INDEPENDENT ADVISORY PANEL FOR UNDERGROUND MINING

ADVICE RE:

DENDROBIUM LONGWALL 18

SUBSIDENCE MANAGEMENT PLAN

Condition 16, Schedule 4

November 2021

TABLE OF CONTENTS

1.0 SCOPE OF WORKS 2

2.0 METHOD OF OPERATION 3

2.1. Subsequent information, supporting documents and Meetings**Error! Bookmark not defined.**

3.0 GROUNDWATER 4

4.0 SURFACE WATER 7

4.1. Water Quality 7

4.2. Surface Water TARPs 7

5.0 CONCLUSIONS 8

Abbreviation	Term
DPIE	Department of Planning, Industry and Environment
IAPUM	Independent Advisory Panel for Underground Mining
LW	Longwall
SMP	Subsidence Management Plan
TARP	Trigger Action Response Plan
VWP	Vibrating wire piezometer

1.0 SCOPE OF WORKS

The Dendrobium Mine, owned and operated by Illawarra Coal Holdings Pty Ltd, as a subsidiary of South32 Limited (the Applicant), is an underground coal mine located approximately 8 km west of Wollongong and 65 km southwest of Sydney in the Southern Coalfield of NSW. The area includes several different significant geological features (such as the Elouera Fault) and is susceptible to mining-induced impacts that have the potential to impact on water quantity and quality in the catchment, requiring careful consideration.

Longwall (LW) 18 is the southern-most longwall panel planned in Area 3B of the mine and is bounded to the south by the defunct workings of Elouera Colliery, to the west by Lake Avon and to the east by Wongawilli Creek. The total void length for LW 18 is planned to be 1,018 metres (m), the proposed total void width (ie including first workings) is 305 m and the maximum mining height is not to exceed 3.9 m. The depth of cover from LW 18 to the surface varies between 295 m and 380 m.

While mining in Area 3B has been granted consent, a Subsidence Management Plan (SMP) must be approved by the Department of Planning, Industry and Environment (DPIE) prior to any longwall mining in the area. LW 9 to LW 16 within Area 3B have been completed and LW 18 is expected to commence once LW 17 has been completed.

In November 2020 and at DPIE's request, the Independent Advisory Panel for Underground Mining ('the Panel') provided advice to DPIE in relation to the SMP for LW 18. This included 10 recommendations related to groundwater and surface water.

DPIE approved the SMP on 8 December 2020 subject to strict conditions, including Condition 16, Schedule 4, which requires the Applicant to:

- *prepare a plan, in consultation with WaterNSW and to the satisfaction of the Secretary, for the effective implementation of all recommendations contained in the Mining Panel's* [the IAPUM] *advice dated November 2020 in respect of the Subsidence Management Plan (2020).*

The Applicant provided this plan to DPIE, on 26 August 2021, and is seeking approval of it.

On 27 September 2021, DPIE requested the Panel to provide advice in relation to the plan. Specifically, DPIE requested advice on:

- *whether the plan appropriately addresses the Panel's recommendations, particularly in relation to the proposed method for quantifying and reporting trends in key water quality indicators.*

The Chair of the Panel nominated the following members of the IAPUM to prepare the advice:

- Em. Professor Jim Galvin – Chair – geotechnical and mining engineering
- Liz Webb – Principal Hydrogeologist - groundwater
- Professor Neil McIntyre – surface water

2.0 METHOD OF OPERATION

COVID19 constraints prevented the Panel from meeting in person and from undertaking a site inspection. Instead, the Panel convened by videoconference throughout the preparation of its advice and was administratively supported by Secretariat staff provided by DPIE's Energy and Resources Policy Team.

A range of documents was provided to the Panel to aid in the preparation of its advice, the principal ones being:

Document Reference	Document Name
IAPUM SMP LW18 Advice	IAPUM Advice re Dendrobium LW18 SMP (November 2020)
Applicant's Letter	Ltr to DPIE - IAPUM Recommendations (26 August 2021)
HGEO Report	Applicant's Letter Attachment – *Reporting of trends in water quality and metal loads in streams* (HGEO, May 2021)
WaterNSW Comments	Content Manager Document: D2021/77625: WaterNSW Letter to DPIE - Dendrobium LW16 EoP Load estimation method (Sent 12 August 2021)

The Panel convened with DPIE on 19 October 2021 for the purpose of receiving a technical briefing from DPIE's Resource Assessments Team.

3.0 GROUNDWATER

The Panel has reviewed and agrees with the proposed actions to address the original recommendations from the Panel regarding mining of LW18. It is noted that COVID restrictions have delayed the implementation of some actions and that access and terrain constraints have been pragmatically managed in the selection of monitoring sites. The table below specifically considers each of the proposed actions and additional comments only pertain to ensuring data is then reported back to address the key knowledge gaps.

Table 1 Panel comments and recommendation

#	Groundwater recommendation from November 2020 Advice	Action	Panel comments on recommendations
1	The Panel supports the recommendation of DPIE Water for additional standpipe monitoring bores to be constructed adjacent to vibrating wire piezometers (VWP) to provide validation of VWP sensor data	Two open standpipes to be established: **AD5 (Dendrobium Area 3B)** • An open standpipe borehole has been established adjacent to borehole S2379C at a depth of 50 m. This borehole will replicate the top piezometer in S2379 as an open standpipe arrangement to provide validation of VWP data **Dendrobium Area 5** An open standpipe borehole has been established adjacent to borehole S2511. This borehole will replicate the piezometer at a depth of 100 m in S2511A as an open standpipe arrangement to provide validation of VWP data	The Panel note and agree with the proposed action. The Panel are comfortable with the construction of an additional two standpipe monitoring bores to provide validation of VWP sensor data at these two locations. Once these standpipes are constructed, they should be equipped with a logger and data should be incorporated into the overall monitoring program. Specifically, the data from these two additional standpipes should be compared to the adjacent VWP to provide clear validation of the VWP data against the measured water levels.
2	It is recommended that one or two additional nested groundwater monitoring sites are established to the south west of LW18: either between LW18 and Lake Avon and/or between LW18 and the Elouera Mine workings, in order to consider groundwater pressures and water quality in the shallow/mid and deeper Hawkesbury Sandstone	The area to the south west of Longwall 18 was investigated to potentially establish a groundwater monitoring site; however, the terrain was determined to be unsuitable. Due to the steep topography in the valley sides to Native Dog Creek, a drilling rig could not access this area. The **Elouera Fault REF Site 3** is located between Longwall 18 and the Elouera Mine workings and is a suitable location to consider groundwater pressures and water quality. One borehole is proposed to be drilled in the HBSS at a depth of 108 m at Site 3 with the following: • Borehole 1 for groundwater pressures and quality; – A string of three nested piezometers & pumps located in the shallow, mid and lower HBSS (30 m, 65 m and 105 m) It is estimated that this site ill be installed by mid September.	The Panel note and agree with the proposed action. The Panel understand the realities of difficult terrain when establishing monitoring sites. The alternate site proposed, Elouera Fault REF Site 3 is considered suitable for the required purpose of considering groundwater levels, pressures and water quality at the location between LW 18 and the Elouera Mine workings. The proposed construction of the site (nested sites adjacent to the shallow mid and lower HBSS with dedicated pumps for sampling) is also considered appropriate. Data from loggers and WQ monitoring should also be included in subsequent monitoring reports, with a focus on the degree of hydraulic connection (or not) between LW18 and Elouera Mine.

Table 1 Panel comments and recommendation

#	Groundwater recommendation from November 2020 Advice	Action	Panel comments on recommendations
3	Ongoing monitoring of groundwater levels within the fault should continue at site 3 (S2490)	Borehole S2490 is currently equipped with three VWPs installed within sand packs at depths of 25 m, 35 m and 85 m. There is also a vented piezometer set at 10 m depth in an adjacent monitoring bore (S2490A). The vented construction will provide results similar to a conventional standpipe. These boreholes will continue to be monitored during and following Longwall 18 extraction.	The Panel note and agree with the proposed action.
4	The Panel supports the recommendation to construct either VWPs or open holes at the vertical holes at sites 1 and 2. Ongoing monitoring of pressures should occur at these two sites. Ideally, if future drilling is to occur in this area, consideration should be given as to whether an open standpipe bore into the fault zone could be constructed to provide both verification of water level and also to provide for monitoring of water quality changes within the fault over time.	Following completion of the Elouera Fault tracer testing which is currently underway, VWP arrays will be installed at **Elouera Fault Sites 1 and 2 vertical holes**. The following VWP arrays will be established at both sites: • Three piezometers in the HBSS; • Three piezometers in the BGSS; • One piezometer in the BACS; • One piezometer in the SBSS; • One piezometer in the BUSM; and • One piezometer in the WWCO (Site 2 only). Elouera Site 2 is being installed at the time of writing.	The Panel note and agree with the proposed action. Data from loggers and WQ monitoring should also be included in subsequent monitoring reports, with a focus on the degree of hydraulic connection (or not) between LW18 and Elouera Mine.
5	The Panel recommends additional stress investigations at end of mining LW18 to confirm unloading changes.	An inclined borehole at **S2475** is proposed to be established to monitor stress between LW18 and the Elouera Fault. The borehole would have overcore testing carried out and a stress cell installed. IMC have engaged SCT to install and undertake the stress monitoring at this site. It is estimated that the site will be established in late September/early October 2021.	The Panel note and agree with the proposed action.

Table 1 Panel comments and recommendation

#	Groundwater recommendation from November 2020 Advice	Action	Panel comments on recommendations
6	Monitoring the groundwater (both pressures at depth and the water table) overlying Elouera Mine is recommended. This information will contribute to the conceptual understanding of groundwater recovery processes post mining in this area.	IMC proposes to use existing boreholes **S1709 and S1710** to monitor groundwater overlying Elouera Mine. These boreholes are operational and providing data. The range of monitoring equipment in the boreholes include: • S1709 has six operational piezometers; two in the HBSS, one in the BGSS; BUCO, SBSS and CCSS. • S1710 has four operational piezometers; two in the HBSS, one in the NPFM and BHCS. Given the location of S1709 and S1710 (just off Fire Road 6A (red dotted line) and over Elouera Mine (black hatching) as shown in the map below); the range of strata which is monitored for groundwater recovery and the length of recorded data from these boreholes (2004-present), the monitoring data provide by these boreholes is considered adequate to monitor the post mining recovery of groundwater above the Elouera Mine as recommended by the Panel "Monitoring the groundwater (both pressures at depth and the water table) overlying Elouera Mine is recommended". It is not clear if the Panel were aware of these two boreholes when they provided their advice. A hydrograph of the S1709 and S1710 are enclosed.	The Panel note and agree with the proposed action and agree that S1709 and S1710, overlying the Elouera Mine, are suitable to achieve the purpose of the original Panel recommendation.
7	Any observed reversal in the Hawkesbury Sandstone groundwater level gradients between Lake Avon and the Elouera fault monitoring bores to the south-west of LW18 should result in a review by an independent expert to ascertain the water loss rate (as committed to in the South32 Response to Agency advice).	Not required at this time.	The Panel note this is not required at this time.
8	For future mining areas groundwater TARPS and performance measures should be considered.	Proposed groundwater TARPs have been developed for Dendrobium Area 3C. These are presented in the Longwalls 22 and 23 Groundwater Assessment. The Longwalls 22 and 23 SMP application is currently with Agencies for comment and will be submitted to the Department for consideration once all feedback is received.	Noted

4.0 SURFACE WATER

4.1. WATER QUALITY

In the advice provided to DPIE for LW18, the Panel's recommendations included "*A method of quantifying and reporting trends in key water quality indicators (both concentrations and loads) should be trialled in addition to applying the proposed water quality TARPs*."

This recommendation was based on the Panel's observation that "*The water quality TARPs remain as in previous (2019) version of the WIMMCP. For the purpose of the LW18 SMP, the Panel has no objections to the TARPs or associated monitoring. However, going forward, the TARPs by themselves are not sufficient indicators of medium to long term trends in water quality*".

In response to this recommendation, the Applicant has presented a report "Reporting of trends in water quality and metal loads in streams" (HGEO Report), which presents methods of trend analysis and worked examples. The HGEO Report concludes that tabulating flow-corrected concentration trend statistics in End of Panel reports, supplemented by visual review of the data, would assist with reporting. The HGEO Report also concludes that analysing trends in annual loads (flow x concentration) is problematic due to the need to infill concentrations on days when measurements have not been taken and so the primary approach should be assessment of flow-corrected concentrations.

The Panel does not have any objection to the methods employed for concentration trend analysis. Regarding the assessment of trends in loads, the conclusion that loads are flow-driven seems inevitable if the relation between flow and concentration (hence flow and load) is time-invariant. Given current data limitations it may be that no better approach exists; however, this deserves ongoing consideration, both with respect to data requirements and with respect to the calculation approach. Nevertheless, the Panel agrees with the conclusions of the HGEO Report that the concentration-based trend analysis should be the primary approach and considers that the proposal meets the recommendation regarding water quality trend analysis.

WaterNSW has reviewed the proposed approach (WaterNSW Comments). The Panel concurs with the WaterNSW comments regarding the need for a tailored sampling approach for load estimation, the limited scope for assessing loads for Area 3B, and the irrelevance of loads for current TARPs. The Panel regards contamination as a potential strategic concern if mining in the Special Areas is to continue long-term or if groundwater levels might recover and lead to increased discharge of contaminated water following the cessation of mining. If either scenario is possible, further consideration by stakeholders of the value and feasibility of estimating contaminant loads and their incorporation in TARPs is recommended.

4.2. SURFACE WATER TARPS

The Panel's advice relating to surface water TARPs for LW18 was: "*The previous (pre-LW15) surface water flow TARPs should be employed in parallel with the new surface water flow TARPs, and the most conservative outcome taken, until the new trigger metrics have undergone further assessment and peer review for fitness for purpose*."

The Applicant has advised that it will continue to use both the old and the new TARPs for LW18 until further assessment and peer review has been completed. This meets the Panel's recommendation.

5.0 CONCLUSIONS

In preparing this advice, the Panel has carefully considered the HGEO Report and Water NSW Comments as well as other relevant information outlined in Section 2. The Panel considers the recommendations it provided in its Panel SMP LW18 Advice in November 2020 have been addressed in the plan the Applicant has provided.

Groundwater:

- As outlined in Section 3, the Panel is satisfied with the actions proposed in the HGEO Report and has suggested:
    - constructed standpipes should be equipped with a logger and data should be incorporated into the overall monitoring program and that this data be compared to the adjacent VWP to provide clear validation of the VWP data against the measured water levels, and
    - data from loggers and WQ monitoring should also be included in subsequent monitoring reports, with a focus on the degree of hydraulic connection (or not) between LW18 and Elouera Mine.

Surface water:

- The Panel considers that its recommendations regarding surface water have been addressed adequately for the purpose of LW18 commencement.

- The Panel concurs with WaterNSW's comments and recommends further consideration of estimating contaminant loads and their incorporation in TARPs under certain circumstances as outlined in Section 4.1.