INDEPENDENT ADVISORY PANEL FOR UNDERGROUND MINING

ADVICE RE:

DENDROBIUM COAL MINE

LONGWALLS 22 & 23

SUBSIDENCE MANAGEMENT PLAN

March 2022

EXECUTIVE SUMMARY

Overview

On the 26 November 2021, the Director, Resources Assessment, NSW Department of Planning, Industry and Environment (the Department) requested the Independent Advisory Panel for Underground Mining (the Panel) to provide advice on the following in relation to the Subsidence Management Plan (SMP) for Longwalls 22 and 23 (LW22 & 23) in Area 3C at the Dendrobium Coal Mine.

- *the appropriateness of the proposed minimum setback of 300 m from the Full Supply Level (FSL) of Cordeaux Reservoir*
- *the appropriateness of the proposed 345 and 320 m respectively setback distance from Wongawilli Creek in relation to the performance measure of "minor impacts" as required by Schedule 3 Condition 2 of the consent and proposed performance indicators outlined in the SMP – Area 3A Watercourse Impact Monitoring, Management and Contingency Plan (WIMMCP – Appendix 4 of the SMP)*
- *the significance of tributaries LC5 and LC6, as well as Swamp 7, and whether these warrant the inclusion of performance measures*
- *the potential impacts to the transmission line TWR17-21 and whether a performance measure of safe and serviceable is recommended.*
- *any other advice it considers would assist the Department in reviewing the SMP.*

The reader is referred to the main body of this advice for discussion on these matters. The Panel's principal conclusions and recommendations are as follows.

Conclusions

1. The Panel is concerned that the long-term groundwater conditions may still not be adequately represented by the modelling outputs.
2. On the basis of current knowledge and information, a minimum set back distance from Cordeaux Reservoir of 300 m is reasonable.
3. A Type 3 Impact as defined in the Rockbar Model cannot automatically be classified as a 'minor impact' as defined in Schedule 3 of the Dendrobium Consent Conditions.
4. Schedule 3 of the Dendrobium Consent Conditions provides an absolute requirement for subsidence not to result in more than 'minor impacts' to any (nominated) pool in the first instance. It does not provide for satisfying this performance measure by utilising remediation after the performance measure has been exceeded.
5. Schedule 3 of the Dendrobium Consent Conditions requires that subsidence does not result in more than 'minor impacts' to the water levels "*in any of the pools being monitored"* with no allowance for a proportion of pools being impacted.
6. Schedule 3 of the Dendrobium Consent Conditions requires that subsidence does not result in more than 'minor impacts' to pool water levels irrespective of whether the mechanism is fracturing or groundwater depressurisation associated with subsidence or a combination of these. The relevance of baseflow losses to the Consent Conditions points to the potential difficulty of relying on remediation for meeting the Conditions, at least until the mine is sealed effectively and groundwater levels recover.
7. Although there are valid questions about whether the approval conditions for Wongawilli Creek have already been breached, the Panel has not found objective evidence that they have.

8. The predictions of valley closure and associated Type 3 impact probability for LW22 & 23 assume the future mining of LW20 on the opposite, western, side of Wongawilli Creek. Analysing the benefit of further setbacks of LW22 & 23 from Wongawilli Creek may benefit from coincident review of the LW20 plan. Based on current knowledge, if LW20 were not to be extracted, the risk of Type 3 fracturing due to LW22 and 23 with their currently proposed setbacks is very low.

9. If LW20 is extracted, Type 3 fracturing rate predictions for individual pools in the LW22 & 23 mining area are similar to those for LW19; however, there is more risk to Wongawilli Creek from mining of LW22 and 23 due to the greater number and connectivity of pools and, quite possibly, the orientation of LW20. This risk includes a significant probability of breach of consent conditions related to pool water levels if impacts cannot be successfully remediated.

10. The proposed performance measures do not clearly align with the Schedule 3 consent condition in relation to impacts on pool levels.

11. The Panel has no reason for suggesting that the dimensions of LW22 & 23 should be reduced for the purpose of managing impacts on LC5, LC6 and Swamp 7.

12. In the context of the approval conditions for Area 3C, and without the benefit of a field visit to survey potentially significant features in these watercourses, the Panel is not aware of any reason for additional performance measures for LC5 and LC6.

13. As impacts on Swamp 7 have been offset by the Maddens Plains Strategic Biodiversity Offset, performance measures for Swamp 7 *per se* are now largely irrelevant.

14. Based on the recorded occurrences within the study area, the Littlejohn's tree frog and potentially also the red-crowned toadlet should arguably be considered not as species dependent on upland swamps but as species dependent on the pools within streams, i.e. within the aquatic ecosystem.

15. Should the Littlejohn's tree frog and/or the red-crowned toadlet be classified as species dependent on the pools within streams, the proponent needs to show how they would meet Clause 17b of Schedule 4 of the 2008 Approval that requires the Consent Holder to *'mitigate and/or offset any adverse impacts on groundwater dependent ecosystems, aquatic ecosystems or riparian vegetation'*.

16. The risk assessment for LW22 and 23 falls well short of what could be considered a robust risk assessment and does not effectively address the identification and management of residual risk.

Recommendations

1. Any approval of the SMP for LW22 & 23 should be conditioned on mining not commencing until predictions of seepage from Avon Reservoir due to mining in Area 3B have been validated to the satisfaction of the Department Secretary and found not to provide a basis for increasing the setback distance of 300 m.

2. The Watercourse Impact Monitoring Management and Contingency Plan should clarify the primary monitoring sites for the performance measures related to pool water levels.

3. For the application of Method D to pool water level reductions or increases in cease to flow days, an appropriate threshold for changes in cease-to-flow days should be specified as well as associated trigger levels for pool water or flow loss.

4. The method of analysis of impacts on swamp hydrology developed in response to IEPMC recommendations should be included in the Swamp Impact Monitoring Management and Contingency Plan.

5. A Performance Measure of Safe and Serviceable should be applied to that section of the 330 kV transmission line that could be impacted by LW22 & 23.

6. Extraction of LW22 & 23 should not be permitted to impact the 330 kV transmission line:

    i. without the agreement of the asset owner (TransGrid),

    ii. without independent verification that the required mitigation strategies have been developed and implemented, and

    iii. without the development of a TARP to monitor the effectiveness of the mitigation strategies and to respond in a timely and effective manner to any adverse deviation from predicted behaviour.

7. Prior to consideration of any further application to mine in the area covered by the current Consent, the Consent Conditions should be harmonised to provide a less ambiguous suite of conditions.

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1.0 SCOPE OF WORKS

On the 26 November 2021, the Director, Resources Assessment, NSW Department of Planning, Industry and Environment ("the Department") requested the Independent Advisory Panel for Underground Mining (IAPUM – "the Panel") to provide advice on the following in relation to the Subsidence Management Plan (SMP) for Longwalls 22 and 23 (LW22 & 23) in Area 3C at the Dendrobium Coal Mine.

- *the appropriateness of the proposed minimum setback of 300 m from the Full Supply Level (FSL) of Cordeaux Reservoir.*
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- *the significance of tributaries LC5 and LC6, as well as Swamp 7, and whether these warrant the inclusion of performance measures.*
- *the potential impacts to the transmission line TWR17-21 and whether a performance measure of safe and serviceable is recommended.*
- *any other advice it considers would assist the Department in reviewing the SMP.*

The Chair of the Panel (Em. Professor Jim Galvin) nominated the same Panel members which reviewed the Dendrobium Extension Project and the SMP for Longwall 19 in Area 3A of Dendrobium Mine, being:

- Em. Professor Jim Galvin – Chair – Subsidence and Mining
- Professor Neil McIntyre – Surface Water
- Dr Ann Young – Swamps and Ecology
- Em. Professor Rae Mackay – Groundwater

2.0 METHOD OF OPERATION

COVID constraints prevented the Panel from meeting in person and from undertaking a site inspection, with the Panel convening by videoconference. This advice has had regard to the following documents made available by the Department.

No	Document
1	*LWs 22-23 Subsidence Management Plan* 1a. Longwalls 22-23 Area 3C – Subsidence Management Plan, September 2021 1b. Longwall 22-23 Area 3C – Subsidence Management Plan – Attachments A to G 1c. Area 3C Watercourse Impact, Monitoring, Management and Contingency Plan (WIMMCP), September 2021 1d. Area 3C Swamp Impact, Monitoring, Management and Contingency Plan (SIMMCP), September 2021
2	*Agency Advice on LWs 22-23* 2a. Environment, Energy and Science – October 2021 2b. WaterNSW – October 2021 2c. Resources Regulator – October 2021
3	*South 32 response to Agency Advice* 3a. Response to Submissions – September 2021
4	*Further Advice* 4a. South32 response to WaterNSW – October 2021
5	*Additional background information* 5a. Development consent conditions 5b. Area 3C approval conditions 5c. Area 3A Longwall 19 Reasons for Approval

This advice has also been informed by:

- A videoconference between the Department and the Panel on 10 February 2010.
- A response from South32 on 1 March 2022 to questions submitted by the Panel on 28/2/2022.
- The knowledge and experience of individual Panel members acquired through preparing other advices and submissions to NSW Government, some dating back to 2001, on matters pertaining to the Southern Coalfield in general and to Dendrobium Mine in particular.

3.0 LW22 & 23 BACKGROUND INFORMATION

3.1. CONSENT CONDITIONS

Dendrobium Mine was approved in 2001 but consent to extract coal from Area C, shown in Figure 1, was only granted in December 2008. The application to extract Area C was supported by a Subsidence Management Plan (SMP) prepared by Cardno Forbes Rigby (CFR, 2007) that addressed the monitoring and management of Longwalls 1 and 2 (Area 1), Longwalls 3 to 5A (Area 2) and Longwalls 6 to 10 (Area 3A). At the time, the mine layout for Area 3B and Area 3C had not been developed.

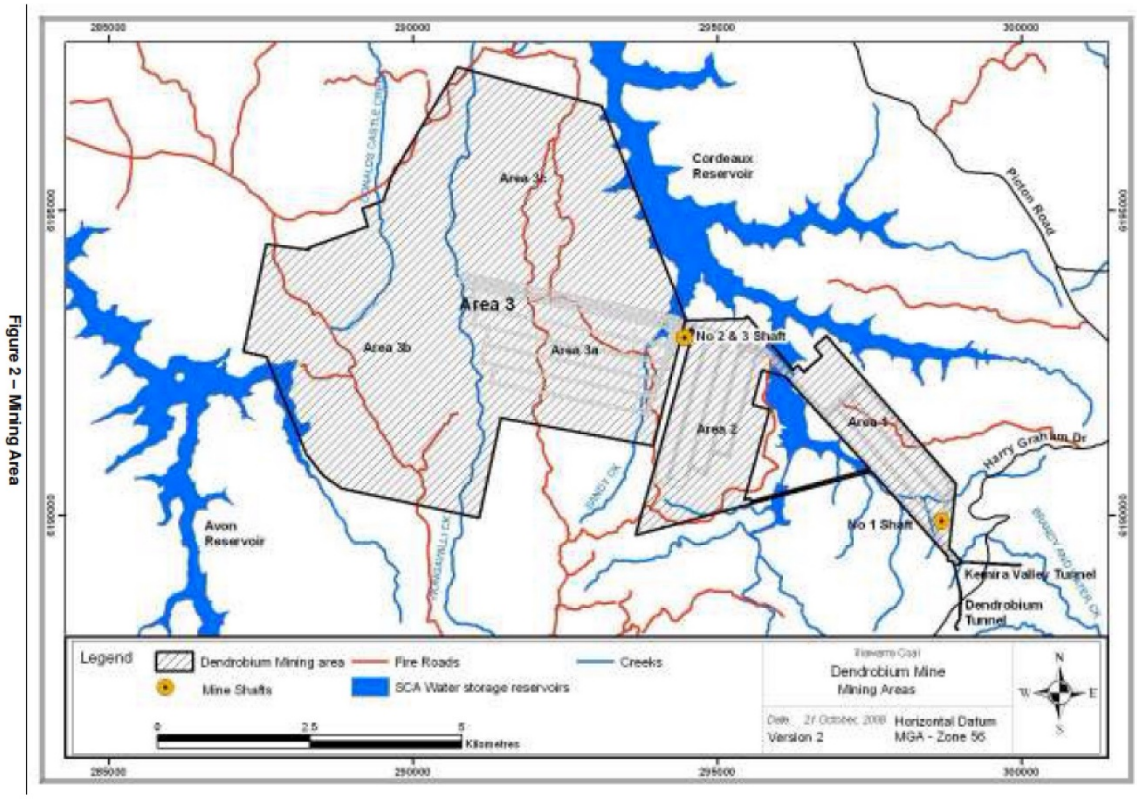

Figure 1: Dendrobium mine plan at the time of the 2008 consent to mine Area 3C.

The approval to mine Area 3A included consent conditions that apply to Area 3B and Area 3C. *Schedule 3 – Specific Environmental Conditions* of the consent comprises Attachment 1 of this advice and its supporting reference defining the meaning of 'minor impacts' for Wongawilli Creek (Table 23.2 of CFR, 2007) comprises Attachment 2. The 2008 consent for Area 3 of Dendrobium Mine was one of the last to be issued under legislation that was based on the development of SMPs and made provision for the Department to specify additional performance measures when approving an SMP. In the case of Dendrobium Area 3, approval conditions also allow for performance measures to be met by avoidance, mitigation, remediation or offsetting.

The Panel recommends that prior to consideration of any further application to mine in the area covered by the current Consent, the Consent Conditions should be harmonised to provide a less ambiguous suite of conditions.

3.2. MINE PLAN

The mine layout currently proposed for Area 3C is shown in Figure 2. The SMPs for LW20 and LW21 were initially referred by the Department to the Independent Expert Panel for Mining in the Catchment (IEPMC) for advice in 2019.[1] Subsequently, LW20 was withdrawn from the assessment and has no approved SMP at this point in time. In approving the SMP for LW21, the Department has specified Performance Measures that apply to all of Area 3C. These comprise Attachment 3 of this advice.

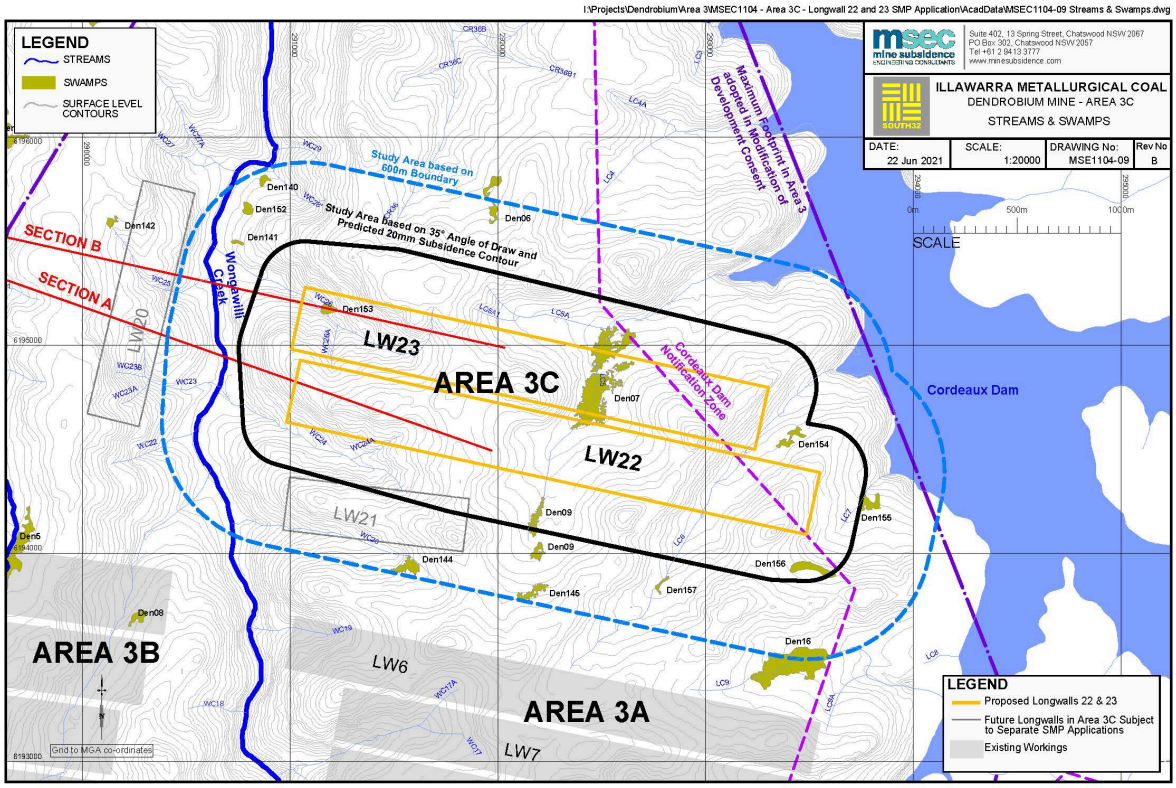

Figure 2: Plan showing longwall panels currently proposed in Area 3C and their spatial relationship to Cordeaux Dam, swamp Den7, tributaries LC5 and LC6, and Wongawilli Creek.

The Panel notes concerns in some submissions regarding the apparent limited extent of mine planning undertaken in Area 3C to date and its conformance to a condition in the approval of the SMP for LW14 & 15 in Area 3B that:

[1] Three members of the current Panel were members of the IEPMC that reviewed the SMP for LW21 (these being Galvin, McIntyre and Young),

By 30 June 2018, and prior to the commencement of any longwall gateroad development in Area 3C, the Applicant must submit the:

(a) proposed mine layout and mining geometry for Area 3C; and

(b) proposed baseline monitoring program for Area 3C,

for approval by the Secretary and DRE.

The Panel also notes that the Scoping Report for the Revised Area 5 Project SSI-33143123 envisages a return to mining in Area 3C after 2035 if that project is approved. These concerns do not impact currently on the Panel's advice. However, any proposal to conduct additional mining in Area 3C after the extraction LW20 to 23 will need to carefully consider the potential for incremental increases in subsidence in the vicinity of LW 20 to 23 and how they may negatively impact on the matters covered by the Panel's current advice.

4.0 GROUNDWATER

The Groundwater Assessment[2] is well presented, clearly written and provides an adequate basis for assessing the likely groundwater related impacts to the surface water courses, the swamps and the flows to the surface reservoirs.

The groundwater model indicates that declines in the water table beneath the streams and Swamp 7 and above the longwalls will lead to water losses from the streams for an extended period after mining. Water table recovery is expected but may not recover to pre-mining conditions. The predicted regional water table map for the year 2200 suggests that the depressurisation will be very long term for LC5 but at this stage the long-term conditions are relatively uncertain. It appears likely that the hydrology of Swamp 7 will be significantly impacted by mining. Continuing efforts are needed to improve the modelling of groundwater recovery post mining to understand the likely impacts both on stream and swamp hydrology and on water quality.

The Groundwater Assessment also provides a response to the IAPUM's advice provided in relation to the SMP for LW19. The response states that the groundwater modelling is consistent with South32's stated option of sealing the mine with material that returns average permeability to the permeability of undisturbed coal (or lower). However, the Panel's concern with the conceptual model used for the groundwater modelling was not about the sealing of the mine (although the integrity of the seals is a concern) but with the opportunity for the mine roadways to remain as high transmissivity connections throughout the mined area. If the roadways have much higher transmissivities than the surrounding formations for the long term, then this will have significant impacts on the distribution and degree of recovery of groundwater levels across the mining area. The data previously presented for the EIS for the Dendrobium Extension Project (Areas 5 and 6) suggest that this has not been sufficiently considered. The current modelling does not appear to have addressed this issue. Therefore:

The Panel is concerned that the long-term groundwater conditions may still not be adequately represented by the modelling outputs.

[2] Attachment B of the Subsidence Management Plan for Longwall 22 and 23

5.0 SETBACK DISTANCE FROM CORDEAUX RESERVOIR

Re: *the appropriateness of the proposed minimum setback of 300 m from the Full Supply Level (FSL) of Cordeaux Reservoir*

South32 proposes to setback LW22 and 23 by at least 300 m from the full water level (FWL) of Cordeaux Reservoir. The setback distance is considerably greater over much of the eastern and northern perimeters of these longwall panels adjacent to Cordeaux Reservoir.

Primary considerations when determining setback distance of longwall workings from stored water bodies are:

- Potential for hydraulic connections from the stored waters to the mine workings associated with:
    - geological structures
    - mining-induced fracturing
- Potential for seepage of stored waters into mine workings due to:
    - mining-induced enhanced permeability of the intervening strata
    - increased hydraulic gradients

Figure 3 shows significant geological structures along the southern flank of LW22 and that some structures pass under Cordeaux Reservoir. It has been suggested in submissions that the mapping of geological structures is deficient and misleading.

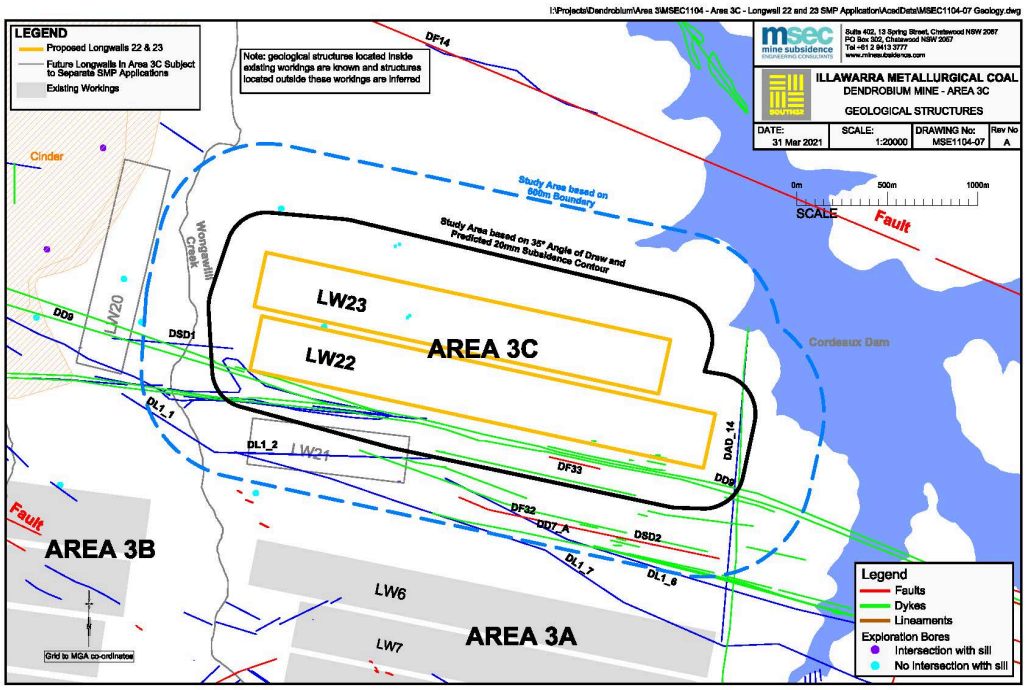

Figure 3: Plan showing the concentration of geological structure (faults and dykes) adjacent to the southern flank of LW22, some of which extend under Cordeaux Reservoir.

Based on the information provided to the Panel, the Panel does not believe the mapping to be misleading or deficient. The issue appears to have arisen in large part due to a misunderstanding of what constitutes a lineament. In responding to submissions, South32 has advised that it has conducted substantial exploration in the areas over Longwalls 22 and 23 and has not confirmed any lineaments at seam level. Exploration datasets include surface vertical and surface-to-inseam boreholes, underground inseam drilling, seismic surveys, surface mapping and aeromagnetic surveys and these activities are ongoing. If structures are confirmed by these exploration techniques, South32 has committed to adding them to the seam structure layers. The Panel notes that the Risk Assessment also makes provision for responding to any unexpected structure encountered during mining.

Based on the information provide to it, the Panel is of the view that the potential for hydraulic connections associated with geological structures to extend from the stored waters to the mine workings is very low.

However, there is potential for mining-induced fracturing to extend to the surface above LW22 and 23 and possibly over the flanks of these longwall panels. In the given circumstances, fracturing that could result in free drainage is very likely to be restricted to directly over the longwall workings. Also, mining-induced movement may also occur on sub-horizontal shear planes (aligned with bedding planes) and it is possible that this could extend from over the mine workings to the reservoir. However, as field studies have revealed around the starting ends of LW15 to 18, which are set back a minimum of 300 m from the FSL of Avon Reservoir, this only results in a relatively small increase in permeability along the shear surfaces and does not result in free drainage. The Panel is of the view that in the case of a 300 m setback distance for LW22 and 23, mining-induced fracturing is extremely unlikely to result in direct hydraulic connections to the stored waters.

Effectively, mining-induced fracturing and strata relaxation towards mining voids contributes to an increase in post-mining permeability of the rock mass that decreases with distance from the edge of a longwall mining panel. The extensive field studies undertaken at the starting ends of LW15 to 18 at Dendrobium Mine have provided estimates of these changes in permeability. These data are put into groundwater models to assess seepage losses into mine workings.

The Panel is of the view that while it is reasonably predicted on the basis of groundwater modelling that there will be some reduction in groundwater flows to Lake Cordeaux, the magnitude of this reduction is not large (predicted to be well below 1GL/y). The modelling of lateral enhancement of hydraulic properties outside of the longwall footprint has been carried out carefully and the results appear to be conservative both in terms of lateral extent of enhanced properties and the magnitudes of the enhancements. It is expected that over the long term, groundwater discharges to the lake will recover to a reasonable degree if adequate sealing of the mine occurs as part of rehabilitation. The assessment suggests that a local model to examine groundwater flows to the Lake could be completed. The Panel is not convinced at this stage that such a modelling exercise would increase the certainty in the estimates of the flows without new data.

The Panel concludes that on the basis of current knowledge and information, a minimum set back distance from Cordeaux Reservoir of 300 m is reasonable.

The Panel recommends that any approval of the SMP for LW22 and 23 should be conditioned on mining not commencing until predictions of seepage from Avon Reservoir due to mining in Area 3B have been validated to the satisfaction of the Department Secretary and found not to provide a basis for increasing the setback distance of 300 m (noting that these predictions cannot be confirmed by monitoring water inflow to the mine).

6.0 SETBACK DISTANCE FROM WONGAWILLI CREEK

Re: *The appropriateness of the proposed 345 and 320m respectively setback distance from Wongawilli Creek in relation to the performance measure of "minor impacts" as required by Schedule 3 Condition 2 of the consent and proposed performance indicators outlined in the SMP – Area 3A Watercourse Impact Monitoring, Management and Contingency Plan (WIMMCP – Appendix 4 of the SMP).*

6.1. CONSIDERATIONS RELATING TO THE PERFORMANCE MEASURE OF MINOR IMPACTS

The Department's request for advice states that:

> *In earlier Panel advice (Longwall 19) it was noted that the previous Independent Expert Panel for Mining in the Catchment* [IEPMC] *took the view that "a Type 3 impact should constitute an exceedance of a performance measure of minor environmental consequence" and, further, that there is no basis for assuming that a low rate of predicted Type 3 impacts (e.g.< 10%) meets the condition of "minor impacts". In relation to this matter, the Department has attached its Reasons for Approval for Longwall 19 (see* ***Attachment 2****)*

A Type 3 impact relates to the Rock Bar Model developed by Mine Subsidence Engineering Consultants (MSEC), which defines it as *fracturing in a rockbar or upstream pool resulting in a reduction in standing water level based on current rainfall and surface water flow*.[3]

The Reasons for Approval for Longwall 19, which is located in Area 3A, notes that the IEPMC views (noted above) did not lead to any formal conclusions or recommendations. It states that:

> *The Catchment Panel* [IEPMC] *suggested in 2019 that any such Type 3 impact is not a "minor impact". The Department considers that the performance measure in the development consent applies to the whole affected length of Wongawilli Creek, rather than individually and separately to each single pool, rockbar or riffle zone. It holds this view based on both the intention of the consent (as shown by the content of the Assessment Report) and also the construction of the condition.*

This Panel, which includes three of the five members of the IEPMC, does not concur fully with this view. An overview of the chronology of events associated with specifying performance measures for watercourses in the Southern Coalfield provides insight into why the Panel is of this view.

The first event dates back to the 2001 Commission of Inquiry that assessed the *Dendrobium Coal Project* and gave rise to the Schedule 3 Consent Conditions (see Attachment 1 of this advice)[4]. Condition 2 of Schedule 3 states:

[3] Longwalls 22 and 23 Subsidence Management Plan, Attachment C, MSEC1104, page 36

[4] The Chair of the IAPUM and this Panel was commissioned by the then Department of Urban Affairs and Planning (DUAP – the Department) to undertake an independent assessment of subsidence predictions for the Dendrobium Coal Project and presented to the Commission of Inquiry

The Applicant must[5] ensure that underground mining operations do not cause subsidence impacts at Sandy Creek and Wongawilli Creek other than "minor impacts" (such as minor fracturing, gas release, iron staining and minor impacts on water flows, water levels and water quality) to the satisfaction of the Secretary[6].

Note: In this condition, "minor impacts" are those defined as minor triggers in Table 23.2 of the draft SMP submitted by the Applicant for Dendrobium Area 3A.

Table 23.2 defines 'minor impacts', as well as 'moderate impacts' and 'severe impacts', for *Creeks and Drainage Lines* under the headings of *Water Quality*, *Water Level/Flow* and *Appearance* (see Attachment 2 of this advice). Minor impacts in respect of subsidence-induced changes in pool water level are defined as

Water Level / Flow

Minor

- *Temporary reduction in pool water level in any of the pools being monitored (<20% decline in any pools monitored at similar flows by comparing pre-mining data with post mining data)*

This may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre mining data.

The Panel does not accept that a Type 3 fracture can automatically be assigned an impact rating of 'minor' as defined above. Depending on the degree of reduction in water level, a Type 3 fracture could, for example, constitute a 'severe impact' as defined in Table 23.2, being:

Severe

- *Major reduction in pool water level or complete loss of pool water (>50% decline in any pools monitored)*

Schedule 3 applies to all of Area 3. Table 23.2 constitutes a Trigger Action Response Plan (TARP) developed for specific sites in Area 1, Area 2 and Area 3A. However, the definitions of what constitute minor impacts are applicable to all areas that fall under Schedule 3.

The Department's view is that *'the performance measure in the development consent applies to the whole affected length of Wongawilli Creek.'.* While the Panel concurs, it is evident in Table 23.2 that a greater than minor impact is considered to have occurred if there is more than 20% water level decline in *any* of the pools being monitored rather than a proportion of pools. In other words, an impact that is greater than minor based on this definition cannot be consider minor based on low frequency of occurrence over Wongawilli Creek. It is also apparent from the list of observed sites in Table 23.2 that it has a focus on the more significant stream reaches, pools, waterfalls and other features '*rather than individually and separately to each single pool, rockbar or riffle zone'*.

Subsequent to the 2001 Commission of Inquiry and consistent with the recommendations of the 2008 Strategic Review into the Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield (DoP, 2008), it has become standard practice to use valley closure as the primary criterion for assessing the potential for fracturing of watercourses due to non-conventional subsidence. The IEPMC discussed in some detail (IEPMC, 2019b) the reliance placed on this concept by the Planning

[5] July 2018 modification (MOD 8) in green type

[6] April 2015 modification (MOD 7) in red type

Assessment Commission (PAC) in its assessment of the Metropolitan Coal Project (MCP) in 2009 and the Bulli Seam Operations Project (BSO) in 2010.

The MCP PAC was required to evaluate the merits of a modified mine plan. Based on field monitoring to that point in time, the PAC made an assumption for the purposes of comparing mine plans that a performance measure of 'negligible' environmental consequences for watercourses would be achieved in circumstances where valley closure was predicted to be less than 200 mm. [7] It stated that:

> *"The Panel* [PAC] *is aware from submissions relating to other operations in the Southern Coalfields that occasional "minor" streambed fracturing and iron staining have been recorded where predictions of closure have yielded values of 200mm or less, albeit that fracturing has not affected the integrity of rockbars".*[8]

The IEPMC stated that subsequently, this approach appears to have become the basis for interpretations and/or expectations by some stakeholders that a performance measure of 'minor', and even 'negligible' in some cases, will be satisfied in situations where total valley closure is predicted to be less than 200 mm or where less than a certain percentage of pools lose their water retaining capacity.

The impact assessment process for watercourses adopted in the EA for the BSO was based on the same approach as in the EA for the MCP but with stream impacts now being categorised as one of three types, namely:

- Type 1: nil or negligible impacts
- Type 2: isolated fracturing, gas releases or iron staining
- Type 3: fracturing which has resulted in pool water levels dropping more than expected after considering the rainfall and surface and groundwater flow conditions.

The developers noted that it was possible that Type 3 water loss impacts could in the future be observed at a site where the predicted total closure was less than 200 mm even though none had been observed up to that time. Subsequently, this has proven to be the case, with Figure 5.5 of the Subsidence Predictions and Impact Assessment[9] for LW22 and 23 indicating that approximately 7% of cases where a Type 3 fracture have now been recorded occurred at a predicted valley closure of less than 200 mm, reducing to 2% at a predicted valley closure of 100 mm, and zero to date where valley closure was predicted to be less than 80 mm.

The IEPMC advised that care is required in interpreting and applying these relationships. The Panel reinforces this caution in light of how the relationships continue to be misinterpreted at times. In particular, it is important to recognise that:

- The rockbar impact database has no regard to site specific factors such as the density of rockbars and site-specific geotechnical conditions. Therefore, frequency of recorded fracturing across the Southern Coalfield may not be representative of the likelihood of fracturing on a site-specific basis.
- Conclusions cannot be drawn from the database as to the magnitude and consequences of impacts associated with the cracking of rock bars. For example, the consequences of fracturing a controlling rock bar for a 500 m long pool are likely to be considerably greater than if the rockbar only controls a 5 m long pool.
- The frequency of known cases of Type 3 rock bar fracturing does not provide a basis for inferring the length, or percentage, of a watercourse likely to be impacted by Type 3 fracturing.

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[7] Refer to IEPMC (2019b) for an explanation on why this criterion is based on predicted rather than measured closure
[8] PAC (2009), p. 34
[9] Longwalls 22 and 23 Subsidence Management Plan, Attachment C, MSEC1104, page 37

That likelihood is, amongst other things, a function of the number of rockbars along a watercourse and the lengths of the pools that they are controlling.

The Panel notes that Schedule 3 and its associated Table 23.2 make no provision for being able to meet performance measures by undertaking remediation. However, this provision is now contained in approval conditions associated with SMPs for Area 3. The Southern Coalfield Inquiry concluded that *remediation measures should not currently be relied upon as a forward management strategy for highly-significant features. However, remediation may be a valuable option as a contingency measure, if actual subsidence impacts exceed predictions.*[10]

In the Panel's opinion, this SMP condition dilutes the Schedule 3 conditions. It raises concerns as to whether the intent of the consent conditions not to cause greater than minor impacts in the first instance are still being satisfied.

Regarding the question of whether the approval conditions for Wongawilli Creek may have already been breached, as raised by stakeholder submissions for this and previous longwalls (e.g. WaterNSW submission of 13/10/2021), the Panel maintains the view that this is a valid question. However, in relation to the Schedule 3 and its associated Table 23.2, the Panel has found no strong evidence that the specified 'minor' trigger levels for Wongawilli Creek have been exceeded. Pool 43A is apparently the most impacted of the observed pools, with the reduction of its water levels seen during 2012-2020 recognised in various analyses as being due to mining-induced depressurisation. The observed data water level for Pool 43A are copied below (from the End of Panel Report for LW17 in order to show the most up to date available data). This shows a sustained loss in water levels of approximately 15 cm during 2016-2020 relative to the 2010-2012 baseline period. As a percentage of the maximum depth of the pool (depth to pool bottom), this is approximately 14% loss in water levels. This would be larger if the loss were expressed as a percentage of the average depth of the pool instead of as a percentage of the maximum depth, the former being more relevant for aquatic ecology. However, the average depth of the pool is unknown, and in any case Table 23.2 is not specific about which baseline depth should be used. Since the pool levels have recovered during 2021, it is also questionable whether this loss in pool level should be considered 'temporary', which is part of the Table 23.2 definition of 'minor'.

In context of the recognised loss of baseflows and the existence of a Type 3 fracture, these ambiguities in applying the relevant trigger to Pool 43A illustrate why it is valid to question whether the approval conditions for Wongawilli Creek may have already been breached. Considering that the impacts to Pool 43A water levels are the most studied and measured impacts to Wongawilli Creek, this example also shows the lack of strong, objective evidence that the relevant approval conditions have been breached. During this assessment, and previous SMP assessments, the Panel has considered the available data and has not found any strong and objective evidence of a breach of environmental conditions.

[10] Southern Coalfields Inquiry Report (DoP, 2008), Executive Summary, p.3

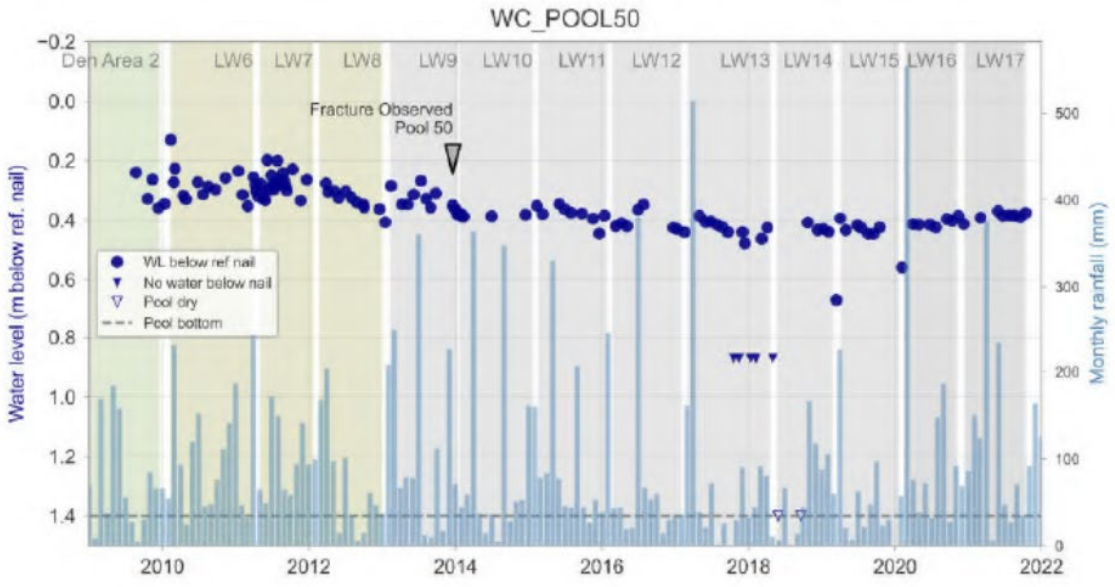

Figure 26. Time series plot of water level observations in Pool 50

Figure 4: Time series of water levels at Pool 43A (now called Pool 50) (Source: End of Panel Report for LW17).

The Panel concludes:

- **A Type 3 Impact as defined in the Rockbar Model cannot automatically be classified as a 'minor impact' as defined in Schedule 3 of the Dendrobium Consent Conditions.**
- **Schedule 3 of the Dendrobium Consent Conditions provides an absolute requirement for subsidence not to result in more than 'minor impacts' to any (nominated) pool in the first instance. It does not provide for satisfying this performance measure by utilising remediation after the performance measure has been exceeded.**
- **Schedule 3 of the Dendrobium Consent Conditions requires that subsidence does not result in more than 'minor impacts' to the water levels *"in any of the pools being monitored"* with no allowance for a proportion of pools being impacted.**
- **Schedule 3 of the Dendrobium Consent Conditions requires that subsidence does not result in more than 'minor impacts' to pool water levels irrespective of whether the mechanism is fracturing or groundwater depressurisation associated with subsidence or a combination of these. The relevance of baseflow losses to the Consent Conditions points to the potential difficulty of relying on remediation for meeting the Conditions, at least until the mine is sealed effectively and groundwater levels recover.**
- **Although there are valid questions about whether the approval conditions for Wongawilli Creek have already been breached, the Panel has not found objective evidence that they have.**

6.2. LW22 AND 23

LW22 and 23 have been set back from Wongawilli Creek by minimum distances of 345 and 320 m, respectively, such that the maximum predicted total closure for all longwall up to the end of LW23 is 190 mm. This distance correlates to an approximate frequency of 6% for rockbar Type 3 fracturing in the Southern Coalfield rockbar model database.

LW22 and 23 have 21 rockbars as well as 22 pools in the mining area. 16 of the rockbars in the LW22/23 mining area have a non-zero frequency of Type 3 fracturing according to the rockbar model. The probability of a Type 3 fracture in at least one of these 16 rockbars is 0.43 (Panel's calculation using the predicted valley closures from the MSEC report and assuming the rockbar model is applied independently to each of the 16 rockbars).

The Panel notes the case for LW22 and 23 is similar to that noted in the Reasons for Approval of LW19 in that for every additional 50 m setback, there may be a steep reduction in extractable coal volume but only a quite small reduction in the probability of Type 3 impacts. This is largely because previously mined or planned longwall panels account for much of the predicted valley closure that drives probability. This is illustrated in Figure 4 in the case of LW22 and 23, which shows that LW20 is the major contributor to predicted valley closure across Wongawilli Creek in the area.

Figure 2 shows that LW20 is proposed to run near parallel and as close as around 150 m to Wongawilli Creek. These characteristics increase both the likelihood that Wongawilli Creek will be negatively impacted by LW20 and the length of Wongawilli Creek exposed to negative impacts. The Panel notes that the SMP for LW20 is yet to be approved.

If LW20 were not to be extracted, the maximum predicted total closure along Wongawilli Creek within the Study based on the 600 m boundary is 80 mm. That being the case, South32 has advised that *"the assessed likelihood of Type 3 impacts due to the extraction of the proposed LW22 and 23 is low, i.e. affecting approximately 2 % of rockbars or stream controlling features located within the Study Area. However, minor fracturing could still occur elsewhere along the creek, at distances up to approximately 400 m from the proposed longwalls."*[11]

It is evident that trade-off analysis of this nature should ideally be part of optimising a mine layout on a total 'Area' basis rather than on an incremental basis for SMPs (or Extraction Plans). Such an analysis would ideally consider the risk (probability and consequence) of flow losses and ecological and visual integrity rather than only Type 3 impact frequency.

In the LW22 & 23 SMP, the Aquatic Flora and Fauna Assessment[12] implies high ecological risk at the scale of individual pools, stating: "*It is probable that one of these rockbars would fracture. Resulting flow diversions could result in the drainage of the upstream pool with associated loss of aquatic habitat. These pools range in length from 15 m to 200 m. The loss of water and aquatic habitat from one of these pools would represent a severe impact at the scale of individual pools, with the probable loss of most aquatic fauna, a reduction in longitudinal connectivity between remaining pools, and a reduction in the population size of aquatic biota*".

[11] South32 response of 1/3/22 to Panel's questions of 28/2/22
[12] Attachment A of the SMP

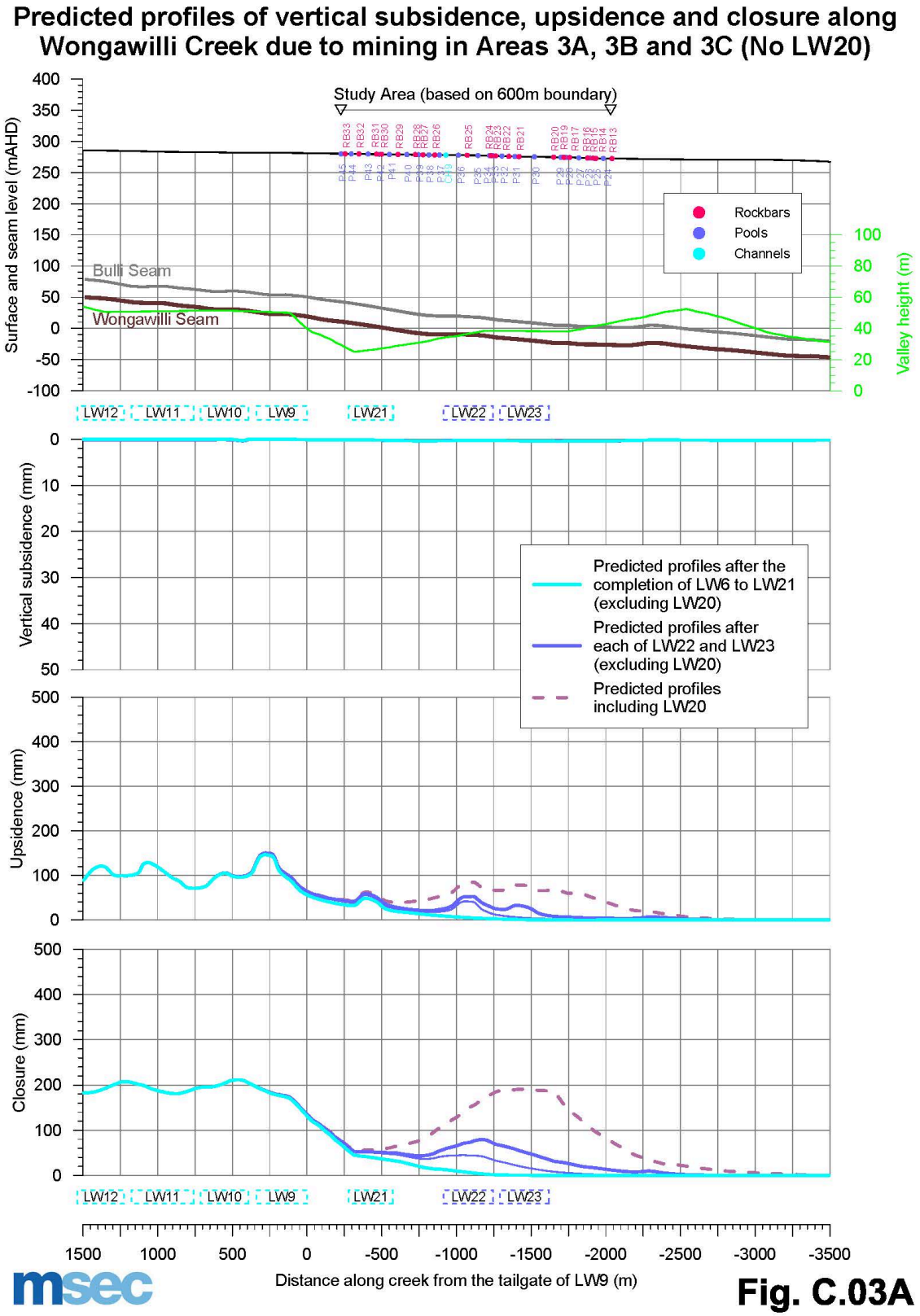

Figure 4: Profile showing the dominant contribution of LW20 to predicted valley closure (Source: South32 response to Panel's questions of 28/2/22).

The corresponding assessment in the LW19 SMP reported a more moderate risk: "*In the unlikely event fracturing resulting in flow diversion occurred at this rockbar, reductions in the availability of aquatic habitat in Wongawilli Creek would be limited due to the presence of several other flow controlling features (shallow riffle sections, channel restrictions and debris dams) further upstream and possibly restricted to the 80 m long pool immediately upstream of the rockbar*".

The Panel cannot advise on the possible degree of consequence related to fracturing and flow diversions and loss at Wongawilli Creek due to LW22 & 23 since it has not visited the site. Nevertheless, from information available regarding number of rockbar-controlled pools, and the size and connectivity of these pools, it appears there may be more to gain by setting back LW22 & 23 further than there was for LW19. If such a trade-off exercise applied only to the probability of Type 3 fracturing, it seems likely to lead to the same outcomes as it did for LW19.

The surface flow loss increments at the WWL flow gauge due to LW22 & 23 are predicted to be at maximum 3% and 2% of the average "dry" year flow[13]. However the number of cease-to-flow days in the middle to lower reach of Wongawilli Creek (adjacent to Areas 3A, 3B and 3C) is predicted to increase from 6% of the time (background rate) to 17% on average (i.e. from 22 days per year to 62 days per year) due to LW22 & 23 plus previous longwalls (including LW20). At the WWL site, further downstream, the corresponding increase is from around 4% to around 30%, with an incremental effect of 14-17% increase attributable to LW22 and a 15-19% increase attributable to LW23. HGEO considers that actual impacts are likely to be less, based on flow observations to date. These predicted increases in cease-to-flow days would increase the probability of greater than minor impacts on pool levels in dry years. This is relevant to the application of the performance measures as discussed below.

The proposed performance measures for minor environmental consequences for Wongawilli Creek relating to flow and water levels are in Table 6.1 of the WIMMCP:

- *structural integrity of the bedrock base of any significant permanent pool or controlling rockbar cannot be restored i.e. pool water level within the pool after CMAs[14] continues to be lower than baseline period*
- *fracturing within Wongawilli Creek resulting in diversion of surface flow such that >10% of the pools have water levels lower than baseline period*
- *measured surface water flow reduction, based on Assessment Methods C and D, to be compared against predictions made in contemporary groundwater modelling conducted (to the satisfaction of the Secretary) to assess whether effects that cannot be explained by natural variability exceed prediction[15]*

The first of these, the structural integrity criterion, relates to any significant permanent pool or rockbar, implying the protection of any monitored pool as required by the Schedule 3 condition, with respect to water loss due to fracturing, if the applicability of CMAs is accepted.

The second, the fracturing criterion, gives protection to the system of pools whether considered significant or not from any fracturing within the creek; however it does not cover baseflow losses. Appendix A of the WIMMCP is unclear about the primary monitoring sites to which these performance measures will be applied.

[13] Surface Water Assessment, Attachment E of the SMP by consultant HGEO.
[14] Corrective Management Actions.
[15] The words "exceed prediction" are not included in Table 6.1 of the WIMMCP but are included in the TARP table in Appendix A of the WIMMCP. Based on this and other documents, the Panel assumes these words apply.

The third, the surface flow reduction criterion, includes the use of Method D "*Assess whether observed dry pools and 'cease-to-flow' conditions along Wongawilli Creek between WWU and WWL gauging stations are anomalies, and indicative of mining-related drawdown along that valley*". The predicted impacts on cease-to-flow days are considered by the Panel to be higher than what could reasonably be considered 'minor' (e.g. 30% increase in cease-to-flow days at WWL). The predicted impacts on cease-to-flow days are also higher than expected based on previous observations of flow according to the Surface Water Assessment and therefore present a liberal target. A more rational definition of what will be considered 'minor' would benefit this performance measure. If the intent of this performance measure in the context of 'minor environmental consequences' is to determine whether observed pool level reductions and cease-to-flow conditions are anomalies associated with mining, then the 5% threshold referred to in the original trial of Method D (as referenced in the Surface Water Assessment) seems reasonable. This performance measure will not replace assessment of pool levels in the LW22 & 23 mining area but, should a pool level be observed to decline or pool cease to flow, it supports the assessment of whether that is a mining impact. As such it requires a complementary pool level or pool flow trigger and it is not clear from the WIMMPC (Table 6.1) or Appendix A what that is. If it is the Level 3 pool level trigger "*Fracturing resulting in diversion of flow such that <10% of the pools have water levels lower than baseline period*" (similar to the second performance measure above) that would be unsatisfactory since it does not cover pool water loss due to baseflow loss.

None of the performance measures explicitly extend to cases such as Pool 43A, where the dominant mining impact is pool level loss due to groundwater depressurisation. Pool water levels are reported and evaluated in End of Panel reports, in particular Pool 43A has received extensive attention as part of the TARP process. However, any loss of water level greater than minor, unless it is associated with a fracture, is not explicitly addressed by the Performance Measures. The Panel notes again that a change in pool level relative to maximum depth of the pool may not be the most appropriate measure of impact. A change relative to average pool depth or to baseline variation could be considered in setting future performance measures.

The Panel concludes:

- **The predictions of valley closure and associated Type 3 impact probability for LW22 & 23 assume the future mining of LW20 on the opposite, western, side of Wongawilli Creek. Analysing the benefit of further setbacks of LW22 & 23 from Wongawilli Creek may benefit from coincident review of the LW20 plan. Based on current knowledge, if LW20 were not to be extracted, the risk of Type 3 fracturing due to LW22 and 23 with their currently proposed setbacks is very low.**
- **If LW20 is extracted, Type 3 fracturing rate predictions for individual pools in the LW22 & 23 mining area are similar to those for LW19, however there is more risk to Wongawilli Creek from mining of LW22 and 23 due to the greater number and connectivity of pools and, quite possibly, the orientation of LW20. This risk includes a significant probability of breach of consent conditions related to pool water levels if impacts cannot be successfully remediated.**
- **The proposed performance measures do not clearly align with the Schedule 3 consent condition in relation to impacts on pool levels.**
- **Clarification is needed in the WIMMCP regarding the primary monitoring sites for the performance measures related to pool water levels.**
- **For the application of Method D to pool water level reductions or increases in cease to flow days, an appropriate threshold for changes in cease-to-flow days has not been specified, nor has the associated trigger for pool water or flow loss.**

7.0 SIGNIFICANCE OF TRIBUTARIES LC5, LC6 & SWAMP 7

Re: *the significance of tributaries LC5 and LC6, as well as Swamp 7, and whether these warrant the inclusion of performance measures*

7.1. GENERAL CONSIDERATIONS

No conditions specific to Area 3C were included in the April 2015 modification (MOD7) and its map of mining area was unchanged. Furthermore, to the Panel's knowledge, no overall SMP for Area 3C has been prepared comparable to that for Area 3B (2013). The Panel notes also that the Scoping Report for the Revised Area 5 Project SSI-33143123 envisages return to mining in Area 3C after 2035 if that project is approved. The Response from BCS (15/10/21) comments that a proposed mining layout and baseline monitoring program for Area 3C was a requirement of the approval for LWs 14-15.

As noted in the IAPUM Advice re Dendrobium LW19 (February 2021), the revised performance indicator for swamp functionality of changes in the '*proportion of Banksia Thicket, Tea-tree Thicket and Sedgeland-Heath Complex does not overcome the problems of time-lag between subsidence impacts to the swamp and consequences to the swamp flora and thus does not provide an adequate early indicator of likely changes in ecosystem functionality*'. That advice reiterated the conclusion of the IEPMC (2019b) that '*piezometric variation must be used not only in TARPs but also in performance measures*'. However, this was not included as a Performance Measure in the Approval of LW19. In its Advice for Dendrobium Longwalls 20 and 21 (December 2019), the IEPMC also had expressed reservations about vegetation change (including in proportions of sub-communities) as an indicator of ecosystem functionality and about the analysis of shallow groundwater impacts in previous mining. The IAPUM also concluded in its October 2020 advice concerning Dendrobium Areas 5 & 6 that

> *34. The impact assessments do not recognize that watercourses constitute systems that can rely on all stream features for their function and ecological integrity. The identification of the select stream features does not assure the full protection of streams from mining impacts. There is doubt about the biodiversity benefits of protecting localised stream features when cease-to-flow conditions in the associated sub-catchments are predicted to occur more than 70% more frequently in some streams under median climatic regimes. The PAC for Bulli Seam Operations concluded that it was not satisfied that stream values were protected by a focus on limiting fracturing only at rockbars but allowing for fracturing elsewhere in the valley floor.*
>
> *36. The principal areas of concern regarding consequences for the ecological integrity of those parts of the Special Areas that are expected to be affected by the DEP are the loss of stream habitat in low order streams, the potential impacts of widespread reduction in near-surface groundwater levels and the direct impacts on upland swamps.*
>
> *39. The risks of permanent loss of swamps due to the combination of mining impacts and severe bushfire need to be further considered in the context of the impacts of the 2019-2020 bushfires observed at other locations.*

These recent advices from the IEPMC and IAPUM represent a consistent view compatible with assessment of 15 years' history of monitoring and environmental assessment at Dendrobium Mine as well as other mines. Understanding of mining-related impacts on swamps today is very different to that at the time that the mine was assessed and approved.

7.2. LC5, LC6 & SWAMP 7

LC5 and LC6 are tributaries of Lake Cordeaux that substantially over-lie the proposed LW22 and 23. It is recognised in the SMP that a large proportion of these watercourses will experience the full range of subsidence impacts and consequences, including fracturing and flow losses and diversions. Some submissions have called for the width of LW22 and 23 to be substantially reduced in order to limit valley closure impacts on the structural integrity of LC5, LC6 and Swamp 7. This approach was considered by the IAPUM in its advice to the Department on the Dendrobium Extension Project, where it concluded that it was very likely the longwall panel width required to achieve this objective was too small to make the operation viable. Submissions have also called for LW22 and 23 to be setback from LC5, LC6 and Swamp 7, thereby causing each of these longwall panels to be broken up into two shorter longwall panels. The Panel considers that this approach is also unlikely to result in a viable longwall operation. It has also been suggested to reorientate the longwall but as reference to Figure 3 shows, the direction of geological structures restricts this option. Hence:

The Panel concludes that it has no reason to suggest dimensions of LW22 & 23 should be reduced for the purpose of managing impacts on LC5, LC6 and Swamp 7.

Data from previously undermined tributaries show median flow losses between 20% and 90% of the pre-mining baseline values[16]. Flow performance measures for LC5 and LC6 are implicit in the Lake Cordeaux performance measures in relation to the approval condition that there should be no more than negligible losses of flow into or water quality of Lake Cordeaux. Sufficient flow and quality measurements are proposed to support this. The Panel has no objections to these performance measures. With respect to whether specific performance measures should be required to protect the rockbars, pools and other features of LC5 and LC6, the Panel refers to the advice that it provided for the Dendrobium Extension Project, that a comprehensive risk assessment and management plan should be developed for lower order tributaries. However:

The Panel concludes that in the context of the approval conditions for Area 3C, and without the benefit of a field visit to survey potentially significant features in these watercourses, the Panel is not aware of any reason for additional performance measures for LC5 and LC6.

Swamp 7 consists of 3.18 ha of Banksia Thicket and 1.69 ha of the hydrophilic sub-community Tea-Tree Thicket (SIMMCP Table 3-3) and significant impacts on this swamp are predicted. As shallow groundwater declines above LW22, it seems likely that Swamp 9 (0.79ha, including 0.29ha Banksia Thicket and 0.50 ha Tea-tree Thicket) will be affected by this, as well as potentially by fracturing (<20mm) as this has been observed at similar distances (335 m) from longwalls (MSEC 2021). The loss of swamp habitat in the LC5 catchment therefore is likely to be 6.23 ha (including 2.19 ha of Tea-tree Thicket), with consequent loss of potential Giant Dragonfly habitat and of surface stream flow to the pools downstream. No-flow periods are predicted to increase from 6% of the time to 21-39% (Attachment A section 4.4.4).

The Panel has been advised that impacts on Swamp 7 have been offset by the Maddens Plains Strategic Biodiversity Offset. Hence:

The Panel concludes that Performance Measures for Swamp 7 are now largely irrelevant.

[16] Figure 11 of Attachment E of the SMP

7.3. MONITORING, ANALYSIS OF PAST DATA AND AVAILABILITY OF BASELINE DATA

The LW22 & 23 Extraction Plan includes a focus on future monitoring in the study area. While South32 is committed to ensuring a baseline period of at least 2 years for monitoring, this is a minimum requirement as climatic variations generally occur over longer periods.

7.3.1. Swamps

Swamp 7 has been monitored since August 2015 as a control swamp for swamps in Area 3B. Of the proposed reference swamps, only Swamp 33 is comparable in location and size and with a similar length of record.

The Aquatic Flora and Fauna Review (Attachment A of the SMP) records that only one gauging site has been established for the streams underlain by the proposed longwalls. This is LC5S1 established in April 2019[17]. One is proposed for LC6 and others for WC24 and WC26 have been approved. Data from similar small catchments such as LA3, LA4 are only from similarly short periods (2019-2020)[18].

The Aquatic Flora and Fauna Review consisted of a desktop review and an assessment of potential impacts. Existing information from previous studies in Area 3C focussed on the larger Wongawilli and Donalds Castle Creeks. The area above the proposed longwalls does not include Key Fish Habitat and is considered to *'generally support limited aquatic ecology'*[19]. However, there is no report of planned monitoring of macroinvertebrates, galaxiids or crayfish along the streams above the longwalls.

Analysis of impacts on swamps from previous mining is restricted to repetition of material from the 2010 Bulli Seam Operation EIS[20], a reference to Watersed HydroGeo's 2019 finding that piezometric changes were restricted to within 60 m of longwalls,[21] and a comment that there could be floristic changes in response to changed groundwater conditions[22]. Given the long record of vegetation within the upland swamps and the agreement that performance measures should be related to the areas of sub-communities within the swamps, it is surprising that there has been no attempt to provide an updated assessment of the vegetation changes that could indicate changes in ecosystem functionality.

In short, there are few and incomplete data available to assess properly the ecological impacts on swamp vegetation that may result from the proposed mining.

The Panel has no suggestions for revisions of the TARPs or Performance Measures for swamps, as the TARPs include changes to shallow groundwater levels[23]. It would be useful to include in the SIMMCP the method of analysis of impacts on swamp hydrology developed in response to IEPMC recommendations, as mentioned in Table 2-5 of the SIMMCP.

7.3.2. Littlejohn's Tree Frog

The *BCS Response - updated Area 3C SMP & RTS* notes that pools above proposed LWs 22 and 23 are 'potentially one of the most significant sites in NSW' for populations of Littlejohn's tree frog and that declines in this species have been identified in previous sites due to drying or lower pool levels in

[17] Aquatic Flora and Fauna Review, Attachment A of SMP, Table 6.
[18] Aquatic Flora and Fauna Review, Attachment A of SMP, Table 7.
[19] Aquatic Flora and Fauna Review, Attachment A of SMP, Section 4.2.3.1.
[20] SIMMCP, Section 4.6.
[21] Attachment F of SMP, Section 3.8.
[22] Attachment F of SMP, Section 6.1.
[23] SIMMCP, Table 1-2.

SC10C, WC21, DC(1) and DC13. Niche (Attachment F, Terrestrial Ecology)[24] suggests mining impacts also in WC17. While potential impacts to the species are often listed as associated with upland swamps, the frog's breeding grounds are either pools within swamps or pools in creeks. Pools along LC6 above LW22 in particular, but also LC5 downstream of Swamp 9, that are shown as recording Littlejohn's tree frog[25] are likely to experience significant cracking and loss of flow due to subsidence impacts. Niche also records individuals *'across multiple pools in LC5 and LC6'* as well as in Swamp 07 and downstream of Swamp 09[26]. The Terrestrial Ecology Report also notes that these populations are at high risk due to fracturing, flow diversion and iron mobilisation.

The Panel recognises that South32 can rely on the Maddens Plains Strategic Biodiversity Offset (2016) for all impacts to upland swamps within Area 3C. As detailed in the SBO, this 598 ha site satisfies Conditions 6 and 7 of the SMP Approval for Dendrobium Area 3B (6 February 2013) including Swamps 2,6,7 and 9 in Area 3C, and '*all the swamp biodiversity offsetting requirements for Dendrobium Mine as currently [in 2016] approved by DA 60-03-2001'*. The offsetting arrangements related to the vegetation communities of the upland swamps, although other 'environmental attributes' (such as 1st and 2nd order streams) and threatened species including the Littlejohn's tree frog were listed as well.

However, on the basis of the recorded occurrences within the study area, the Panel suggests that the Littlejohn's tree frog and potentially also the red-crowned toadlet should be considered not as species dependent on upland swamps but as species dependent on the pools within streams, within the aquatic ecosystem. This raises the question of Clause 17b of Schedule 4 of the 2008 Approval that requires the company to *'mitigate and/or offset any adverse impacts on groundwater dependent ecosystems, aquatic ecosystems or riparian vegetation'*. The Panel considers that mitigation by grouting to restore pool levels is problematic, in that remediation works may cause unacceptable environmental consequences.

The Panel suggests that a full assessment of the impacts and success of previous grouting in re-establishing pool ecosystem health (e.g. on WC21) for aquatic ecosystems and of the practicality of this mitigation measure above LWs 22 and 23 be undertaken. If this strategy is not achievable, then the possibility of offsets being required for frog species and potentially other aspects of stream ecology should be considered by the Department.

The Panel concludes that:

- **on the basis of the recorded occurrences within the study area, the Littlejohn's tree frog and potentially also the red-crowned toadlet should arguably be considered not as species dependent on upland swamps but as species dependent on the pools within streams, within the aquatic ecosystem; and**
- **should the Littlejohn's tree frog and/or the red-crowned toadlet be classified as species dependent on the pools within streams, the proponent needs to show how they would meet Clause 17b of Schedule 4 of the 2008 Approval that requires the Consent Holder to *'mitigate and/or offset any adverse impacts on groundwater dependent ecosystems, aquatic ecosystems or riparian vegetation'*.**

[24] Attachment F, Terrestrial Ecology, Table 14.
[25] Attachment F, Terrestrial Ecology, Figure 5.
[26] Attachment F, Terrestrial Ecology, Table 11 & 12.

8.0 330 KV TRANSMISSION LINE

Re: *the potential impacts to the transmission line (sic) TWR17-21 and whether a performance measure of safe and serviceable is recommended*

There is considerable experience in NSW of successfully managing subsidence impacts on high voltage transmission lines. Tension towers generally present the greatest challenge since they are already eccentrically loaded due to acting as an anchor for a change in powerline direction. As such, their stability is much more sensitive to subsidence parameters, particularly tilt.

Each tension tower needs to be assessed on its own merits. A range of engineering controls are available, with their application usually being determined by cost-benefit considerations. In some circumstances, a change in mine plan may prove to be the optimum management tool.

Based on the information provided to the Panel, the development of engineering controls is a work in progress. The Subsidence Predictions and Impact Assessments Report (June 2021) only deals with the issue generally, stating:

> *..Tower TWR17-21 is a tension tower and, therefore, consideration should be given to the appropriate management strategies for this tower.*
>
> *With the implementation of the appropriate monitoring and management strategies, it is expected that the 330 kV transmission line could be maintained in safe and serviceable condition throughout the mining period, similar to that during the extraction of completed longwalls in Area 3A.*

This statement does not confirm that this includes managing impacts on tension towers in Area 3A.

The Risk Assessment (June 2021) records that:

> *South32 will not cause subsidence impacts to the Avon to Macarthur 330 kV Transmission Line, including tower TWR17-21 prior to with (sic) agreement of TransGrid and implementing the required mitigation strategies required to safely mine beneath the asset. South32 is currently consulting with TransGrid regarding a transmission tower that may be impacted by Longwall 19 in Area 3A.*

Subsequently (August, 2021)), the Resources Regulator, which includes the Subsidence Engineering Section, submitted to DPIE that:

> *The Tower TWR17-21 is an angled transmission tower. Due to their structural characteristics and the associated vulnerability to any subsidence, secondary extraction has been kept away from these types of towers, by leaving adequate coal barriers to provide protection.*

Given the critical role of high tension transmissions in general and the elevated risks associated with impacting tension tower TWR17-21, the Panel advises that:

A Performance Measure of Safe and Serviceable should be applied to that section of the 330 kV transmission line that could be impacted by LW22 & 23.

Extraction of LW22 & 23 should not be permitted to impact the 330 kV transmission line:

- **without the agreement of the asset owner (TransGrid),**
- **without independent verification that the required mitigation strategies have been developed and implemented, and**
- **without the development of a TARP to monitor the effectiveness of the mitigation strategies and to respond in a timely and effective manner to any adverse deviation from predicted behaviour.**

9.0 OTHER ADVICE

9.1. RISK ASSESSMENT

When preparing the SMP for LW20 & 21, South32 responded to a recommendation in the IEPMC Panel's Part 1 Report (IEPMC, 2019a) that all future applications to extract coal within Special Areas should be supported by independently facilitated and robust risk assessments that conform to ISO 31000. The SMP was review by the IEPMC which, in concluding that it added value to the SMP process, identified a number of opportunities for improvement. The risk assessment for LW22 & 23[27] mirrors that submitted for LW20 & 21 and so some of the basic opportunities to improve the robustness of the risk assessment remain. In particular:

- The risk assessment would benefit from an introduction that includes plans of the mining layouts and associated features that are being risk assessed and a description of the mining proposal, such that, the document can stand alone for those not familiar with the project.
- Although the risk assessment team included appropriately qualified team members, it did not include any external members. Effectively, the team have risk assessed their own work. The inclusion of external expertise on a risk assessment panel can assist in avoiding the common faults in risk assessment discussed in MDG-1010 (2011) and MDG-1014 (1997), being two NSW regulatory guidelines concerned with undertaking and reviewing risk assessments and which are listed as reference documents in the risk assessment.[28]

There is a basic flaw in the presentation of the risk assessment outcomes. Risk rankings have been determined for hazards based on a combined score of the consequence of the hazard materialising and the likelihood that it will materialise. Because there are different types of risk (e.g. workplace health and safety, financial, political, reputational), a range of scores can apply to a given hazard. The LW22 & 23 risk assessment only documents the 'worst case' (highest scoring) risk for each hazard (combined score = consequence rating x likelihood rating). It is reported that this approach was adopted *'to reduce the complexity and volume of reporting.* This is an unusual practice and has implications for the robustness of the risk assessment in that the full range of risk rankings is not presented for the record, for third party review and to inform the presentation of risks based only on their consequence rating, consistent with robust risk assessment practice (reference, for example, MDG-1014 (1997)).

Ranking risk in terms of consequence, as well as in terms of consequence x likelihood, is a due diligence practice to identify hazards that may need to be avoided irrespective of the perceived (un)likelihood of them materialising. It is also a control for managing over-optimistic estimates of likelihood ratings that have the effect of underestimating risk. This aspect is flawed in the LW22 &23 risk assessment because the consequence ranking is based only on those hazards with worst case risk scores. Hence, it only reorders these same risks in terms of their consequence score. Risks that may have a higher consequence rating but a lower combined risk score (less than worst case) are not identified.

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[27] Longwalls 22 and 23 Subsidence Management Plan, Attachment D, Risk Assessment Report, AXYS Consulting Rort No AR3122, 29 June 2012.

[28] The Panel acknowledges that the Risk Assessment records that Professor Bruce Hebblewhite was not an attendee at the risk assessment but reviewed the risk assessment report and provided feedback on it. The Panel is supportive of this initiative but notes that it only goes part way to addressing the composition of a risk assessment team and to constituting a peer review of the risk assessment process (as opposed to content).

The risk assessment for LW22 and 23 is based on a WRAC (Workplace Risk Assessment and Control) form of analysis. The risk assessment report notes that this system of risk analysis is very powerful for identifying potential hazard situations and is considered to provide for easier reading for non-technical persons. The Panel does not dispute this. However, it supports the view of the IEPMC when it reviewed the risk assessment for LW20 & 21 that, given the critical nature of the risks and the time span over which they must be managed, a more detailed form of risk assessment based on fault tree and event tree analysis is warranted.[29] This type of risk assessment underpinned the decision some 10 years ago to permit longwall mining beneath the Upper Canal and Simpsons Creek Aqueduct (which gravity feed water to Sydney from the Reservoirs in the Southern Coalfield) and informed the various management plans. It has the scope to assess the likelihood and consequences of other important factors, such as human error, which are difficult to account for in a WRAC and it provides a much more powerful way of identifying controls to prevent a hazard from materialising, contingencies for limiting and managing consequences should a hazard still materialise and the residual risks.

The Panel considers that the need for a much more robust form of risk assessment is reflected in the outcomes. The WRAC documents existing controls but provides minimal insight into the nature and magnitude of residual risk and, therefore, into contingencies for managing this risk. The range of treatment options is quite limited and repetitive and includes actions concerned with 'continuing to review' and 'continuing to consider'. These types of actions are not associated with any initiatives to manage residual risk and to reduce or eliminate its consequences.

It is difficult to relate some treatment options to the risk that they are apparently intended to manage (treat). For example, *'Continue to periodically review and calibrate the groundwater model against monitoring results, including peer review at appropriate intervals'* is listed as the Treatment Option for the hazard *'unnamed faults and dykes result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy and associated minimal harm criteria) on (sic) groundwater quantity'.* The timing and frequency of the review are not defined and the treatments do not lead to any actions that could prevent the risk from materialising and to manage it if it does arise.

The most comprehensive treatment option relates to encountering an unmapped geological structure. The steps involved in that treatment lead to the action *'if the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure'.* This is an example of a risk that, given the physical environment associated with LW22 and 23, warrants assessment based on fault tree and event tree analysis.

The Panel concludes that:

The risk assessment for LW22 and 23 falls well short of what could be considered a robust risk assessment and does not effectively address the identification and management of residual risk.

[29] This is only to be expected as three members of the current Panel (Galvin, McIntyre and Young) were also members of the IEPMC.

10.0 CONCLUSIONS

The Panel concludes that:

1. The long-term groundwater conditions may still not be adequately represented by the modelling outputs.
2. On the basis of current knowledge and information, a minimum set back distance from Cordeaux Reservoir of 300 m is reasonable.
3. A Type 3 Impact as defined in the Rockbar Model cannot automatically be classified as a 'minor impact' as defined in Schedule 3 of the Dendrobium Consent Conditions.
4. Schedule 3 of the Dendrobium Consent Conditions provides an absolute requirement for subsidence not to result in more than 'minor impacts' to any (nominated) pool in the first instance. It does not provide for satisfying this performance measure by utilising remediation after the performance measure has been exceeded.
5. Schedule 3 of the Dendrobium Consent Conditions requires that subsidence does not result in more than 'minor impacts' to the water levels "*in any of the pools being monitored"* with no allowance for a proportion of pools being impacted.
6. Schedule 3 of the Dendrobium Consent Conditions requires that subsidence does not result in more than 'minor impacts' to pool water levels irrespective of whether the mechanism is fracturing or groundwater depressurisation associated with subsidence or a combination of these. The relevance of baseflow losses to the Consent Conditions points to the difficulty of relying on remediation for meeting the Conditions, at least until the mine is sealed effectively and groundwater levels recover.
7. Although there are valid questions about whether the approval conditions for Wongawilli Creek have already been breached, the Panel has not found objective evidence that they have.
8. The predictions of valley closure and associated Type 3 impact probability for LW22 & 23 assume the future mining of LW20 on the opposite, western, side of Wongawilli Creek. Analysing the benefit of further setbacks of LW22 & 23 from Wongawilli Creek may benefit from coincident review of the LW20 plan. Based on current knowledge, if LW20 were not to be extracted, the risk of Type 3 fracturing due to LW22 and 23 with their currently proposed setbacks is very low.
9. If LW20 is extracted, Type 3 fracturing rate predictions for individual pools in the LW22 & 23 mining area are similar to those for LW19, however there is more risk to Wongawilli Creek from mining of LW22 and 23 due to the greater number and connectivity of pools and, quite possibly, the orientation of LW20. This risk includes a significant probability of breach of consent conditions related to pool water levels if impacts cannot be successfully remediated.
10. The proposed performance measures do not clearly align with the Schedule 3 consent condition in relation to impacts on pool levels.
11. The Panel has no reason for suggesting that the dimensions of LW22 & 23 should be reduced for the purpose of managing risks to LC5, LC6 and Swamp 7.
12. In the context of the approval conditions for Area 3C, and without the benefit of a field visit to survey potentially significant features in these watercourses, the Panel is not aware of any reason for additional performance measures for LC5 and LC6.

13. As impacts on Swamp 7 have been offset by the Maddens Plain Maddens Plains Strategic Biodiversity Offset, Performance Measures for Swamp 7 *per se* are now largely irrelevant.

14. However, on the basis of the recorded occurrences within the study area, the Littlejohn's tree frog and potentially also the red-crowned toadlet should arguably be considered not as species dependent on upland swamps but as species dependent on the pools within streams, within the aquatic ecosystem.

15. Should the Littlejohn's tree frog and/or the red-crowned toadlet be classified as species dependent on the pools within streams, the proponent needs to show how they would meet Clause 17b of Schedule 4 of the 2008 Approval that requires the Consent Holder to *'mitigate and/or offset any adverse impacts on groundwater dependent ecosystems, aquatic ecosystems or riparian vegetation'*.

16. The risk assessment for LW22 and 23 falls well short of what could be considered a robust risk assessment and does not effectively address the identification and management of residual risk.

11.0 RECOMMENDATIONS

The Panel recommends that:

1. Any approval of the SMP for LW22 and 23 should be conditioned on mining not commencing until predictions of seepage from Avon Reservoir due to mining in Area 3B have been validated to the satisfaction of the Department Secretary and found not to provide a basis for increasing the setback distance of 300 m;
2. The WIMMCP should clarify the primary monitoring sites for the performance measures related to pool water levels;
3. For the application of Method D to pool water level reductions or increases in cease to flow days, an appropriate threshold for changes in cease-to-flow days should be specified as well as associated trigger levels for pool water or flow loss.
4. The method of analysis of impacts on swamp hydrology developed in response to IEPMC recommendations, should be included in the SIMMCP.
5. A Performance Measure of Safe and Serviceable should be applied to that section of the 330 kV transmission line that could be impacted by LW22 & 23.
6. Extraction of LW22 & 23 should not be permitted to impact the 330 kV transmission line:
    i. without the agreement of the asset owner (TransGrid),
    ii. without independent verification that the required mitigation strategies have been developed and implemented, and
    iii. without the development of a TARP to monitor the effectiveness of the mitigation strategies and to respond in a timely and effective manner to any adverse deviation from predicted behaviour.
7. Prior to consideration of any further application to mine in the area covered by the current Consent, the Consent Conditions should be harmonised to provide a less ambiguous suite of conditions.

REFERENCES

CFR. (2007). Dendrobium Colliery Area 3A - Longwalls 6 to 10. Part B - Subsidence Management Plan for Areas 1, 2 and 3A. Cardo Forbes Rigby Pty Ltd Report 003 Part B Rev 0. November 2007. Report 003 Part B Rev 0.

DoP. (2008). Hebblewhite, B.K., Galvin, J.M., Mackie, C.D., West, R. & Collins, D. Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield - Strategic Review. ISBN 978 0 7347 5901 6. Sydney: NSW Government, Department of Planning.

DOP. (2009). The Metropolitan Coal Project Review Report. Planning Assessment Commission. ISBN 978-0-9806592-0-7. May 2009

DOP. (2010). Bulli Seam Operations - Planning Assessment Commission Report. ISBN 978-0-9806592-6-9. July 2010.

IEPMC. (2019a). Galvin, J.M., McIntyre, N., Young, A., Williams, R.M., Armstrong, C. & Canbulat, I. Independent Expert Panel for Mining in the Catchment Report: Part 1. Review of Specific Mining Activities at the Metropolitan and Dendrobium Coal Mines. NSW Office of NSW Chief Scientist and Engineer.

IEPMC. (2019b). Galvin, J.M., McIntyre, N., Young, A., Williams, R.M., Armstrong, C. & Canbulat, I. Independent Expert Panel for Mining in the Catchment Report: Part 2. Coal Mining Impacts in the Special Areas of the Greater Sydney Water Catchment. NSW Office of NSW Chief Scientist and Engineer

MDG-1010. (2011). *Minerals Industry Safety and Health Risk Management Guideline*. Sydney: NSW State Government.

MDG-1014. (1997). *Guide to Reviewing a Risk Assessment of Mine Equipment and Operations*. Sydney: NSW State Government.

ATTACHMENT 1

Schedule 3

Specific Environmental Conditions – Mining Area – MOD 8 – 2018

SCHEDULE 3
SPECIFIC ENVIRONMENTAL CONDITIONS – MINING AREA

SUBSIDENCE

Note: These conditions should be read in conjunction with the Statement of Commitments.

Watercourse Impact Management

1. The Applicant must ensure that, as a result of the development:
   (a) no rock fall occurs at Sandy Creek Waterfall or from its overhang;
   (b) the structural integrity of the waterfall, its overhang and its pool are not impacted;
   (c) cracking in Sandy Creek within 30 m of the waterfall is of negligible environmental and hydrological consequence; and
   (d) negligible diversion of water occurs from the lip of the waterfall
   to the satisfaction of the Secretary.

2. The Applicant must ensure that underground mining operations do not cause subsidence impacts at Sandy Creek and Wongawilli Creek other than "minor impacts" (such as minor fracturing, gas release, iron staining and minor impacts on water flows, water levels and water quality) to the satisfaction of the Secretary.

   Note: In this condition, "minor impacts" are those defined as minor triggers in Table 23.2 of the draft SMP submitted by the Applicant for Dendrobium Area 3A.

3. The Applicant must ensure the development does not result in reduction (other than negligible reduction) in the quality or quantity of surface water or groundwater inflows to Lake Cordeaux or Lake Avon or surface water inflow to the Cordeaux River at its confluence with Wongawilli Creek, to the satisfaction of the Secretary.

4. Prior to carrying out any underground mining operations that could cause subsidence in either Area 3A, Area 3B or Area 3C, the Applicant must prepare a Watercourse Impact Monitoring, Management and Contingency Plan to the satisfaction of the Secretary. Each such Plan must:
   (a) demonstrate how the subsidence impact limits in conditions 1 - 3 are to be met;
   (b) include a monitoring program and reporting mechanisms to enable close and ongoing review by the Department and DRG of the subsidence effects and impacts (individual and cumulative) on Wongawilli Creek, Sandy Creek and Sandy Creek Waterfall;
   (c) include a general monitoring and reporting program addressing surface water levels, water flows, water quality, surface slope and gradient, erodibility, aquatic flora and fauna (including Macquarie Perch, any other threatened aquatic species and their habitats) and ecosystem function;
   (d) include a management plan for avoiding, minimising, mitigating and remediating impacts on watercourses, which includes a tabular contingency plan (based on the Trigger Action Response Plan structure) focusing on measures for remediating both predicted and unpredicted impacts;
   (e) address third and higher order streams individually but address first and second order streams collectively;
   (f) be prepared in consultation with OEH, WaterNSW and DRG;
   (g) incorporate means of updating the plan based on experience gained as mining progresses;
   (h) be approved prior to the carrying out of any underground mining operations that could cause subsidence impacts on watercourses in the relevant Area; and
   (i) be implemented to the satisfaction of the Secretary.

   Notes:
   - *Should review by the Department of reports by the Applicant under paragraph (b) indicate that subsidence impacts have exceeded or threaten to limits imposed in conditions 1-3, then under condition 4 of Schedule 2 the Secretary may instruct the Applicant to implement reasonable and feasible requirements, which may include to cease mining within the operative longwall, shorten the length of that longwall or shorten the length and/or width of future longwalls.*
   - *Requirements under paragraphs (a) and (b) in respect of Sandy Creek and Sandy Creek Waterfall relate only to the Watercourse Impact Monitoring, Management and Contingency Plan for Area 3A.*

Swamp Impact Management

5. The Applicant must ensure that subsidence does not cause erosion of the surface or changes in ecosystem functionality of Swamp 15a and that the structural integrity of its controlling rockbar is maintained or restored, to the satisfaction of the Secretary.

6. Prior to carrying out any underground mining operations that could cause subsidence in either Area 3A, Area 3B or Area 3C, the Applicant must prepare a Swamp Impact Monitoring, Management and Contingency Plan to the satisfaction of the Secretary. Each such Plan must:
   (a) demonstrate how the subsidence impact limits in condition 5 are to be met;
   (b) include a monitoring program and reporting mechanisms to enable close and ongoing review by the Department and DRG of the subsidence effects and impacts (individual and cumulative) of each Area 3A longwall on Swamp 15a;
   (c) include a general monitoring and reporting program addressing surface water levels, near-surface groundwater levels, water quality, surface slope and gradient, erodibility, flora and ecosystem function;
   (d) include a management plan for avoiding, minimising, mitigating and remediating impacts on swamps, which includes a tabular contingency plan (based on the Trigger Action Response Plan structure) focusing on measures for remediating both predicted and unpredicted impacts;
   (e) address headwater and valley infill swamps separately and address each swamp individually;
   (f) be prepared in consultation with OEH, WaterNSW and DRG;
   (g) incorporate means of updating the plan based on experience gained as mining progresses;
   (h) be approved prior to the carrying out of any underground mining operations that could cause subsidence impacts on swamps in the relevant Area; and
   (i) be implemented to the satisfaction of the Secretary.

   Notes:
   - *Should review by the Department of reports by the Applicant under paragraph (b) indicate that subsidence impacts have exceeded or threaten to exceed limits imposed in condition 5, then under condition 4 of Schedule 2 the Secretary may instruct the Applicant to implement reasonable and feasible requirements, which may include to cease mining within the operative longwall, shorten the length of that longwall or shorten the length and/or width of future longwalls.*
   - *Requirements under paragraphs (a) and (b) relate only to the Swamp Impact Monitoring, Management and Contingency Plan for Area 3A.*

Subsidence Management Plans

7. Prior to carrying out any underground mining operations that could cause subsidence in either Area 3A, 3B or 3C, the Applicant must prepare a Subsidence Management Plan (SMP) to the satisfaction of the Secretary and the DRG. Each such SMP must:
   (a) integrate ongoing management of Areas 1 and 2;
   (b) integrate the Watercourse and Swamp Impact Monitoring, Management and Contingency Plans required under conditions 4 and 6;
   (c) include monitoring of subsidence effects;
   (d) include a WaterNSW Assets Protection Plan;
   (e) include monitoring, management, and contingency plans for all other significant natural features and all significant man made features which may be impacted by subsidence, including:
      - landscape (including cliffs and steep slopes);
      - groundwater (see condition 13);
      - terrestrial flora and fauna and ecology (including all threatened species assessed as being likely to be significantly affected by the development and their habitats);
      - Aboriginal and other cultural heritage (see condition 12); and
      - electrical, communications and other infrastructure;
   (f) be prepared in consultation with OEH, WaterNSW and DRG;
   (g) be approved prior to the carrying out of any underground mining operations that could cause subsidence in the relevant Area; and
   (h) be implemented to the satisfaction of the Secretary and the DRG.

   Notes:
   - *The WaterNSW Assets Protection Plan required under this condition must also be prepared and implemented to the satisfaction of the WaterNSW.*
   - *The contingency plans required under paragraph (e) must address remediation (as appropriate) and be based on a TARP structure.*

8. The SMPs prepared under condition 7 for Areas 3B and 3C must:
   (a) include a mine plan for the relevant Area;
   (b) include a detailed subsidence impact assessment, clearly setting out all predicted subsidence effects, subsidence impacts and environmental consequences;
   (c) include a minimum of 2 years of baseline data, collected at appropriate frequency and scale, for all significant natural features;
   (d) identify and assess the significance of all natural features located within 600 m of the edge of secondary extraction;
   (e) distinguish between, clearly describe and adequately quantify all subsidence effects, subsidence impacts and environmental consequences;
   (f) propose limits on subsidence impacts and environmental consequences to be applied within the relevant Area;
   (g) be otherwise prepared in accordance with any guidelines for SMPs developed by the Department and/or DRG;
   (h) be approved prior to the carrying out of any underground mining operations that could cause subsidence in the relevant Area; and
   (i) be implemented to the satisfaction of the Secretary and the DRG.

   Note: In approving an SMP, the Secretary may impose conditions containing subsidence impact limits (similar to conditions 1- 3 & 5), subsidence management mechanisms (similar to conditions 4 & 6) or other conditions.

End of Panel Reporting

9. Within 4 months of the completion of each longwall panel, or as otherwise permitted by the Secretary, the Applicant must:
   (a) prepare an end-of-panel report:
      - reporting all subsidence effects (both individual and cumulative) for the panel and comparing subsidence effects with predictions;
      - describing in detail all subsidence impacts (both individual and cumulative) for the panel;
      - discussing the environmental consequences for watercourses, swamps, water yield, water quality, aquatic ecology, terrestrial ecology, groundwater, cliffs and steep slopes; and
      - comparing subsidence impacts and environmental consequences with predictions; and
   (b) submit the report to the Department, DRG, WaterNSW, OEH, DoI and any other relevant agency

   to the satisfaction of the Secretary.

10. The Applicant must include a comprehensive summary, analysis and discussion of the results of monitoring of subsidence effects, subsidence impacts and environmental consequences in each Annual Review.

    Note: Conditions 9 and 10 apply to Area 2, as well as to Areas 3A, 3B and 3C.

Subsidence Expert Assessments

11. The Applicant must pay the reasonable costs of the Department in engaging independent experts to advise it when it assesses SMPs prepared under condition 7 for Areas 3B and 3C.

ABORIGINAL HERITAGE

12. The SMPs prepared under condition 7 must include an Aboriginal Heritage Plan, which must include a:
   (a) description of known Aboriginal heritage sites;
   (b) protocol for the ongoing consultation and involvement of the Aboriginal community in the conservation and management of Aboriginal heritage;
   (c) description of the measures that would be implemented to protect Aboriginal sites generally, including measures that would be implemented to secure, analyse and record sites at risk of subsidence;
   (d) description of the measures that would be implemented to protect Aboriginal site 52-2-1646, including:
      - a full recording and assessment of the site's rock art;
      - a more detailed subsidence assessment for the site;
      - measures which seek to avoid any significant impact on the site and any necessary contingency plans to protect the site against collapse or substantial impact on its rock art; and

(e) description of the measures that would be implemented if any new Aboriginal objects or skeletal remains are discovered during the development.

GROUNDWATER MONITORING PROGRAM

13. The SMPs prepared under condition 7 must include a Groundwater Monitoring Program, which must include:
    (a) proposals to develop a detailed regional and local groundwater model, with special reference to flows to and from nearby water storages;
    (b) detailed baseline data to benchmark the natural variation in groundwater levels, yield and quality;
    (c) groundwater impact assessment criteria;
    (d) a program to monitor the impact of the development on:
        - groundwater levels, yield and quality (particularly any potential loss of flow to, or flow from, WaterNSW water storages);
        - coal seam aquifers and overlying aquifers; and
        - groundwater springs and seeps; and
    (e) consideration of the requirements of the latest version (or subsequent replacement) of WaterNSW's *The Design of a Hydrological and Hydrogeological Monitoring Program to Access the Impacts of Longwall Mining in SCA Catchment*.

ENVIRONMENTAL OFFSETS

14. The Applicant must provide suitable offsets for loss of water quality or loss of water flows to WaterNSW storages, clearing and other ground disturbance (including cliff falls) caused by its mining operations and/or surface activities within the mining area, unless otherwise addressed by the conditions of this consent, to the satisfaction of the Secretary. These offsets must:
    (a) be submitted to the Secretary for approval by 30 April 2009;
    (b) be prepared in consultation with WaterNSW;
    (c) provide measures that result in a beneficial effect on water quality, water quantity, aquatic ecosystems and/or ecological integrity of WaterNSW's special areas or water catchments.

ATTACHMENT 2

Table 23.2 of the Draft SMP submitted for Dendrobium Area 3A and Embedded in Schedule 3 – 2008, Mod 7 (2015) and MOD 8 (2018)

Table 23.2 – Potential Impacts, Key Monitoring, Triggers, Response & Responsibilities

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
CREEKS AND DRAINAGE LINES								
Water Quality	**Area 1 Sites (6 total):** • GS1 (Goondarrin Ck) • KS1 (Kembla Ck Pool 3) • KS2 (trib. of Kembla Ck, Un-named Ck) • KS3 (Kembla Ck Pool 4) • KS4 (Kembla Ck Pool 6) • KS5 (Kembla Ck Pool 25) **Area 2 Sites (9 total):** • MC (Middle Gully or Ck 13) • GFC (Green Fields Ck Waterfall Pool) • WC (Waratah Ck) • FTC (Fern Tree Ck • SC (Sandy Ck D/S) • P3 (Sandy Ck U/S trib. Pool 3) • LGU (Locked Gate Ck or Creek 10 U/S) • LGD (Locked Gate Ck or Creek 10 D/S) • C12 (Creek 12) **Area 3A (11 total):** • WWU1 (headwaters of Wongawilli Ck) • WWU4 (U/S Wongawilli Ck) • WWM1 (mid Wongawilli Ck adjacent to LW 10) • WWM2 (mid Wongawilli Ck adjacent to LW 8) • WWM3 (mid Wongawilli Ck D/S of LW 6) • WWL2 (D/S Wongawilli Ck) • SCU1 (U/S Sandy Ck) • SCL (D/S Sandy Ck adjacent to LW 7) • BC1 (Sandy Ck trib. SC10 over LW 8) • BCC1 (Sandy Ck trib. SC10C over LW 8) • CC1 (Sandy Ck trib. SC7 adjacent to LW10) Refer to Area 3A SMP **Figures 18.1, 18.2, and 18.4** for location of these sites.	Automatic Data Logging (Areas 1 and 2 only): • Temperature • Dissolved oxygen • Conductivity • pH • Turbidity Manual Field Testing: • Field pH • EC • DO • ORP* • Lab. analytes (incl. lab check of pH, lab. check of EC, Na, K, Ca, Mg, Filt. SO_4, Cl, T. Alk., Total Fe, Mn, Al, Filt. Cu, Ni, Zn, TKN, NH_3-N, NO_x-N, TP)	• Monthly Baseline monitoring 1 year prior to mining. • 5 minute logging intervals for automatic data loggers. (Areas 1 and 2 only) • Monthly manual monitoring during and post mining. • Monthly manual monitoring post mining for two years or until required.	• To provide pre-mining baseline water quality for comparison with post-mining. • To identify any water quality impact from mining. • To identify water quality impacts related to physical or chemical changes to the creeks and/or drainage lines during mining.	***Minor*** • Temporary moderate reduction in water quality (observed for less than 2 months) at any site when comparing baseline period to mining period, ie: – pH drop of 1.5 – 2 units – EC increase of 50-100 uS/cm – ORP* drop 150 -200 mV These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.	• Notify relevant stakeholders and other relevant specialists (IC) immediately. • Review monitoring program. • Implement additional monitoring or increase frequency if required within 1 month. • Report impacts in monthly reports. • Capture photographic record immediately.	• Manager Environment – IC. • Expert Water Consultants	• Inform stakeholders of baseline assessment • Report to key stakeholders in SMP Application and AEMR. • Identify, investigate and report on impacts. • To provide data for any investigation into impacts.
					Moderate • Moderate reduction in water quality (observed for more than 2 months) at any site when comparing baseline period to mining period, ie: – pH drop of 1.5 – 2 units – EC increase of 50-100 uS/cm – ORP* drop 150 -200 mV These may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.	• Notification to DPIM and resource manager/s immediately. • Notify Ecological Specialists and other relevant Specialists immediately. • Capture photographic record immediately. • Collect additional laboratory samples if required within 2 weeks and analyse for: • pH, EC, major cations, major anions, Total Fe, Mn & Al. • Review sampling program within 1 month. • Implement additional monitoring or increase frequency if required within 1 month. • Review with SCA and on a monthly basis during any ongoing impact as required • Develop site CMA in consultation with key stakeholders if required within 1 month, (pending stakeholder availability) and seek approvals. • Implement CMA if required as agreed with stakeholders. • Conduct initial follow up monitoring & reporting within 2 months of CMA completion. • Report in the End of Panel Report submitted annually with AEMR. • Summarise all actions and monitoring in AEMR by end of February (Annually).	• Manager Environment – IC. • Expert Water Consultants	
					Severe • Major reduction in water quality when comparing baseline period to mining period, ie: – pH drop of >2 – EC increase >100 uS/cm – ORP* drop >200 mV • A 2 standard deviation reduction in water quality apparent at downstream monitoring site or	• Notification to DPIM and resource manager/s immediately. • Notify Ecological Specialists and other relevant Specialists immediately. • Site visits with stakeholders within 1month. • Capture photographic record immediately. • Collect laboratory samples within 2 weeks and analyse for: • pH, EC, major cations, major anions, Total Fe, Mn & Al. • Analyse filterable suite of metals. • Review sampling program within 1 month and modify if necessary. • Notify other relevant specialists (IC). • Develop site CMA in consultation with key stakeholders within 1 month, (pending stakeholder availability) and seek approvals. • Completion of works following approvals.	• Manager Environment – IC. • Expert Water Consultants.	

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
			• Monthly manual monitoring during and post mining. • Monthly manual monitoring post mining for two years or until required.			• Additional follow up monitoring and reporting within 2 weeks if required. • Report in the End of Panel Report submitted annually with AEMR. • Summarise all actions and monitoring in AEMR by end of February (Annually).		
Water Level / Flow	**Area 1 Water Level Logger Sites (6 total):** • GS1 (Goondarrin Ck • KS1 (Kembla Ck Pool 3) • KS2 (trib. of Kembla Ck, Un-named Ck) • KS3 (Kembla Ck Pool 4) • KS4 (Kembla Ck Pool 6) • KS5 (Kembla Ck Pool 25) **Area 2 Water Level Logger Sites (3 total):** • GFC (Green Fields Ck) Waterfall Pool • FTC (Fern Tree Ck) • LGU- (Locked Gate Ck Creek 10) **Area 3A Water Level Logger Sites (7 total):** • WWU4 (U/S Wongawilli Ck) • WWL2 (D/S Wongawilli Ck) • SCU1 (U/S Sandy Ck) • SCL (D/S Sandy Ck adjacent to LW 7) • BC1 (Sandy Ck trib. SC10 over LW 8) • BCC1 (Sandy Ck trib. SC10C over LW 8) • CC1 (Sandy Ck trib. SC7 adjacent to LW10) **Area 3A Pool level Benchmarks (i.e. nails)** • WWM1 (mid Wongawilli Ck adjacent to LW 10) • WWM2 (mid Wongawilli Ck adjacent to LW 8) • WWM3 (mid Wongawilli Ck D/S of LW 8) (These cover 3 of the five major pools in Wongawilli.	Water level / flow Automatic pool water level measurements (in various flows) which are converted to flows by calculation of rating curves using measured creek cross sections at the monitoring point. Monthly Manual Water level measurements using pre-established benchmarks (i.e. nails) in major pools.	• Monthly baseline monitoring 1 year prior to mining. Area 2 baseline monitoring was bi-monthly. • Continuous 1hr logging intervals for automatic data logger sites. • Monthly manual monitoring during mining. • Ongoing monthly monitoring post mining.	• To provide pre-mining baseline water levels/flows for comparison with post-mining. • To identify any water levels/flow impacts from mining. • To identify water levels/flow impacts related to physical changes to the creeks and/or drainage lines during mining.	***Minor*** • Temporary reduction in pool water level in any of the pools being monitored (<20% decline in any pools monitored at similar flows by comparing pre-mining data with post-mining data). This may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.	• Review monitoring program. • Implement additional monitoring or increase frequency if required within 1 month. • Report impacts in monthly reports. • Capture photographic record immediately. • Notify relevant stakeholders and other relevant specialists (IC) immediately.	• Manager Environment – IC. • Expert Water Consultants.	• Inform stakeholders of baseline assessment. • Report to key stakeholders in SMP Application and AEMR. • Identify, investigate and report on impacts (in SMP and AEMR). • To provide data for any investigation into impacts.
					Moderate • Pool water levels declining 20-50% during mining in any of the pools being monitored when compared with similar flows before mining. This may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.	• Notification to DPIM and resource manager/s and other relevant stakeholders immediately. • Notify Ecological Specialists and other relevant Specialists immediately. • Capture photographic record immediately. • Review sampling program within 1 month and modify if necessary. • Implement additional monitoring or increase frequency if required within 2 weeks. • Monthly review with SCA. • Develop site CMA in consultation with key stakeholders if required within 1 month (pending stakeholder availability) and seek approvals. • Implement CMA if required as agreed with stakeholders. • Conduct initial follow up and additional monitoring & reporting within 2 months of CMA completion if required. • Report in the End of Panel Report submitted annually with AEMR. • Summarise all actions and monitoring in AEMR by end of February (Annually).	• Manager Environment – IC. • Expert Water Consultants.	
					Severe • Major reduction in pool water level or complete loss of pool water (>50% decline in any pools monitored). This may be revised in consultation with DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data.	• Notification to DPIM and resource manager/s immediately. • Notify Ecological Specialists and other relevant Specialists immediately. • Site visits with stakeholders. • Capture photographic record immediately. • Review monitoring program within 2 weeks and Implement additional monitoring or increase frequency if required. • Notify other relevant specialists (IC) immediately. • Develop site CMA in consultation with key stakeholders within 2 months. • Completion of works following approvals. • Conduct initial follow up and additional monitoring & reporting within 2 months of CMA completion if required. • Report in the End of Panel Report submitted annually with	• Manager Environment – IC. • Expert Water Consultants.	

ASPECT	MONITORING				MANAGEMENT			
	SITES	PARAMETERS	FREQUENCY	PURPOSE	TRIGGER	ACTION	RESPONSIBILITY	PURPOSE
	Ck in Area 3A.) 75% of the major pools in Banksia Ck and Cascade Ck will also have Pool level Benchmarks installed. Refer to Area 3A SMP **Figures 18.1, 18.2, and 18.4** for location of these sites.							
Appearance	All flow and quality monitoring sites as listed above. General observation of active mining areas.	Visual signs of impacts on creeks and drainage lines (i.e., cracking, vegetation changes, increased erosion, changes in water colour etc.) determined by comparing baseline photos with photos during the mining period	• Monthly Baseline monitoring 1 year prior to mining. • Monthly monitoring during mining. • 6 Monthly monitoring for 2 yrs post mining	• To provide pre-mining baseline creek bed, bank and water quality observations for comparison with post-mining. • To identify any creek bed, bank and water quality impacts from mining. • To identify any creek bed, bank and water quality impacts related to physical or chemical changes to the creeks and/or drainage lines during mining.	***Minor*** • Small crack/s with no observable loss of surface water flow. • Slight increase in turbidity, iron staining, algal growth, or other visible water quality parameters determined by comparing baseline photos with photos during the mining period.	• Continue monitoring program. • Implement additional monitoring or increase frequency if required within 2 weeks. • Report impacts in monthly reports. • Capture photographic record immediately. • Notify other relevant specialists (IC) immediately. • Notify relevant stakeholders immediately.	• Manager Environment – IC. • Expert water & Ecology Consultants.	• Inform stakeholders of baseline assessment • Report to key stakeholders in SMP Application and AEMR. • Identify, investigate and report on impacts (in SMP and AEMR). • To provide data for any investigation into impacts.
					Moderate • Crack in a watercourse which does not appear to result in visible loss of surface water, but may result in significant erosion. • Moderate increase in turbidity, iron staining, algal growth, or other visible water quality parameters.	• Notification to DPIM and resource manager/s immediately. • Notify Ecological Specialists and other relevant Specialists immediately. • Capture photographic record immediately. • Collect laboratory samples within 2 weeks and analyse for: – pH, EC, major cations, major anions, Total Fe, Mn & Al. • Review sampling program within 1 month. • Implement and conduct additional monitoring or increase frequency if required within 2 weeks.	• Manager Environment – IC. • Expert water & Ecology Consultants.	
					Severe • Crack in a watercourse that is resulting in visible loss of surface water or erosion. • Major increase in turbidity, iron staining, algal growth, or other visible water quality parameters. • Vegetation changes. • Increased erosion.	• Notification to DPIM and resource manager/s immediately • Notify Ecological Specialists and other relevant Specialists immediately. • Site visits with stakeholders within one month. • Capture photographic record immediately. • Review sampling program and modify if necessary within 2 weeks. • Implement additional monitoring or increase frequency if required within 2 weeks. • Notify other relevant specialists (IC) immediately. • Develop site CMA in consultation with key stakeholders within 1 month, (pending stakeholder availability) and seek approvals. • Completion of works following approvals. • Conduct initial follow up monitoring & reporting within 2 months of CMA completion. • Issue CMA report within 1 month of works completion. • Report in the End of Panel Report submitted annually with AEMR. • Summarise all actions and monitoring in AEMR by end of February (Annually).	• Manager Environment – IC. • Expert water & Ecology Consultants.	

ATTACHMENT 3

Schedule 3 – SMP Approval for LW 21 - 2019

Subsidence Management Plan Approval

I, the Executive Director, Energy & Resource Assessments, of the Department of Planning, Industry & Environment, under the provisions of the development consent referred to in Schedule 1, approve the development set out in Schedule 2, subject to the conditions set out in Schedules 3 and 4.

Mike Young
Executive Director
Energy & Resource Assessments
as nominee of the Secretary

Sydney 19 DECEMBER 2019

SCHEDULE 1

Condition 7 of Schedule 3 of the development consent granted by the Minister for Urban Affairs and Planning on 20 November 2001 for the development of the Dendrobium Coal Mine and the construction and operation of associated surface facilities (DA 60-03-2001), as modified.

SCHEDULE 2

Underground mining operations, and associated monitoring, management and remediation, in Area 3C of the Dendrobium Coal Mine.

SCHEDULE 3 – GENERAL CONDITIONS

Definitions

1. The following definitions apply to this approval.

Area 3C WIMMCP	Watercourse Impact Monitoring, Management and Contingency Plan and its associated Trigger Action Response Plan for Area 3C, as required to be prepared under condition 4 of Schedule 3 of the development consent
Area 3C SIMMCP	Swamp Impact Monitoring, Management and Contingency Plan and its associated Trigger Action Response Plan for Area 3C, as required to be prepared under condition 6 of Schedule 3 of the development consent
BCD	Biodiversity Conservation Division within the Department
Department	Department of Planning, Industry and Environment
Development consent	Development consent DA 60-03-2001, as modified
Independent Expert Panel	Independent Expert Panel for Mining in the Catchment
Minor	Not very large, important or serious
Mitigation	Activities associated with reducing the impacts of mining operations prior to or during those impacts occurring
Negligible	Small and unimportant, such as to be not worth considering
Remediation	Activities associated with partially or fully repairing or rehabilitating the impacts of mining operations or controlling the environmental consequences of these impacts
Resources Regulator	NSW Resources Regulator
Secretary	Planning Secretary of the Department, or nominee
Subsidence Management Plan 2019	Longwalls 20 & 21 Subsidence Management Plan prepared by Illawarra Coal South32 dated November 2019, including its Appendices 1 – 4
TARP	Trigger Action Response Plan
WaterNSW	Water NSW, as established under the *Water NSW Act 2014*

2. Subject to the definitions above, the definitions in the development consent apply to this approval.

Terms of Approval

3. The Applicant must carry out the development:
   (a) in compliance with the conditions of the development consent;
   (b) in compliance with the conditions of this approval; and
   (c) generally in accordance with the Subsidence Management Plan 2019 (subject to review and approval of the WIMMCP and/or SIMMCP under the conditions of this approval).

4. If there is any inconsistency between the documents listed in condition 3, then the conditions of this approval and the development consent prevail to the extent of the inconsistency.

Limits on Approval

5. The Applicant must not extract the Wongawilli coal seam to a height of greater than 3.9 metres, subject to approval from the Resources Regulator to extract a greater height for identified mine safety reasons.

Performance Measures for Area 3C

6. The Applicant must ensure that the development does not cause any exceedance of the performance measures in Table 1, to the satisfaction of the Secretary.

Table 1: Subsidence Impact Performance Measures

Swamps	
Swamps Den09, Den144, Den145	Minor environmental consequences including: • *negligible* erosion of the surface of the swamp; • *minor* changes to the hydrology of the swamp; • *minor* changes in the size of the swamp; • *minor* changes in the ecosystem functionality of the swamp; and • *maintenance or restoration* of the structural integrity of the bedrock base of any significant permanent pool or controlling rockbar within the swamp.
Watercourses	
Wongawilli Creek	Minor environmental consequences including: • *minor* fracturing, gas releases and iron staining; and • *minor* impacts on water flows, water levels and water quality.

The Applicant may meet the requirements of this condition either by avoidance, mitigation, remediation or offsetting, or any combination of these measures.

Rehabilitation

7. If the Applicant does not meet the performance measures in Table 1, then following consultation with BCD, WaterNSW and Resources Regulator, the Secretary may issue the Applicant with a direction in writing to undertake actions or measures to mitigate or remediate subsidence impacts and/or associated environmental consequences. The Applicant must implement the direction in accordance with its terms and requirements, in consultation with the relevant agencies and to the satisfaction of the Secretary.

Groundwater Impact Monitoring

8. The Applicant must:
   (a) install groundwater monitoring boreholes containing multi-level piezometers along the centreline of each longwall proposed to be extracted within Area 3C, each containing at least 5 transducers, at least 2 years prior to commencing extraction of that longwall;
   (b) use data from these boreholes and other investigations to develop a database for the Dendrobium Coal Mine for the height of complete drainage over longwalls;
   (c) monitor rainfall and mine water ingress from overlying and surrounding strata in Area 3C on a daily basis; and
   (d) use its best endeavours to identify the components of mine water make that derive from surface waters;
   to the satisfaction of the Secretary.

Offsets

9. The Applicant must offset any reduction of surface water reporting to WaterNSW storages or weirs caused by the extraction of longwalls within Area 3C, in consultation with WaterNSW and to the satisfaction of the Secretary.

Review of WIMMCP and SIMMCP

10. The Applicant must submit a revised Area 3C WIMMCP (including its associated TARP) to the Secretary by 30 June 2020 for approval. The revised Area 3C WIMMCP must:
   (a) be prepared in consultation with WaterNSW;
   (b) include a TARP which contains quantitative triggers which support adaptive management measures directed to avoiding exceedances of the performance measures for Wongawilli Creek set out in in Table 1;
   (c) fully reflect the recommendations of the Independent Expert Panel which directly relate to impact monitoring, management, remediation and contingency planning in respect of watercourses;
   (d) reflect the nine monitoring program recommendations included in *Height of Cracking – Dendrobium Area 3B* (PSM, 2018); and
   (e) include a methodology for developing a rating curve and establishing the relationship between the existing WWL gauge and the new gauge required to be constructed under condition 13 below.

11. The Applicant must submit a revised Area 3C SIMMCP (including its associated TARP) to the Secretary by 30 June 2020 for approval. The revised Area 3C SIMMCP must:
   (a) be prepared in consultation with WaterNSW and BCD;
   (b) include a TARP which contains quantitative triggers which are directly linked to maintaining achievement of the performance measures for swamps set out in in Table 1;
   (c) fully reflect the recommendations of the Independent Expert Panel which directly relate to impact monitoring, management, remediation and contingency planning in respect of swamps;
   (d) fully reflect the advice of the of the Independent Expert Panel dated 13 December 2019 on the Subsidence Management Plan 2019 relating to monitoring of swamp impacts; and
   (e) reflect the nine monitoring program recommendations included in *Height of Cracking – Dendrobium Area 3B* (PSM, 2017).

12. The Applicant must not undertake extraction of Longwall 21 until the Area 3C WIMMCP and Area 3C SIMMCP are revised and approved under conditions 10 and 11 of this Schedule.

Replacement of WWL Flow Gauge

13. The Applicant must complete construction of the flow gauge on Wongawilli Creek proposed to replace the existing WWL gauge to the satisfaction of WaterNSW and as soon as is practicable, and in any case by 30 May 2020.

Area 3C Mine Layout and Monitoring Program

14. By 30 June 2020, the Applicant must submit to the Secretary the:
   (a) mine layout and mining geometry, as proposed at that date for Area 3C; and
   (b) baseline monitoring program, as existing and as proposed at that date for Area 3C,
   for review.

Groundwater Modelling

15. By 30 June 2020, the Applicant must submit to the Secretary revised groundwater modelling for Area 3C that:
    (a) includes cell dimensions of 50 m x 50 m within the footprint of all proposed longwalls; and
    (b) adequately justifies any continued use of the "stacked drains method" as accurately reflecting groundwater drainage above the goaf,

    for review.

Regular Reporting

16. During the extraction of longwalls in Area 3C, the Applicant must submit a summary report to the Secretary every 4 months (unless some other period is agreed with the Secretary) which reflects Recommendation 20 of the Independent Expert Panel's Final Report (Part 2) and which includes:
    (a) a consolidated summary of the monitoring results gathered during each 4-month period;
    (b) assessment of compliance with the performance measures listed in Table 1;
    (c) assessment of any exceedances of predictions in the Subsidence Management Plan 2019;
    (d) assessment of any exceedances of Level 2 or Level 3 Triggers in the TARPs;
    (e) details of any actions taken or measures implemented in response to any such exceedance; and
    (f) accurately records the seam mining height during the period,

    to the satisfaction of the Secretary.

Independent Environmental Audit

17. The Applicant must ensure that the audit team for the Independent Environmental Audit, required under condition 6 of Schedule 8 of the development consent, includes suitable experts in the fields of mine subsidence impacts and remediation, upland swamps, and stream hydrology and water quality; and carries out an audit of the impacts of mining undertaken in Area 3C as at the date of the Audit.

SCHEDULE 4 – CONDITIONS GOVERNING INDIVIDUAL LONGWALLS

LONGWALL 20

1. This Subsidence Management Plan Approval does not include approval of Longwall 20. The Applicant must obtain the approval of the Secretary (under condition 7 of Schedule 3 of the development consent) for the extraction of Longwall 20 prior to commencing development of the maingate and/or tailgate for that longwall. The Secretary's approval will take into account the:
   (a) Subsidence Management Plan 2019 and any additional advice provided by the Applicant;
   (b) independent expert advice, including with regard to achieving the performance measures in Table 1 for Wongawilli Creek;
   (c) documents required to be reviewed or prepared and other measures required to be developed or implemented under the conditions of this approval; and
   (d) Applicant's performance under the conditions of this approval and development consent.

   The Secretary's approval may be subject to conditions.
