below the cease to flow level in the Goulburn River. The river will be a losing stream with this depressed water table level and consequently there could be more than a negligible impact on the Goulburn River flows. A more appropriate level would be the cease to flow level of 382.74 mAHD at SW2.
- The nominated trigger level at PZ234A will probably be more than 1 m below the cease to flow level in the Goulburn River. The river will be a losing stream with this depressed water table level and consequently there could be more than a negligible impact on the

Goulburn River flows. A more appropriate level would be the cease to flow level of 372.98 mAHD[6] at SW22.

The later monitoring and reporting program for The Drip, Corner Gorge and Goulburn River (Yancoal, 2025c) states that "definitive triggers levels would be developed once sufficient baseline data has been collected, prior to the commencement of LW409". This timing is satisfactory. It is important that the nominated triggers are meaningful and objective to ensure there are negligible environmental impacts or consequences to the Goulburn River. Revised groundwater triggers and TARPS should be approved in a final monitoring and reporting program document that is to the satisfaction of the Department.

The new standpipe PZ129 SP2 close to the Goulburn River is proposed to monitor physical impacts such as accelerated water level declines in the sandstone aquifer that could be caused by far-field and differential subsidence movements. This is a reasonable site for this purpose, but the Panel believes it is inappropriate as a trigger location as the Triassic sandstone aquifer is expected to drain with the progression of LW409 to LW414. PZ129 SP1 would be more appropriate to monitor the regional water table, and any environmental impacts associated with the reversal in the hydraulic gradients toward the river.

The Panel recommends an additional trigger location to monitor potential impacts to The Drip even though this was discounted for unknown reasons in Section 6.3 of Yancoal 2025b. The proposed nested standpipes above the cliff line on the northern side of the Goulburn River should be added into The Drip monitoring and reporting program (Yancoal 2025c) as a nominated site with appropriate water level triggers and TARPs to protect groundwater flow from the northern flank of the catchment to both the upper cliff and lower cliff seepage faces.

5.6.2. TARPS

There are no Performance Measures for groundwater stated in the Consolidated Consent, however (by implication) groundwater is captured in the subsidence impact performance measures (Table 1 of this Advice) for The Drip (Nil impact or environmental consequences to The Drip) and the Goulburn River (Negligible impact or environmental consequences), and the proposed draft TARPS for The Drip and Corner Gorge (Attachment 1 of Yancoal 2025c) and for the Goulburn River (Attachment 2 of Yancoal 2025c).

The draft TARPS in Yancoal 2025c are the most relevant and the Panel's assessment is:

- For the TARP for The Drip and Corner Gorge (Table A1-1):
  - The proposed subsidence trigger for 'water supply to The Drip' (being visual inspections and photography) is largely subjective and the proposed management measures of more investigations and notifying DPHI and other agencies will do nothing to prevent nil environmental consequences if mining-induced impacts are confirmed. Additional lines of evidence are required.
  - The Panel recommends that management measures also be tied to a more objective trigger for perched and water table groundwater level trends. A trigger that assesses water levels outside of the natural range at the proposed standpipe monitoring location located immediately north of The Drip would be appropriate.

[6] A more accurate 'cease to flow' level needs to be determined for the Goulburn River adjacent to the nested monitoring bores and not at the upstream SW22 gauge location

    - The proposed groundwater trigger currently relies on groundwater level monitoring of PZ129 SP2. This site is appropriate for monitoring far-field and differential subsidence movements, and the likely dewatering of the Triassic sandstone aquifer but it is not a useful trigger location for assessing impacts to The Drip and Corner Gorge.
    - The Panel accepts the groundwater in the Triassic sandstone will be dewatered with the passage of these longwalls, and that water levels will decline towards the Goulburn River. It is more important to maintain the hydraulic gradient of the water table towards The Drip and the Goulburn River, and hence the Panel recommends that a SP1 trigger would be more appropriate than SP2 at both PZ128 and PZ129 locations.
- For the TARP for the Goulburn River (Table A2-1):
    - The proposed groundwater trigger relies on groundwater level monitoring at PZ234 and PZ237 (which aquifer and depth interval is not specified but the A locations are specified in the Surface water – Flow triggers). As for The Drip and Corner Gorge TARP, the Panel accepts the groundwater in all the underlying groundwater systems will be dewatered with the passage of these longwalls, and that water levels will decline towards the Goulburn River. It is more important to maintain the hydraulic gradient of the water table towards the Goulburn River (or to at the very least minimise stream losses), and hence the focus should be on a trigger that monitors the water table aquifer at both these sites and ensures negligible environmental consequences on the river rather than nil.
    - Nominating additional shallow groundwater monitoring sites (as listed in Table 9 of Yancoal 2025b) as secondary triggers would be useful in assessing baseflow impacts.

5.7. GROUNDWATER CONCLUSIONS

The Panel has reviewed the groundwater impact assessment and supporting documents referred for the review of the LW409 to LW414 EP and concludes:

1. The regional water table in the Triassic sandstone aquifer will decline and it will be extensively dewatered south of the Goulburn River. There are uncertain regional water table impacts north of the Goulburn River.
2. The perched groundwater discharging to the upper cliff faces at The Drip from the Triassic sandstone should not be impacted based on the subsidence predictions that non-conventional impacts are unlikely at distance.
3. Seepage discharges from the Triassic sandstone at the base of the cliff face at The Drip could be impacted by a declining regional water table.
4. Baseflow impacts to the Goulburn River are expected as the regional water table declines south of the Goulburn River and the river changes from a connected gaining stream to a losing stream. Intercepted groundwater and streamflow losses could be more than negligible between stream gauges SW2 and SW22.
5. Current mine water discharges occurring from both UMC and MCC are masking natural groundwater baseflows. These high flows will make it difficult to measure and identify any small streamflow losses to groundwater.
6. The current groundwater model adopts lateral general head boundary conditions that are not clearly consistent with the available water at the model boundary. This may have

introduced bias into the calibration of the model and reduced the reliability of the model for long term predictions. The boundary conditions require further evaluation.

7. The lack of a model uncertainty analysis of groundwater conditions at The Drip and the impacts to baseflows for the period of mining limits the value of the modelling in assessing future environmental consequences resulting from a declining regional water table and groundwater depressurisation.
8. When the groundwater monitoring network is complete, it is expected to provide an appropriate quantum of data to monitor the groundwater impacts arising from the extraction of LW409 to LW414.
9. The 'open hole' completion for the monitoring bore located immediately north of The Drip is inappropriate as it is likely to drain perched groundwater and could have the unintended consequence of impacting and draining seepage flows migrating towards The Drip.
10. The frequency of monitoring both groundwater levels and groundwater quality is adequate.
11. The groundwater triggers in The Drip and Corner Gorge, and Goulburn River TARPS do not provide useful management measures to ensure nil impact or environmental consequences to The Drip and Goulburn River Gorge or negligible impact or environmental consequences to the baseflow in the Goulburn River.
12. The nominated trigger locations are reasonable except:
    i. There is limited value in nominating triggers for the southern sites PZ128 SP2 and PZ129 SP2.
    ii. A northern monitoring site is required to monitor both the perched and regional water table level trends immediately north of The Drip.

5.8. GROUNDWATER RECOMMENDATIONS

The Panel recommends:

1. Full re-appraisal of the modelled general head boundary conditions is prioritised and the model recalibrated to the satisfaction of the Department, prior to the extraction of LW410 as part of the modelling improvements to increase the reliability of the long-term predictions of mining impacts on the environment.
2. Formal uncertainty analysis is undertaken as part of the proposed review and updating of the model with specific attention paid to areas of environmental concern including the Goulburn River and the Drip.
3. The examination of possible options for mitigation of impacts to The Drip, not only if performance measures are exceeded but also if groundwater impacts become apparent that are likely to result in performance measures being exceeded.
4. The proposed additions to the groundwater monitoring network be installed and fully operational by the end of Q3 2025.
5. The 'open hole' completion specification for the monitoring bore located immediately north of The Drip be revised to monitor perched water table and regional water table in separate standpipes with appropriate isolation of aquifer zones and be based on a robust environmental risk assessment.
6. The groundwater trigger in the draft TARP for the Goulburn River be revised by:
    i. Setting trigger water levels and objective management measures for the two nested sites located near SW2 and SW22 (PZ237A and PZ234A respectively) to coincide with when the surface water-groundwater connectivity changes from connected gaining to connected losing, and

ii. Identifying all other standpipe sites (such as PZ105C, PZ128 SP1, PZ129 SP1, and PZ-G) that would assist with assessing baseflow impacts and determining appropriate management measures.

7. The water supply and groundwater triggers in the draft TARP for The Drip and Corner Gorge be expanded by nominating appropriate standpipe sites (such as the nested locations north of The Drip) and by including objective management measures to ensure nil impact or environmental consequences to the water supply to The Drip.

6. SURFACE WATER

6.1. BACKGROUND

The upper Goulburn River catchment has been heavily modified since the 1920s and particularly since 2005, including the river diversion, mine water and sediment and salt discharges from the mines, reductions in and modifications to the catchment due to the mines, mine dams, flow diversions due to subsidence impacts on tributaries, and alterations to the flow regime due to groundwater depressurisation and pumped discharges. The heavily modified nature of the catchment and the absence of baseline data that track the evolution of changes mean that contemporary best practice in impacts assessment using BACI (before-after-control-impact) assessment is not possible for the river flows and quality, and attribution of observed flow, water quality and stream health impacts may be challenging. This context needs kept in mind when reviewing the water management plan.

The natural flow in the Goulburn River in the vicinity of The Drip and Corner Gorge is unknown due to absence of pre-mining baseline data. As noted in section 5.2, MCO (2025) reported a 2024 discharge volume of 2,097ML while UMC Glencore 2025) reported a 2024 discharge volume of 5,888ML, which combined are equivalent to an average discharge rate of 257L/s. During the Panel's visit on 18th February 2025, Panel members estimated the river flow at the entrance to the State Conservation Area to be in the range 300-400L/s (the flow record at the further downstream Coggan flow gauge indicates that near-median flow conditions existed at that time). In summary, the Goulburn River baseflows are dominated by the pumping of water from the mines and likely to be so until the end of mining.

The salinity of the Goulburn River is highly spatially variable due to contrasting salinities of source hydrogeological units. Discharge to the river from the Permian units are highly saline (electrical conductivity, EC, of 2500 - 7500µS/cm), whereas discharges from the Triassic units are fresher (~150µS/cm) (Imrie 2019). EC values in non-mine impacted creeks upstream of the mine impacted areas are reported as 280 and 3,360µS/cm (medians at SW06 and SW07). EC limits for major discharge points at the Ulan and Moolarben mines are 900µS/cm and 685µS/cm. The EC of the actual discharge from Moolarben mine in 2024 was in the range 100-270µS/cm (Yancoal 2025d). In summary, the water quality as indicated by EC is highly spatially and temporally variable, with low-salinity water discharged by MCC.

6.2. THE SCALE AND LIKELIHOOD OF POTENTIAL IMPACTS

Impacts on Goulburn River flows due to the project may arise from:

- Enhanced leakage due to fracturing of the riverbed. Based on the subsidence impacts assessment (section 4 of this advice), the Panel considers that leakage rates due to subsidence impacts on the Goulburn River bed are highly unlikely to be detectable. The proposed monitoring (visual assessments of physical impacts and flow gauging) and associated TARPs are appropriate for managing this potential impact, subject to the advice elsewhere in this document.
- Loss of tributary flow into the Goulburn River. Flow diversions from drainage line 2 are expected; however, this being an ephemeral stream, flow diversions will not occur during baseflow conditions and impacts on the Goulburn River flows are highly unlikely to be detectable.

- Loss of groundwater discharge due to groundwater drawdown. The incremental impacts of LW409 to LW414 are predicted by AGE (2024) to be negligible up to 2036 (no modelled predictions have been provided beyond that). The maximum predicted cumulative loss of flow due to UG4 (LWs 401-414) is approximately 22.1ML/year or 1L/s (MCO response to RFI on 6 April 2025), while the predicted cumulative impact of all mining between 2016 and 2036 is shown in AGE (2024) to be approximately 40ML/year or 1.3L/s. Such losses would not be detectable by measurement or by eye during typical baseflow conditions and are highly likely to have negligible consequences for visual amenity, aquatic ecology or water resources. However, the Panel considers that baseflow impacts are likely to be higher than predicted and could result in non-negligible impacts (see section 5.2 and section 5.7 of this advice).
- In terms of scale, beyond the Corner Gorge the catchment area rapidly expands (e.g. 234km^2 at SW02 and 3,340km^2 at Coggan, which is approximately 70km downstream, half-way through the National Park). Any river flow losses due to the project, while they may be non-negligible in the vicinity of the Drip and Corner Gorge, will quickly become undetectable and negligible at the broader national park scale.

Impacts on Goulburn River water quality due to LW409 to LW414 may arise from:

- Discharge of mine-affected water. MCO has discharge licenses and a mine water management system that controls releases of mine affected water. No water quality triggers were reported in the Goulburn River in 2024 (Yancoal 2025d). In January 2023 an emergency release of water caused an exceedance of the electrical conductivity trigger at all reported sites in the Goulburn River (Yancoal 2024b). However, the Panel is not aware of any new concerns regarding discharges of mine-affected water for LW409 to LW414 and the additional likelihood of impacts to the Goulburn River associated with LW409 to LW414 is not of concern to the Panel.
- Discharge of water with impaired quality from drainage lines. Discharges from drainage lines are expected to have increased loads of sediments, salts and some metals due to subsidence impacts (erosion and diversion of flows through fractured rock). MCO propose that this is managed by monitoring water quality both in the main drainage lines and in the Goulburn River, with associated TARPs in drainage line 2 and in the Goulburn River. As any discharges from the tributaries will be in medium-high flow conditions, the Panel considers that the likelihood of these discharges leading to detectable impacts to the Goulburn River is very low.
- Relatively fresh discharges of groundwater from the Triassic units moderate the naturally higher saline water from Permian units. Loss of baseflow from the Triassic units will therefore lead to loss of salinity moderation. This has the potential to impact the river baseflow salinity in the vicinity of The Drip and Corner Gorge. This is more likely to be significant after the end of mining when the low-salinity mine discharges cease. The advice relating to baseflow impacts applies.

As described in MSEC (2024) there are expected impacts on drainage line including changes to stream slopes, ponding, erosion and sediment deposition. These impacts are proposed to be managed as they have been under LW401 to LW408.

Potential consequences for aquatic ecosystems and GDEs of the Goulburn River are covered in section 7 of this advice.

6.3. WHETHER EXISTING PERFORMANCE MEASURES COULD BE MET

The Panel does not consider it reasonable to conclude from the information provided that the performance measure for the Goulburn River "Negligible impact or environmental consequences" could be met under the proposed Extraction Plan because:

- There is a reasonable likelihood that baseflow losses due to LW409 to LW414 will be higher than predicted and may have non-negligible incremental consequences for the Goulburn River in the vicinity of the Drip and Corner Gorge.
- The degree of likelihood of this outcome has not been sufficiently investigated in the documents provided to the Panel.
- Although there is a TARP and proposed contingency actions, these actions would not prevent a further decline in baseflows due to time-lags between mining and maximum baseflow impacts.
- While baseflows may recover when mining ceases, the timeframe and degree of recovery is unknown (this has not been investigated in the documents provided to the Panel).

6.4. ADEQUACY OF MONITORING AND TARPS

The Panel considers that the proposed monitoring programs for surface water flows and surface water quality are adequate. Comments on the adequacy of the stream health monitoring are in section 7 of this advice, and on fracturing of the riverbed are in section 4.

The following comments on the TARPs are based on the TARP tables provided to the Panel as part of further information on 6 June 2025.

The TARPs for Goulburn River flows and water quality have the fundamental limitation that the baseline conditions will represent a recent/current period affected by impacts due to already-mined parts of the project. The TARPs are not designed to manage impacts and consequences of the project as required by the Consent – only to manage the impacts of LW409 to LW414. There is no solution to this.

The triggers for flow, water quality and groundwater at PZ234 and PZ237 have not been specified in the latest information seen by the Panel (document provide on 6 June) due to ongoing collection of baseline data. It is recommended that the triggers and associated monitoring data (including flow rating curves) are independently reviewed to the satisfaction of the Department prior to the start of extraction of LW409.

The proposed Goulburn River flow trigger is, by itself, unlikely to provide a reliable indication of impacts to the Goulburn River flows, due to imprecision of rating curves and random variations in flows between SW02 and SW22. It is essential that the flow impacts and potential consequences are also assessed using the water levels at PZ234 and PZ237 (for which a TARP is proposed).

The level 2 trigger action for Goulburn River flow and water quality includes:

"If trigger exceedance is mining-related, the Technical Committee to consider whether monitoring observations and/or revised subsidence predictions require the investigations/actions as detailed in Section 5.2 and confirm if mining-related activities have caused, or have the potential to cause, material environmental harm (i.e. exceedance of performance criteria).

a. If so, notify DPHI and other relevant agencies immediately.

b. If not, notify DPHI and other relevant agencies as soon as practicable."

The Panel has three comments on this:

1. The TARPs do not present any objective performance indicators for the Technical Committee to judge whether a non-negligible consequence may have occurred. With regard to the NSW Extraction Plan guideline (DPE 2022) "*Triggers should generally be set as exceedances of particular performance indicators. However, it may be appropriate to include a trigger level before a performance indicator is exceeded*". The Panel's view is the latter (i.e. a trigger to initiate the actions and also an objective performance indicator) should apply.
2. The practical distinction between "immediately" and "as soon as practicable" is unclear. Any Goulburn River flow or water quality trigger event that is determined to be potentially related to LW409 to LW414 extraction should be reported as soon as practicable; otherwise the distinction between "immediately" and "as soon as practicable" should be clarified.
3. In response to the Panel's RFI, MCO clarified that the term "*material environmental harm (i.e. exceedance of performance criteria)"* stems from terminology in the Consent. Nevertheless, the use of both "negligible" and "material" at different parts of the flow and water quality TARP tables is potentially confusing (and the use of "nil" and "material" in other TARPs). It would be better to say "… *and confirm if mining-related activities have caused, or have the potential to cause, exceedance of the performance conditions*".

Each surface water TARP relies on a single trigger. Based on that single trigger, if it is attributed to mining, whether or not there is an exceedance of the performance measure is judged by the Technical Committee. This seems contrary to the purpose of TARPs, which according to the NSW Extraction Plan guidelines (DPE 2022) are "*aimed at ensuring compliance with all relevant performance measures*". As noted above, a trigger which initiates actions potentially including contingency measures plus a quantitative performance indicator is advisable.

The flow, water quality and PZ234/237 TARP table headers identify the relevant performance measure as "*Nil Impacts or Environmental Consequences*", which the Panel understands should be "*Negligible Impact or Environmental Consequences*".

6.5. SURFACE WATER CONCLUSIONS

- The upper Goulburn River is heavily influenced by historical and ongoing mining activities that have already caused non-negligible impacts on river geomorphology, flows and water quality. The Panel's current consideration is the incremental impacts of LW409 to LW414.
- It is likely that there will be more than "negligible impact or consequences" to baseflows in the Goulburn River.
- Activating the contingency plans associated with the TARPs is unlikely to stop or reverse impacts on baseflows. This is because of the time-lag between groundwater depressurisation at the mine void and the change in hydraulic gradient between the groundwater and the river.
- The surface water TARPs (water quality, flow and shallow groundwater) could not be fully assessed by the Panel because their trigger levels were not defined in the last seen version of the TARP tables.
- The monitoring and TARPs are designed to assess the Goulburn River impacts of LW409 to LW414 rather than the impacts of "the project" (as defined in the Consent). This is related to lack of long-term baseline data and cannot now be resolved.
- The Goulburn River TARPs use a single trigger that leaves little room for meaningful action before determination of whether the performance measure is exceeded.
- There are no quantitative performance indicators that will support the determination of whether a consequence is negligible or not. This puts weight on the judgements of the Technical Committee, DPHI and agencies.
- The TARPS are potentially confusing with respect to their dual use of "negligible" and "material".

6.6. SURFACE WATER RECOMMENDATIONS

- The trigger levels for flow, water quality and riparian groundwater (PZ124/127) should be independently reviewed, to the satisfaction of the Department, after they are proposed and before start of mining of LW409.
- Quantitative performance indicators for flow loss, water quality and groundwater decline at PZ234/237 should be proposed and embedded in the TARP tables.
- The dual use of "negligible" and "material" in the Goulburn River TARPs and "nil" and "material" in other TARPs should be avoided, for example by referring instead more generally to the "performance conditions".
- The performance condition stated in the header of the Goulburn River (water quality flows and PZ234/237) TARP tables should be checked for accuracy.

7. BIODIVERSITY

7.1. BACKGROUND AND EXISTING ENVIRONMENT

The Moolarben Coal Project Flora, Fauna and Aquatic Ecology Assessment (Moolarben Biota 2006) identifies a mix of Scribbly Gum Woodlands and Ironbark Forests on upper slopes and plateaus, with Tablelands Redgum Woodlands on lower slopes grading into Alluvial Apple Forests along the Goulburn River and associated tributaries. Moolarben Biota (2006) conservatively maps areas of Tablelands Redgum Woodlands as a variant of White Box Yellow Box Blakely's Redgum Woodland Distribution.

The UG4 LW409-414 Biodiversity Technical Report (Niche 2024) includes more detailed vegetation mapping updated to contemporary plant community types (PCTs). Niche (2024) maps five PCTs across the study area, defined as the land within the 26° angle of draw. The majority of the study area is mapped as dry sclerophyll forests, including Ironbark-Pine Woodland (PCT 3781) and Scribbly Gum-Pine woodland (PCT 3786) across plateaus and upper slopes. A damp shrubland community (PCT 3766) is mapped on flatter areas on the plateau. Drainage line 2 supports an Apple Gum community (PCT 3528) while narrow strip of Red Gum Shrub Forest (PCT 3530) is mapped along Saddlers Creek Road. Niche (2024) concludes that these PCTs do not align with any threatened ecological communities (TECs) listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) or Commonwealth E*nvironment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

No terrestrial GDEs were identified within the study area (as defined above) by Moolarben Biota (2006) or Niche (2024) largely due to the depth to the water table being greater than 25m.

Niche (2024) identifies the Goulburn River as a low to moderate potential GDE but concludes that none of the features above LW409 to LW414 are high priority GDEs under the Water Sharing Plan. It is noted that this does not mean that the study area does not support GDEs. Data presented in AGE (2025) indicates the presence of a shallow groundwater system around 10-20 mbgl adjacent to the Goulburn River, The Drip and Corner Gorge (piezometers PZ105A, PZ105C, PZ234A, PZ234B, PZ237A, PZ237B). The Goulburn River is currently a connected gaining stream and groundwater is above river level. Given this, it is likely that vegetation along the Goulburn River has some level of facultative groundwater dependence.

The Drip is identified by Moolarben Biota (2006) as a *"seep spring GDE"* (pp.6, 50). The Drip supports multiple seepage zones where groundwater emerges. Vegetation at this seepage zones includes ferns such as Coral Fern (*Gleichenia dicarpa*) and *Asplenium* sp. as well as sedges and grasses such as *Cladium procerum* (Figure 22). This vegetation is groundwater dependent; however, some uncertainty remains whether all seepage zones are sustained by a perched groundwater table or the groundwater table in the Triassic sandstone.

Figure 22: The Drip showing seepage zones in the rock face supporting groundwater dependent vegetation

Several cave-dwelling microbat species, including the Large-eared Pied Bat (C*halinolobus dwyeri*), Large Bent-winged Bat (*Miniopterus orianae oceanensis*) and Eastern Cave Bat (*Vespadelus troughtoni*) have been recorded within or adjacent to the study area. It is possible that these species are roosting within the sandstone cliffs possibly within the LW409 to LW414 study area, with surveys undertaken by Niche (2024) indicating the potential that the Large-eared Pied Bat is roosting in cliffs within the southern portion of the study area. No targeted surveys have been undertaken to identify specific roost features and determine if breeding habitat is present.

Sampling of aquatic ecosystems was undertaken by Moolarben Biota (2006) at three sites along the Goulburn River; (GR1, GR2 and GR3). These sites had:

- diversity scores of 23-28, 16 and 17-30 respectively, and
- SIGNAL scores of 4.48-4.85, 3.60 and 4.13-5.11 respectively, indicating poor (4-5) to fair (5-6) water quality.

Updated data is provided in Yancoal (2024a) which indicates that stream health at the three proposed monitoring locations is consistent with conditions recorded during the environmental assessment (Moolarben Biota 2006) with no significant change in stream health.

The majority of the biodiversity values documented by Moolarben Biota (2006) and Niche (2024) are considered to be at minimal risk of negative environmental consequences from subsidence impacts. Biodiversity values most susceptible to environmental consequences include groundwater dependent vegetation and aquatic ecosystems along the Goulburn River and The Drip, and cliffs supporting potential roosting and breeding habitat for microbats.

7.2. Environmental Consequences

7.2.1. Native vegetation

Impacts to general terrestrial environments above LW409 to LW414, including native vegetation, are expected to be negligible. While Niche (2024) concludes that PCTs 3528, 3530 and 3766 are reliant on overland flows, subsidence impacts are not expected to result in environmental consequences for these PCTs.

Whilst localised impacts such as cracking of surface rock, alteration of flows or ponding may result in localised impacts to terrestrial ecosystems, the environmental consequences of these impacts are expected to be negligible.

Impacts to riparian vegetation sustained by groundwater are discussed in section 7.2.4.

7.2.2. Threatened species

Moolarben Biota (2006) predicted that UG4 would affect roosting habitat, with destabilisation of cliffs and potential that some small caves and crevices would be damaged or lost, but that there would be *"no net loss of potential roosting features for the Large-eared Pied Bat in the study area"* and that mining would be unlikely to *"affect caves of particular value for this species for breeding"* (p.112). Niche (2024) predicts that subsidence impacts will occur, including localised surface tension cracking, cliff line instability and rock fall and these may result in environmental consequences, including impacts to potential roosting/breeding habitat. The impact predictions by Niche (2024) do not accurately reflect the impact predictions from the environmental assessment.

The LW409 to LW414 study area supports a number of cliff lines within and adjacent to the study area (Figure 23). Most prominent of these is CL3, an approximately 500 m long cliff line up to 21 m in height and supporting numerous overhangs and crevices (Figure 24). LW413 has been shortened to avoid mining beneath the major cliff and avoid impacts to CL3. Mining will still occur beneath a portion of CL3 supporting a minor cliff and this section may experience minor impacts. During the site inspection, this section of CL3 was inspected by the Panel and is considered unlikely to support roosting habitat for microbats. Southern sections of CL3, further from LW413, were not inspected. These areas are considered at negligible risk of subsidence impacts and environmental consequences due to the redesign of the mine plan to avoid impacts to CL3.

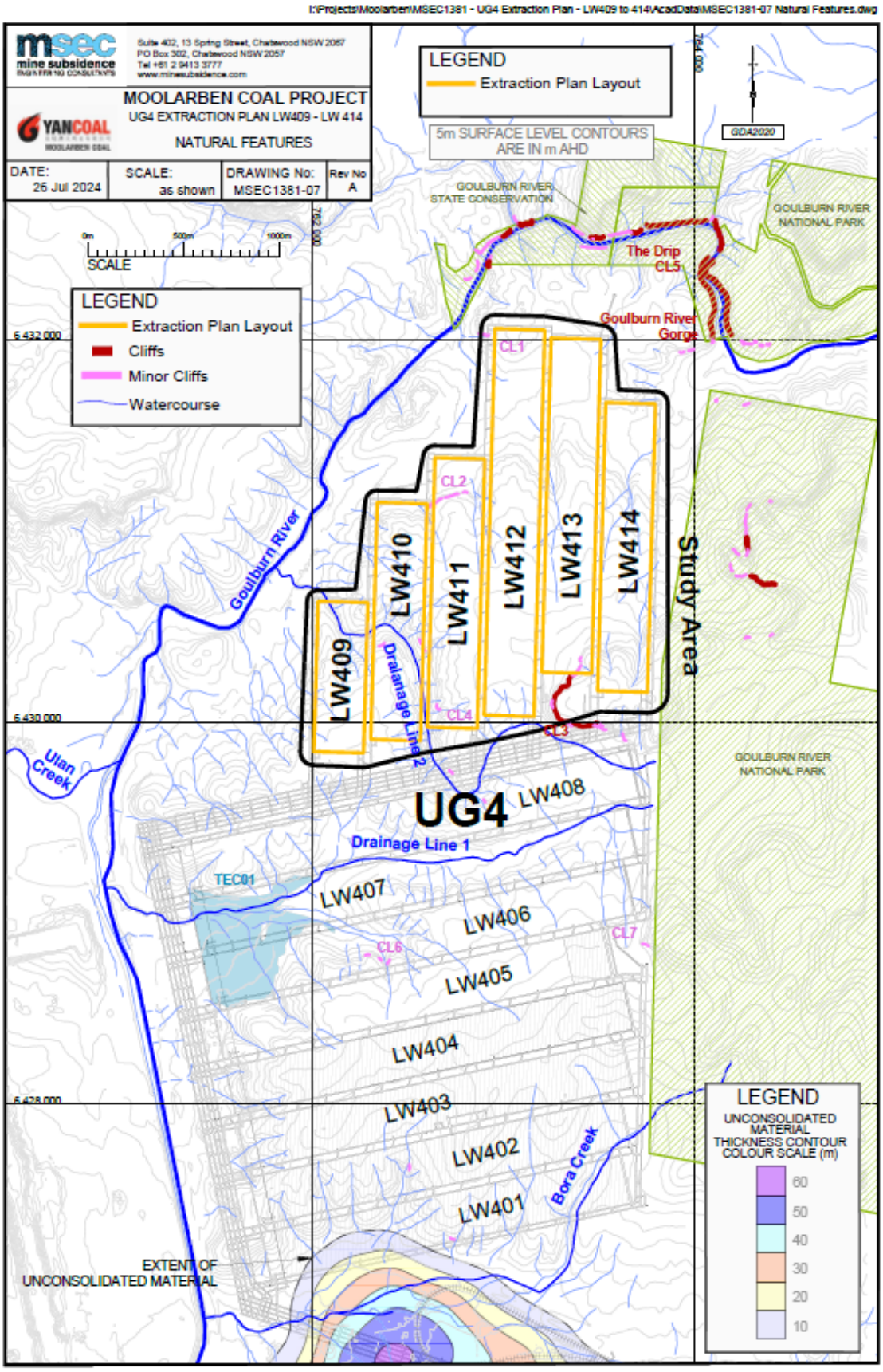

Figure 23: Cliff line mapping across the LWs 409-414 study area (Source: Drawing MSEC1381-07 of MSEC 2024)

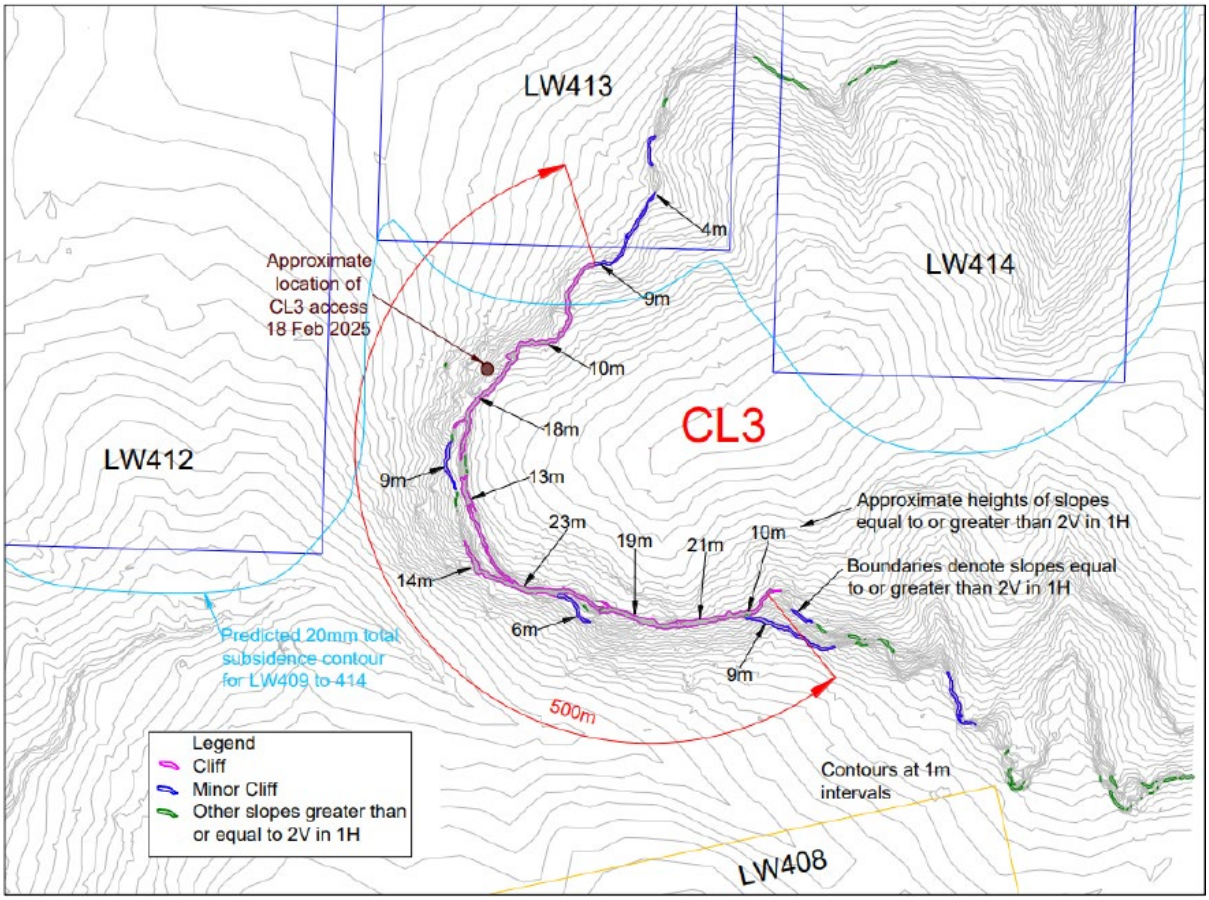

Figure 24: Mapping of cliff line CL3 showing the shortening of LW413 (Source: Figure A2-1, Attachment 2 of Yancoal 2025e)

Other cliff lines within and adjacent to the study area include CL1, CL2, CL4, a cliff line to the east of the study area (in the Goulburn River National Park) and cliff lines along the Goulburn River and Corner Gorge (Figure 23). No surveys have been undertaken to determine the potential for these cliff lines to support roosting or breeding habitat. Minor cliff lines within the study area will experience impacts including fracturing and rockfalls (MSEC 2024); however, the potential for impacts to microbat habitat are unknown. Cliff lines outside the study area would only be impacted by non-conventional subsidence and the likelihood of impacts is considered *"very low"* (MSEC 2024, p.51).

Without an understanding of how microbats are using cliff lines within and adjacent to the study area, it is difficult to determine what environmental consequences may arise from the subsidence impacts outlined above and whether these environmental consequences are in accordance with the predictions in the environmental assessment (no net loss of potential roosting features and no impacts to breeding caves).

A population of *Androclava procumbens*, a threatened species listed as vulnerable under the BC Act and EPBC Act, was confirmed during baseline surveys undertaken by Niche (2024), with five individuals recorded south of LW413. The species is not reliant on habitats considered at risk due to subsidence impacts and the species is considered at negligible risk of environmental consequences.

7.2.3. AQUATIC ECOSYSTEMS

Impacts to aquatic ecosystems are not well considered in the environmental assessment (Moolarben Biota 2006) or the technical report (Niche 2024).

As outlined in section 6.2, there is potential for impacts to water quality and quantity in the Goulburn River, potentially resulting in impacts to aquatic ecosystems. Reductions in baseflow, increased salinity, and increased frequency and periods of no to very low flow have potential to impact on aquatic ecosystems and stream health; this is likely to be exacerbated following cessation of mining.

The impacts to aquatic ecosystems arising from reductions in baseflow, increased salinity, and increased frequency and periods of no to very low flow have not been assessed but could reasonably be expected to include reductions in macroinvertebrate diversity and SIGNAL scores.

7.2.4. GROUNDWATER DEPENDENT ECOSYSTEMS

Moolarben Biota (2006) did not identify any terrestrial GDEs in the UG4 study area and predicted that there would be *"no significant loss of surface or ground water to mining operations in the Underground No. 4 area"* (p.69). Niche (2024) similarly concludes that the study area does not support any "high priority" GDEs.

As discussed in section 5 and section 6 above, there is potential for reduced baseflow contribution from the Triassic sandstone aquifer north of the Goulburn River to the Goulburn River and no groundwater baseflow contribution from the Triassic sandstone aquifer south of the Goulburn River to the Goulburn River following mining, with a reversed hydraulic gradient resulting in the southern flank of the Goulburn River changing from a connected gaining to a connected losing or disconnected losing stream with non-negligible consequences for the Goulburn River in the vicinity of The Drip and Corner Gorge. This may have consequent impacts for riparian vegetation which is likely to have some level of groundwater dependence. The degree of any impacts is unquantified.

The study area for the work undertaken by Niche (2024) was restricted to 26.5° angle of draw and 20mm subsidence contour and did not consider groundwater drawdown impacts. The assessment of potential impacts to GDEs along the Goulburn River is insufficient to demonstrate that impacts are in accordance with the conclusions of the environmental assessment (Moolarben Biota 2006).

As outlined above, the lower sections of The Drip may be sustained by seepage of groundwater from the regional groundwater table, supporting water dependent vegetation. Moolarben Biota (2006) states "*the removal of this water would almost certainly result in the loss of this vegetation"* (p.50); the Panel concurs with this conclusion. Section 5 concludes that there is potential for these seepage discharges to be impacted by depressurisation of the deeper Permian strata. If this occurs, this could impact on a key feature of The Drip and result in environmental consequences; i.e., loss of vegetation along those seepage zones. The work being undertaken by MCO to understand the groundwater system sustaining The Drip will assist in determining whether this impact will result. If so, the existing subsidence performance measures would not be met.

7.3. PROPOSED MONITORING PROGRAM, PERFORMANCE INDICATORS AND TARPS

The Project Approval does not include any performance measures directly related to biodiversity. Schedule 3 Condition 73 requires MCO to minimise subsidence damage to CL3, indirectly minimising potential for damage to microbat habitat. MCO have developed performance indicators related to biodiversity, as listed in Table 6 below:

Table 6: Biodiversity Management Plan Performance Indicators (*Source: Table 4 of Yancoal 2025f*)

Table 4: LW409-414 BMP Performance Indicators

Biodiversity Value	Performance Indicator
Threatened flora (*Androcalva procumbens*)	Threatened flora remains present within the Study Area.
Threatened fauna (Threatened Cave-dwelling bat species)	Reduction of species abundance at impact site is not greater than at reference sites for four consecutive years in conjunction with observed impacts to habitat directly related to subsidence.

Source: Niche (2024)

The Panel considers that any performance indicators and TARPs adopted should be put in place to ensure impacts are in accordance with the impact predictions in the environmental assessment. The Panel does not believe this is the case.

7.3.1. NATIVE VEGETATION (EXCLUDING GDES)

The Biodiversity Management Plan (Yancoal 2025f) proposes a combination of floristic monitoring plots and photo point monitoring at six monitoring locations with monitoring undertaken annually during spring before, during and for two years after mining below a monitoring point. Monitoring is generally in accordance with the Biodiversity Assessment Method (BAM, DPIE 2020). A Before-After Control-Impact (BACI) design is proposed with data analysis including comparison of the vegetation integrity score (VIS) between at impact sites before and after mining and between control and impact sites.

Given the likelihood of negligible impacts to terrestrial ecosystems and that, if impacts do occur, they would be unlikely to be detectable by floristic surveys as proposed, the Panel questions the use of the BAM floristic survey method for monitoring of native vegetation. For example, native vegetation above longwalls may show some degree of water stress during drought conditions, with consequent impact to plant health, without showing any change in the composition and structure of vegetation. These changes would not be detected by the BAM.

If MCO wishes to undertake monitoring of native vegetation, remote sensing may provide more suitable methods for detecting large-scale changes in water usage by vegetation above longwall mining areas. If the use of floristic plots is used to monitor changes, it is recommended that a minimum of two years baseline survey is required and that monitoring continue until mining is beyond the 26° angle of draw and that a monitoring plot is unlikely to experience and further conventional subsidence.

Impacts to riparian vegetation sustained by groundwater are discussed in section 7.3.4.

7.3.2. THREATENED SPECIES

7.3.2.1. MICROBATS

The Biodiversity Management Plan (Yancoal 2025f) proposes use of acoustic monitoring at three impact sites and on reference site (four sites) with monitoring undertaken twice per season for four days during the breeding period for the Large-eared Pied Bat (November to January) before, during and for two years after mining. The Biodiversity Management Plan (Yancoal 2025f) states that data will be used to *"determine changes over time in abundance, diversity, habitat preference, foraging guild and activity of target microbat species"* and to *"approximate the abundance (based on activity and the number of passes) of each species"* (p.22).

In their response to the Panel, Yancoal (2025e) state that abundance will be measured based on the number of passes, with a frequency calculated as an indicator of microbat abundance; no detail is provided on how 'frequency' will be determined. Acoustic detectors are a gross measure of bat activity, and it is difficult to determine whether 100 calls are one bat passing the detector 100 times or 100 bats passing the detector once. Whilst recent research has used generalized linear mixed-effects models and generalised random encounter models to assess abundance and density of microbats (Whiting, Doering and Aho 2022, Hoggatt, Starbuck and O'Keefe 2024) a baseline understanding of abundance and density was required. The LW409 to LW414 study area is within the nightly foraging range of microbats likely to be roosting in the extensive cave network in the surrounding landscape, and acoustic detectors will detect microbat foraging within the study area. Any changes in activity within the study area arising from subsidence impacts are likely to be masked by activity from surrounding areas. The use of acoustic detectors, as proposed, is insufficient to reliably determine changes in abundance.

The proposed monitoring of microbat activity is also insufficient to determine whether impacts are in accordance with the environmental assessment (Moolarben Biota 2006) which indicated that, whilst some impacts to roosting habitat may occur, there would be no net loss of roosting features and no impacts to caves of particular value. There is no current understanding of whether the study area supports roosting or breeding habitat, other than the potential that cliff line CL3 ***may*** support roosting habitat for the Large-eared Pied Bat based on the numbers of passes (Niche 2024).

It is recommended that baseline surveys of cliff lines are undertaken to determine whether the study area for LW409 to LW414 supports roosting and breeding habitat. If so, more targeted monitoring of these locations would be required to ensure impacts are in accordance with the environmental assessment and determine whether mining results in environmental consequences for microbats.

Given the adoption of a performance indicator of negligible impact due to longwall mining for cliffs and minor cliffs in the Goulburn River National Park and Goulburn River State Conservation Area (Yancoal 2025g), baseline surveys for microbats roosting and breeding should be extended to these cliffs.

7.3.2.1. THREATENED FLORA

The Biodiversity Management Plan (Yancoal 2025f) proposes monitoring of *Androclava procumbens* via population counts, assessment of population health and monitoring of subsidence impacts during spring, before, during and after mining.

As outlined above, it is considered unlikely that mining will result in environmental consequences for this species. However, the monitoring proposed is sufficient to detect large-scale changes in the population of this species. Given *Androclava procumbens* can be clonal, population counts should be revised to stem counts.

7.3.3. AQUATIC ECOSYSTEMS

The Extraction Plan does not include monitoring of aquatic ecosystems. Yancoal (2024a) proposes monitoring of stream health at two sites on the Goulburn River adjacent to LW409 to LW414 (SH02 and SH13) with SH02 listed as a reference site. Monitoring is also proposed along Bobadeen Creek, north of the study area (SH01B). Monitoring is based on the Australian Rivers Assessment System (AusRivAS) aquatic macroinvertebrate monitoring method, with surveys undertaken twice per year in spring and autumn with analysis of macroinvertebrate diversity and Stream Invertebrate Grade Number Average Level (SIGNAL) scores as an index of pollution tolerance.

SH02 should be considered a potential impact site and the program would benefit from establishment of an additional monitoring location downstream of Corner Gorge in proximity to surface water monitoring site SW22. Figure 4 of Yancoal (2025b) appears to indicate an additional monitoring site has been established next to SW22. This should be confirmed and the Surface Water Management Plan (Yancoal 2024a) updated.

Subject to these amendments, the proposed monitoring program is considered sufficient to document changes in stream health.

7.3.4. GROUNDWATER DEPENDENT ECOSYSTEMS

No monitoring of GDEs is proposed in the Biodiversity Management Plan (Yancoal 2025f).

Given the potential for impacts to groundwater dependent vegetation along the Goulburn River, the Panel recommends baseline surveys to map and identify likely GDEs in this area are warranted. This would be accompanied by revised predictions based on modelled drawdown.

If these surveys and analysis identify potential for impacts to groundwater dependent vegetation, a monitoring plan should be developed. As outlined above, remote sensing techniques are likely to provide more reliable monitoring outcomes than traditional floristic monitoring, particularly when accompanied by analysis of changes in depth to groundwater.

If the proposed groundwater monitoring of The Drip identifies that lower seepages zones are sustained by the regional groundwater table, rather than a perched system, monitoring of vegetation health in lower seepage zones may be required.

7.3.5. PERFORMANCE INDICATORS AND TARPS

The Project Approval (05_0117) does not outline any performance measures specific to biodiversity. The Biodiversity Management Plan (Yancoal 2025f) proposes two performance indicators (Table 6 of this report). Associated TARPS are identified in Attachment 1 of Yancoal (2025f).

As outlined above, environmental consequences for *Androclava procumbens* are expected to be negligible and the Panel queries the benefit of a performance indicator for this species. Irrespective, a more contemporary performance indicator would be no significant reduction in the population of *Androclava procumbens* when compared to baseline data.

The proposed TARP for threatened flora outlines a process for management impacts to *Androclava procumbens.* A Level 1 TARP trigger occurs when impacts are greater than predicted but the performance indicator has not been triggered. A Level 2 TARP trigger occurs when impacts are greater than predicted and the performance indicator has not been triggered. The Biodiversity Management Plan (Yancoal 2025f) predicts that *"subsidence impacts are not likely to adversely affect the population of Androcalva procumbens within the Study Area"* (p.14). Thus, a Level 1 TARP trigger occurs when there has been an adverse impact (presumably a reduction in population counts) but the species remains present. At this point management measures outlined in Section 7.0 of the Biodiversity Management Plan (Yancoal 2025f) are implemented, including seed collection and propagation/translocation into other area of suitable habitat. The Panel notes that monitoring of any translocated plants must be included to ensure success. A Level 2 TARP trigger occurs when there has been an adverse impact, but the species is no longer present in the study area. A Level 2 trigger results in the implementation of the contingency measures outlined in Section 8.0 of the Biodiversity Management Plan (Yancoal 2025f). The contingency measures outlined are vague and unlikely to be successful in managing impacts. It is recommended that in the result of a Level 2 trigger offsets are provided in accordance with the BAM (DPIE 2020) as per Schedule 3 Condition 74 of the Project Approval.

The proposed monitoring program for microbats is considered unsuitable for the reasons outlined in section 7.3.2.1; it is unlikely to detect changes in species abundance and is not targeted to the predicted impacts. In this regard, the proposed performance indicator is also considered unsuitable.

The TARP for threatened fauna outlines a process for management impacts to cave-dwelling microbats. A Level 1 TARP trigger occurs when impacts are greater than predicted but the performance indicator has not been triggered. A Level 2 TARP trigger occurs when impacts are greater than predicted and the performance indicator has not been triggered. As outlined in section 7.3.2, the impacts outlined in the Biodiversity Management Plan (Yancoal 2025f) are not consistent with the environmental assessment (Moolarben Biota 2006) and the Biodiversity Management Plan should be updated to ensure consistency; this will require updates to the performance indicator and TARPs.

Under the proposed TARP, if a Level 1 TARP trigger occurs management measures outlined in Section 7.0 of the Biodiversity Management Plan (Yancoal 2025f) are implemented, including site assessment, review of the monitoring program and installation of alternative roosting habitat. No detail is provided on how installation of alternative roosting habitat would be achieved, despite the Panel requesting further information from MCO. If a Level 2 TARP trigger occurs the contingency measures outlined in Section 8.0 of the Biodiversity Management Plan (Yancoal 2025f) will be implemented. As for threatened flora, the contingency measures outlined are vague and unlikely to be successful in managing impacts. It is recommended that in the result of a Level 2 trigger offsets are provided in accordance with the BAM (DPIE 2020) as per Schedule 3 Condition 74 of the Project Approval.

The Panel is of the view that the performance indicators and TARPs require further consideration, including alignment with the impact predictions in the environmental assessment (Moolarben Biota 2006) and review of the management measures in Section 7.0 and contingency measures in Section 8.0 of the Biodiversity Management Plan (Yancoal 2025f) to try and avoid or minimise further impacts.

7.4. BIODIVERSITY CONCLUSIONS

The Panel has reviewed the Biodiversity Management Plan and supporting documents referred for the review of the LW409 to LW414 EP and concludes:

1. The majority of the biodiversity values in the LW409 to LW414 study area are considered to be at minimal risk of negative environmental consequences from mining-induced impacts.
2. Impact predictions for microbats in the Biodiversity Management Plan (Yancoal 2025f) do not reflect the impact predictions from the environmental assessment (Moolarben Biota 2006) including no net loss of roosting habitat and no impacts to breeding caves. There is potential for impacts to minor cliffs. However, surveys have not been undertaken to determine the potential for these minor cliff lines to support roosting or breeding habitat. Thus, it cannot be determined whether proposed monitoring can satisfactorily identify subsidence impacts and related environmental consequences.
3. Monitoring proposed for microbats is insufficient to reliably assess performance against the performance indicator (changes in abundance) and is also insufficient to determine whether impacts are in accordance with the environmental assessment (no net loss of roosting features and no impacts to caves of particular value).
4. There is potential for reductions in baseflow, increased salinity, and increased frequency and periods of no to very low flow to impact on aquatic ecosystems and stream health; this will be exacerbated following cessation of mining.
5. Drawdown of groundwater in the Triassic sandstone and underlying Permian may impact on GDEs, including riparian vegetation along the Goulburn River and lower sections of The Drip. These impacts have not been assessed.
6. The performance indicators and TARPs proposed do not ensure that impacts are in accordance with the impact predictions in the environmental assessment.
7. Subject to the recommendations below, the proposed aquatic monitoring program is considered sufficient to document changes in stream health.

7.5. BIODIVERSITY RECOMMENDATIONS

The Panel recommends:

1. Impact predictions for microbats in the Biodiversity Management Plan (Yancoal 2025f) are updated to reflect the impact predictions from the environmental assessment (Moolarben Biota 2006) including no net loss of roosting habitat and no impacts to breeding caves.
2. Baseline surveys of cliff lines within and adjacent to the study area are undertaken to determine whether the study area supports roosting or breeding habitat for microbats.
3. The results of this baseline survey should inform management measures and revisions to the monitoring program, with identified roosting and breeding habitat subject to monitoring to ensure environmental consequences are in accordance with the predictions in the environmental assessment.
    i. If breeding and roosting habitat is not identified, monitoring could be removed from the monitoring program.
    ii. If breeding and roosting habitat is identified more targeted monitoring of these locations would be required to ensure impacts are in accordance with the environmental assessment and determine whether mining results in environmental consequences for microbats.
4. Baseline surveys for microbats should be extended to cliffs in the Goulburn River National Park and Goulburn River State Conservation Area given the adoption of a performance indicator of negligible impact due to longwall mining for cliffs and minor cliffs in these areas.
5. A baseline assessment is undertaken prior to mining to identify and map aquatic ecosystems and GDEs, along with a baseline assessment of their current condition and health and an assessment of the potential impacts to aquatic ecosystems and GDEs arising from loss of baseflow to the Goulburn River.
6. The results of this assessment should inform the development of a monitoring program to detect changes in identified GDEs. The monitoring program would require further assessment after trends in the groundwater monitoring data show that drawdown has occurred in the Triassic sandstone to be below river level, and that the Goulburn River is potentially a losing stream. Periodic monitoring of GDEs and aquatic ecosystems would be required thereafter to record impacts to aquatic ecosystems and GDEs. Any monitoring program should focus on use of reliable metrics for assessment of changes in vegetation condition; this may include remote sensing.
7. If MCO wishes to undertake monitoring of native vegetation, remote sensing may provide more suitable methods for detecting large-scale changes in water usage by vegetation above longwall mining areas. If the use of floristic plots is used to monitor changes, it is recommended that a minimum of two years baseline survey is required and that monitoring continue until mining is beyond the 26° angle of draw and that a monitoring plot is unlikely to experience and further conventional subsidence.
8. The monitoring program and TARP for threatened flora should be updated to include monitoring of any plants translocated into new habitat resulting from a Level 1 trigger and require biodiversity offsets if a Level 2 trigger occurs.

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APPENDIX A – DPHI REQUEST FOR PANEL ADVICE

Department of Planning, Housing and Infrastructure

Our ref: MP05_0117-PA-98

Emeritus Professor Jim Galvin

Chair Independent Expert Advisory Panel for Mining

By email: j.galvin@bigpond.net.au

21 January 2025

Subject: Request for Advice

Moolarben Coal Complex – Stage 1 (MP05_0117) Extraction Plan for Longwalls 409-414

Dear Prof Galvin

I am writing to you to request advice from the *Independent Expert Advisory Panel for Mining* (the Panel) in relation to the *UG4 Longwalls 409-414 Extraction Plan*.

The extraction plan seeks approval for secondary extraction from Longwalls 409 to 414 located in the UG4 mining area (see Appendix 7 of Attachment 1). The UG4 area comprises a total of 14 longwall panels, of which the first series of longwall panels (Longwalls 401 to 408) was approved for extraction in July 2022. The extraction plan for longwalls 401 to 408 was reviewed by the Panel and its approval was subject to conditions (see Attachment 4).

The UG4 mining area is located to the south of significant water features of the Goulburn River National Park, including the Drip, Corner Gorge and the Goulburn River. The protection of these features has been a key issue for this project, particularly in relation to the management of potential subsidence and associated surface and groundwater impacts. The project's development consent contains specific performance measures for these features, which include nil to negligible environmental consequences. In the UG4 mining area, Longwalls 409 to 414 are closest in proximity to these features.

Moolarben Coal has consulted with several agencies in the preparation of the extraction plan. A copy of the relevant agency advice and the Proponent's response to this advice is attached for your consideration (see Attachment 3). Key issues raised relate to potential impacts on the Goulburn River National Park (water, Aboriginal cultural heritage and public safety), and the installation of monitoring bores proximal to the Drip.

The Department has received a high volume of email correspondence from members of the community raising concern about the potential impacts on local significant features. The Department also met with a received a submission from the Mudgee District Environmental Group (MDEG). The

group requested an opportunity to speak with the Panel during its consideration of the extraction plan. A copy of this submission is provided in Attachment 5.

The Department considers the key technical issues for the extraction plan are in relation to subsidence and water-related impacts, particularly on proximal water features and Aboriginal cultural heritage.

The Department is seeking targeted advice from the Panel for the following:

- the scale and likelihood of potential subsidence, water-related impacts and environmental consequences on key water features in the vicinity of the Extraction Plan area, including the Drip gorge, Corner Gorge and the Goulburn River;
- whether is it reasonable to conclude that existing subsidence performance measures could be met;
- the scale and likelihood of potential subsidence impacts to Aboriginal Heritage sites within the Extraction Plan area, including SM1C287; and
- whether the proposed monitoring program and Trigger Action Response Plans are adequate to satisfactorily identify subsidence impacts and related environmental consequences.

The Panel should feel free to provide any other advice it considers would assist the Department in reviewing the extraction plan.

To assist the Panel, supplementary documentation is attached.

It would be appreciated if the Panel can provide advice by 10 March 2025.

If you have any questions or require additional information for your review, please contact Gen Lucas on (02) 9274 6489 or gen.lucas@planning.nsw.gov.au.

Yours sincerely

Steve O'Donoghue
Director Resource Assessments

NSW GOVERNMENT

Attachments

1. Project approval (as modified) for Moolarben Coal Stage 1 (MP05_0117)
2. Extraction Plan and all attachments – to be sent via separate link due to file size.
3. Agency advice
4. Extraction Plan approval and conditions for LW401-408
5. MDEG submission

APPENDIX B – PANEL BIOGRAPHY

Emeritus Professor Bruce Hebblewhite (Moolarben UG4 LWs 409-414 Panel Convener)

Bruce Hebblewhite is an Emeritus Professor and was formerly the Professor of Mining Engineering at the University of New South Wales (UNSW) until his retirement from UNSW in 2020. He has over 45 years of international mining experience, specialising in the fields of underground mining systems, geomechanics, mine safety and risk management. He has held senior positions with Australian Coal Industry Research Laboratories (ACIRL Ltd), has served 25 years at the UNSW including 12 years as the Head of Mining Engineering, and was also the Secretary General of the international Society of Mining Professors. He was also the Chair of the NSW Independent Panel for the Southern Coalfield Inquiry (2008).

Emeritus Professor Jim Galvin (IEAPM Chair)

Professor Galvin is an Emeritus Professor (University of New South Wales) in Mining Engineering and former member of the NSW Planning Assessment Commission. He has professional qualifications in science, engineering and mine management and extensive international experience in mining and geotechnical engineering, risk management and workplace health and safety. Professor Galvin is one of the world's foremost experts on underground coal mining and ground subsidence. He was a member of the Independent Panel for the Southern Coalfield Inquiry (2008), several subsequent reviews of mining projects in the Southern Coalfield and most recently, Chair of the Independent Expert Panel on Mining in the Catchment.

Neil Alston

Neil is a mining engineer with over 30 years of experience, including in senior operational, technical and statutory positions. He has been a mine manager across a broad range and scale of underground bord-and-pillar and longwall coal mines. Neil has expertise in mine management, mine design and planning, due diligence, research and development and strata control for projects across Australia. Neil's technical experience has ensured high levels of safety and productivity improvements.

Mr John Ross

John Ross is a Senior Principal Hydrogeologist with over 40 years' experience specialising in water resource, site contamination, infrastructure, mining and natural resource impact assessment and management. His specialty is sedimentary basin hydrogeology, particularly the Great Artesian Basin, Sydney-Gunnedah and Gloucester basins here in NSW. John has held specialist management roles in public and private corporations and environmental consultancies. He has a Bachelor of Science (Geology) and a Certificate in Engineering Hydrology and Groundwater Hydrology.

John provides technical hydrogeological expertise and advice across the spectrum of water resource development, environmental/water planning, assessment and management projects, including environmental impact assessments, environmental audits and technical peer reviews, monitoring programs, remedial action plans, modelling and groundwater licensing matters.

John also has extensive experience in community and regulatory consultation across the eastern seaboard.

Professor Rae Mackay

Emeritus Professor Rae Mackay was until 2024 the Executive Chair of the Victoria's Mine Land Rehabilitation Authority. He has over 40 years of experience as a practicing engineer, hydrogeologist and academic. Before his previous role he was the Latrobe Valley Mine Rehabilitation Commissioner (2017-2020). Professor Mackay was also a member of the Victoria Technical Review Board, which had oversight of ground stability issues across the state's mines and quarries. Before moving to Australia, he served 15 years as the Head of Hydrogeology at Birmingham University in the United Kingdom.

Professor Neil McIntyre

Neil McIntyre is Professor of Hydrology and Water Resources at The University of Queensland. He holds a Bachelor of Engineering (Civil) from Edinburgh University, a Master of Science in Environmental Engineering and Doctor of Philosophy in water quality modelling from Imperial College London. He is a Chartered Civil Engineer (UK Engineering Council), with expertise including surface water hydrology, water security assessments, and impacts of land use changes and mining on hydrology and water quality. His advisory roles have included serving on the Institution of Civil Engineer's Water Expert Panel (UK), the Steering Committee of the Commonwealth Leading Practice Sustainable Development Program, and the NSW Independent Expert Panel for Mining in the Catchment.

Nathan Garvey FEIANZ

Nathan is an experienced ecologist with over 20 years' practice in biodiversity assessment and approvals across eastern Australia. Nathan holds a Bachelor of Science and Graduate Diploma in Biological Science from the University of NSW and is a Certified Environmental Practitioner. Nathan is also a Fellow of the Environment Institute of Australian and New Zealand (EIANZ) for his contribution to the field of environmental science and management.

Nathan has experience across a diverse range of sectors including mining, oil and gas, linear infrastructure, renewable energy and residential development, including biodiversity assessment for major projects, offsetting and *Environment Protection and Biodiversity Conservation Act* referrals. He has strong expertise and experience in the assessment of impacts to biodiversity arising from subsidence, as well as impacts to groundwater dependent ecosystems arising from groundwater drawdown. He is one of NSW's leading experts in biodiversity approvals and offsetting.