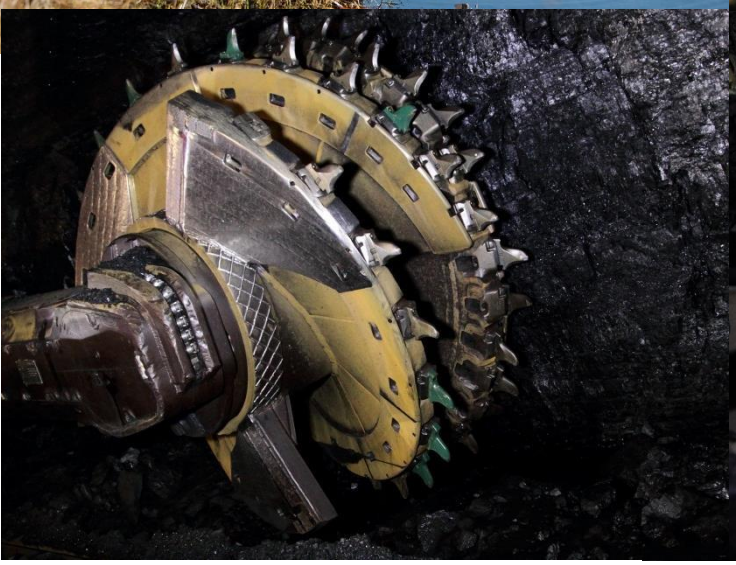
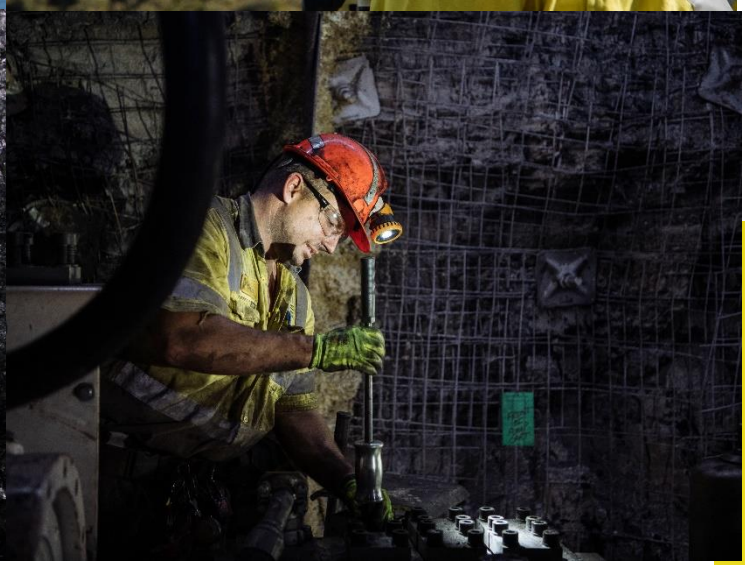
SOUTH32

Illawarra Metallurgical Coal
End of Panel Report



DENDROBIUM AREA 3B
LONGWALL 18
END OF PANEL REPORT

October 2022

EXECUTIVE SUMMARY

This End of Panel (EoP) report has been prepared in accordance with Schedule 3 Condition 9 of the Dendrobium Development Consent (DA 60-03-2001). The EoP report outlines the measured and observed impacts during the extraction of Dendrobium Area 3B (DA3B) Longwall 18, and presents monitoring results and analyses compared to relevant impact assessment criteria and predictions in the DA3B Subsidence Management Plan (SMP).

Dendrobium Longwall 18 is located within Consolidated Coal Lease 768 and is the tenth panel to be extracted in DA3B. Extraction of Longwall 18 commenced on 2 December 2021 and was completed on 17 May 2022. The extracted longwall has a length of 1018 metres (m), a void width of 305m (including first workings) and a maximum cutting height up to 3.9m.

The extraction of underground coal reserves from DA3B provides benefits at international, national, state and local levels. Illawarra Metallurgical Coal (IMC) provides an essential supply of coking coal to BlueScope Steel for its steelmaking production, and for export to overseas customers. Operations at Dendrobium Mine represent continuing significant capital and operating investments in the Southern Coalfield of New South Wales.

Continuing benefits occur through continuity of employment, export earnings and government revenue. From the operations of Dendrobium Mine, IMC paid approximately $52.7 million in government royalties during the general period of Longwall 18 extraction i.e. the months December 2021 to May 2022.

Subsidence movements resulting from the extraction of Longwall 18 were monitored along lines and points within the SMP Area. The measured ground movements after the extraction of Longwall 18 are generally similar to or less than the predicted values.

During the extraction of Longwall 18, 24 new surface impacts were identified. These impacts are labelled as "*DA3B_LW18_001*" to "*DA3B_LW18_024*". These impacts were observed on natural features.

At tributary monitoring site *LA4_S1*, a Trigger Action Response Plan (TARP) level of Exceeding Predictions was recorded for Electrical Conductivity (EC) and pH, and a Level 1 trigger for Dissolved Oxygen (DO). No adverse changes in water quality are noted in Lake Avon and Lake Cordeaux. New or recurrent iron staining has been noted on Wongawilli Creek, WC21 and LA5. The observations are likely related to recovery of groundwater levels and the reactivation of iron-rich springs near creek channels.

TARP triggers for surface water hydrology were identified at Donalds Castle Creek (*DCS2; DCU*); DC13 (*DC13S1*); WC21 (*WC21S1*); WC15 (*WC15S1*), LA4 (*LA4S1*), LA3 (*LA3S1*) and LA2 (*LA2S1*). Water flow performance measures were met for Longwall 18. Analysis of available surface water flow observation records for Wongawilli Creek did not trigger a TARP for any months assessed during the Longwall 18 period.

The average daily inflow to Area 3B during Longwall 18 extraction was 4.5 ML/day which represents 50% of total mine inflow for the period (a similar proportion to Longwall 16). Compared with the previous longwall, the total mine inflow increased by 11% whereas the inflow in Area 3B decreased by 14%.

Seepage losses from Lake Avon have been estimated by regional and local scale numerical models to be in the range of 0.09 to 0.89 ML/day as at the end of Longwall 18. The estimates are within the tolerable loss limit of 1 ML/day prescribed by Dams Safety NSW and supported by the low levels of tritium and carbon-14 in mine inflow water in Area 3B.

Longwall 18 passed beneath, or within 400m of Swamp 149, 14, 35a/b, 151 and 150. A Level 3 TARP for shallow groundwater remains in place at Swamp 14 from previous longwalls. No TARP triggers were recorded in other swamps in the Longwall 18 study area

Reduction in aquatic habitat for over 2 years at Donalds Castle Creek and WC21 constitutes a Level 3 TARP trigger. No TARPs have been triggered with respect to Wongawilli Creek.

Three Aboriginal cultural heritage sites were visited, with no impacts related to the extraction of Longwall 18 observed.

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Attachment D – Surface Water and Shallow Groundwater Assessment (HGEO)

Attachment E – Groundwater Assessment (HGEO)

Attachment F – Aquatic Ecology Assessment (Cardno)

Attachment G – Heritage Assessment (Niche)

Attachment H – Terrestrial Ecology Assessment (Niche)

1 INTRODUCTION

1.1 Approval and Legislative Requirements

Dendrobium Longwall 18 is located within Consolidated Coal Lease 768 and is the tenth panel to be extracted in DA3B. Extraction of Longwall 18 commenced on 2 December 2021 and was completed on 17 May 2022.The extracted longwall has a length of 1018m, a void width of 305m (including first workings) and a maximum cutting height up to 3.9m.

This EoP report has been prepared in accordance with Schedule 3 Condition 9 of the Development Consent (DA60-03-2001 – MOD 9) (Table 1). The EoP report outlines the measured and observed impacts of Longwall 18 and the analyses of monitoring results compared to relevant impact assessment criteria and predictions made in the SMP and associated management plans and reports.

The DA3B SMP was approved by the then Department of Trade and Investment, Regional Infrastructure and Services NSW (DTI) on the 5 February 2013 and the then Department of Planning and Environment (DP&E) on the 6 February 2013. Subsequent approval for Longwall 18 SMP was granted on the 8 December 2020 by DPIE, which is provided as **Attachment A**.

Schedule 3 Conditions 9 and 10 of the Development Consent are provided in Table 1.

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Table 1: Approval conditions excerpt from the Dendrobium Development Consent (DA60-03-2001 – MOD 9).

Development Consent Approval Condition	Relevant Section in EoP Report
Schedule 3 of Development Consent DA60-03-2001 – MOD 9	
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	*Sections 2 to 8, Attachments B to H*
(b) submit the report to the Department, Resources Regulator, WaterNSW, BCS, DPE Water and any other relevant agency to the satisfaction of the Secretary	*The Annual Review (July to June) is submitted in September each year*

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.	

The impact predictions for Longwall 18 are described in the following reports:

- Dendrobium Area 3B Subsidence Management Plan (SMP);
- Dendrobium Area 3B Watercourse Impact, Monitoring, Management and Contingency Plan (WIMMCP) (December 2020);
- Dendrobium Area 3B Swamp Impact, Monitoring, Management and Contingency Plan (SIMMCP) (December 2020 amendment); and

Impacts have been reported by the Illawarra Metallurgical Coal Environmental Field Team (IMCEFT) and specialist consultants during and following mining.

1.2 Economic Benefits

The extraction of underground coal reserves from DA3B provides benefits at international, national, state and local levels. IMC provides an essential supply of coking coal to BlueScope Steel for its steelmaking production, and for export to overseas customers. Mining operations at Dendrobium Mine represents continuing significant capital and operating investments in the Southern Coalfield of New South Wales.

Continuing benefits occur through continuity of employment, income, export earnings and government revenue. From the operations of Dendrobium Mine, IMC paid approximately $52.7 million in government during the general period of Longwall 18 extraction i.e. the months December 2021 to May 2022.

1.3 Stakeholder Consultation

Provision of monitoring data and ongoing information to the community has been undertaken during the extraction of DA3B. Information on IMC operations is provided to the community and key stakeholders through the following mechanisms:

- Dendrobium Community Consultative Committee (DCCC) meetings;
- Community information sheets and letter box drops;
- Media releases and other media activities;
- General community surveys and reports;
- Dendrobium Community Newsletter – distributed to the community;
- Updates and document uploads to the South32 Internet site: http://www.south32.net/our-operations/australia/illawarra-coal/regulatory-document;
- Annual Review reports
- Frequent consultation with WaterNSW and Dam Safety NSW (i.e. technical working group committee); and
- Public enquiries can be submitted through a 24-hour free community call line (1800 102 210) and email (illawarracommunity@south32.net)

IMC aims to mitigate the potential impacts subsidence may cause through various means outlined in Table 2.

Table 2: Social Impact Variables Associated with Subsidence.

Potential Impact	Monitoring Variables	Mechanism
Subsidence Impacts	Level of community concern relating to subsidence Awareness of subsidence, its effects and management Level of perceived community riskassociated with subsidence Level of satisfaction with the company's subsidence management practices The extent to which the community attributes environmental, social and economic change within the community tomining activities	Inform via the DCCC meetings including presentations and data relating to subsidence and its potential impacts. Minutes are published publicly on the South32 website. A triennial telephone survey of residents inthe communities in which IMC operates. The survey aims to determine the community's perception of the company's overall performance.

2 PREDICTED AND OBSERVED SUBSIDENCE

Subsidence movements resulting from the extraction of Longwall 18 were monitored along lines and points within the SMP Area. A comparison of the observed and predicted movements has been prepared by Mine Subsidence Engineering Consultants (MSEC) and is included as **Attachment B**.

Monitoring points and lines associated with Longwall 18 include (Figure 1):

- Wongawilli Creek Closure Lines;
- Avon Dam Closure Lines;
- DA3B and Avon Dam 3D Monitoring Point
- Tributary Cross Lines;
- Swamp Cross Line;
- Waterfall 54; and
- Airborne Laser Scans (ALS) of the area.

The predicted subsidence effects have been obtained using the re-calibrated subsidence model presented in Reports Nos. MSEC792, MSEC865 and MSEC914 and MSEC1103.

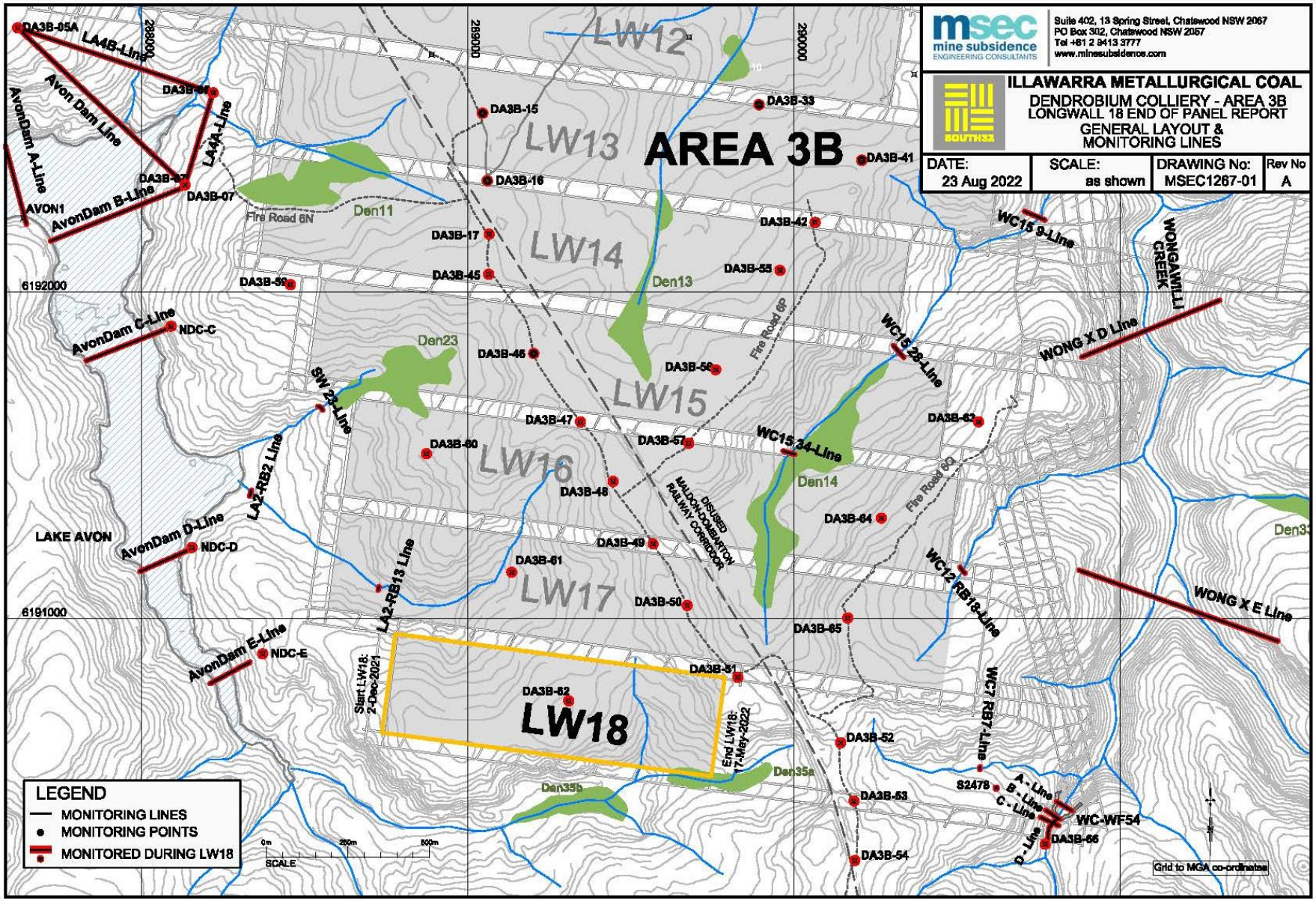

Figure 1: Overview of subsidence monitoring sites, comprised of monitoring lines and monitoring points (Source: Attachment B).

2.1 Wongawilli Creek Closure Lines

The closure movements across Wongawilli Creek have been measured by IMC using 2D survey techniques at the Wong X D-Line and Wong X E-Line. The Wong X A-Line, Wong X B-Line and Wong X C-Line were not measured at the completion of Longwall 18 due to their distances from that longwall.

The measured total closure at the Wong X C-Line of 123 mm is similar to, but slightly greater than, the predicted total closure of 120 mm. The exceedance of 3 mm represents less than 3 % of the predicted value and it is in the order of survey tolerance. The maximum measured total closures at the remaining Wongawilli Creek closure lines are less than the predicted values at the completion of Longwall 18.

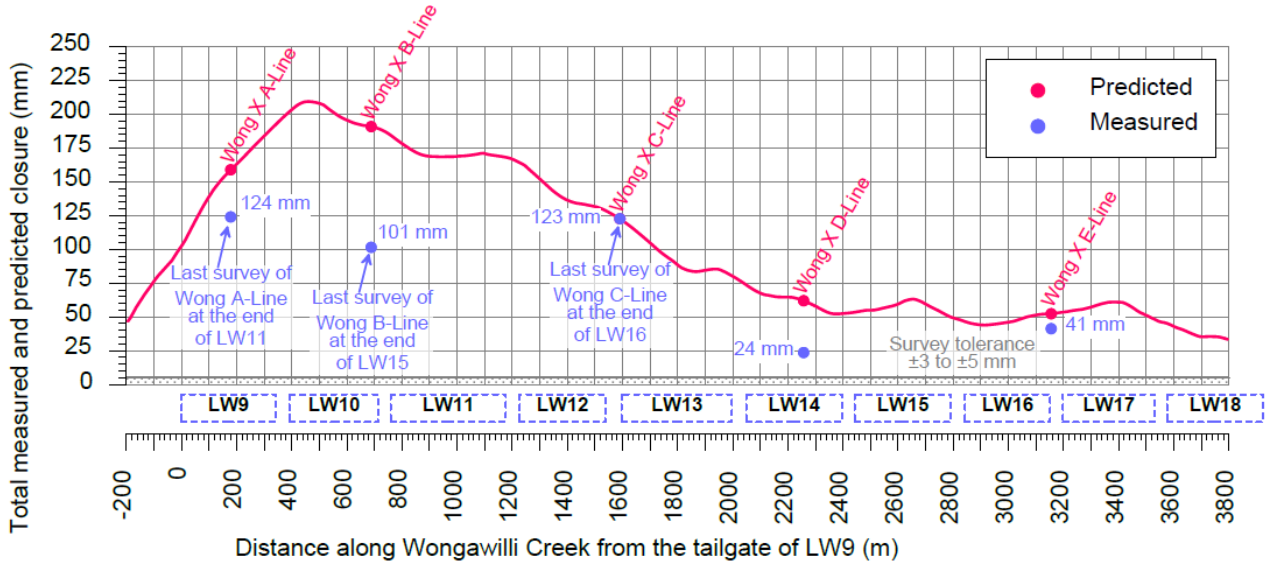

Figure 2: Measured and predicted total closure along Wongawilli Creek after extraction of Longwall 18. (Source: Attachment B).

2.2 Avon Dam Closure Lines

The closure across the Avon Dam has been measured by IMC using the Avon Dam A-Line to E-Line. The base surveys were carried out just prior to the commencement of Longwall 12 and, therefore, the closure lines have measured the accumulated movements due to the mining of Longwall 12 to Longwall 18.

The measured total closure at the LA4A monitoring line is less than the predicted value at the completion of Longwall 18. Net opening movements have been measured at the LA4B and Avon monitoring lines due to the conventional subsidence effects (i.e. horizontal movements towards the mining area) being greater that the valley-related effects (i.e. closure). The absolute magnitudes of the measured opening movements are less than the absolute magnitudes of the predicted closure movements.

The maximum measured total closure across Lake Avon is less than the maximum predicted value at the completion of Longwall 18. It is considered that the ground movements measured using these monitoring lines are consistent with the predictions.

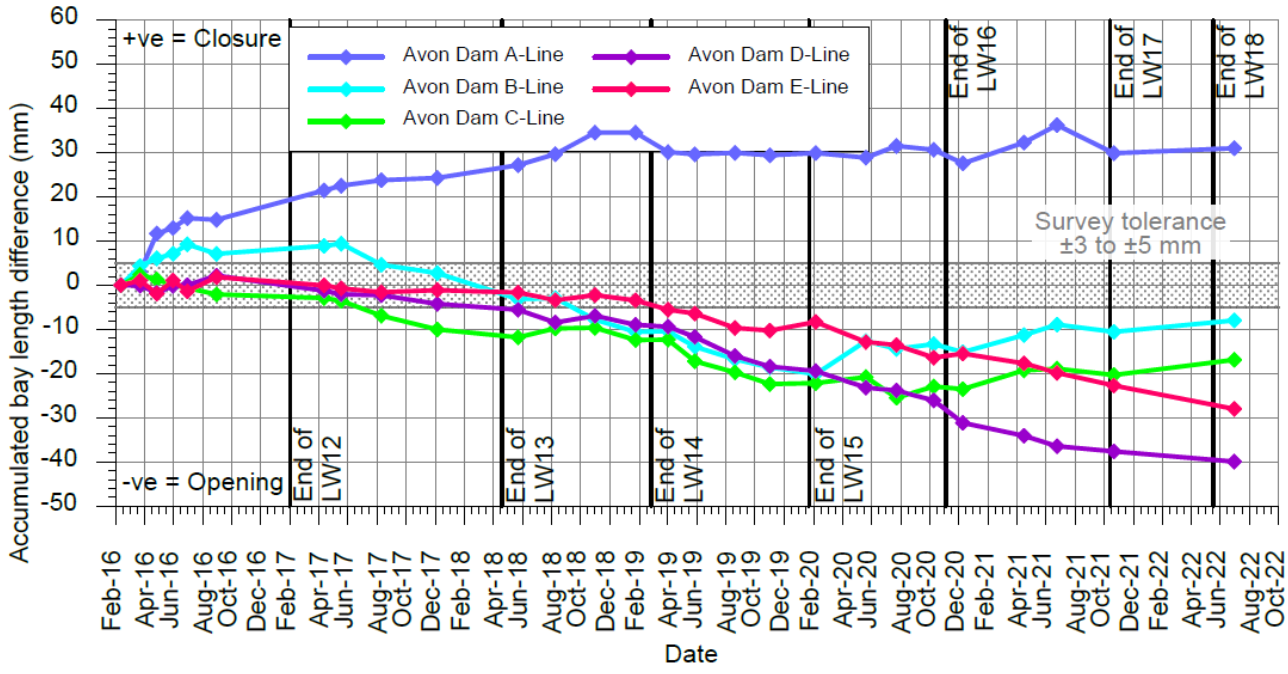

Figure 3: Measured accumulated closure for the Avon Dam closure lines. (Source: Attachment B).

2.3 Wongawilli Creek Tributaries and Avon Dam Tributary Cross Lines

The mine subsidence effects for LA2 (a tributary to Lake Avon) have been measured by IMC using 2D survey techniques using the LA2 RB2-Line and LA2 RB13-Line. Only low-level closure has been measured at the LA2 RB2-Line due to the mining of part LW15 to LW18. This movement is similar to the order of survey tolerance. There was a reduction in the closure measured at the LA2 RB13-Line during the mining of Longwall 18. The ground movements measured using LA2 RB13-Line are less than the predictions.

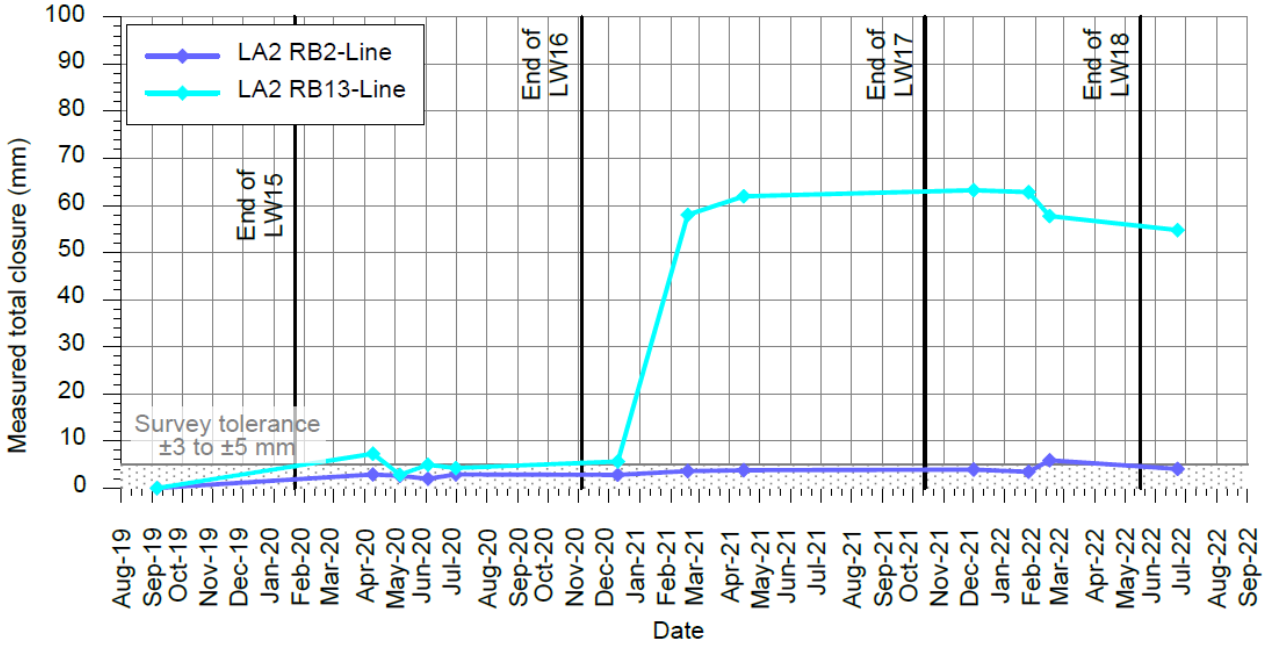

Figure 4: Measured total closure for LA3 cross lines due part Longwall 15 to Longwall 18 (Source: Attachment B).

The mine subsidence effects for WC7 and WC12 (tributaries to Wongawilli Creek) have been measured by IMC using 2D survey techniques using the WC7 RB7-Line and WC12 RB18-Line, respectively. The mining of Longwall 18 has resulted in negligible change (i.e. less than 2 mm) in the closure measured at the WC7 RB7-Line and WC12 RB18-Line. The measured incremental movements are in the order of survey tolerance. Only low-level vertical subsidence and closure have been measured at the WC7 RB7-Line which are similar to the order of survey tolerance. The ground movements measured at the WC12 RB18-Line are less than the predictions

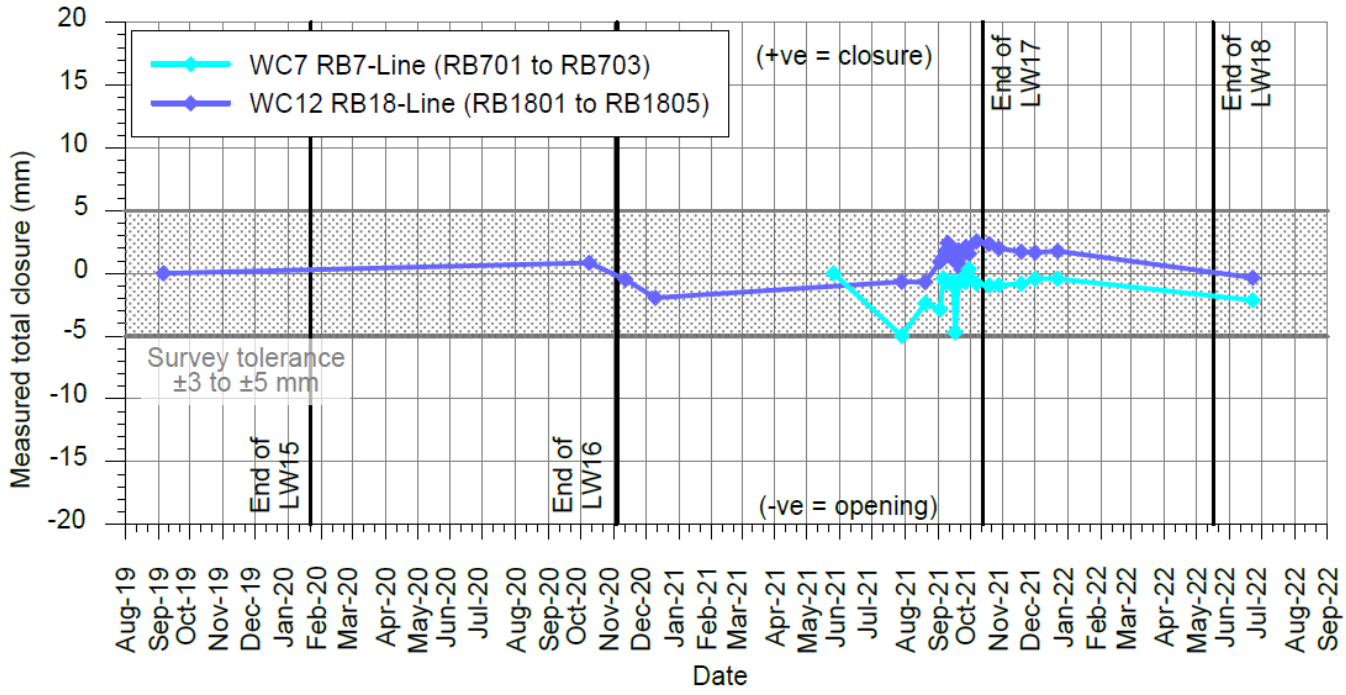

Figure 5: Measured accumulative total for the WC7 and WC12 cross lines (Source: Attachment B).

The mine subsidence effects for WC15 (a tributary to Wongawilli Creek) have been measured by IMC using 2D survey techniques at the WC15 RB34-Line. The subsidence and closure measured at the WC15 RB34-Line are less than the predicted values.

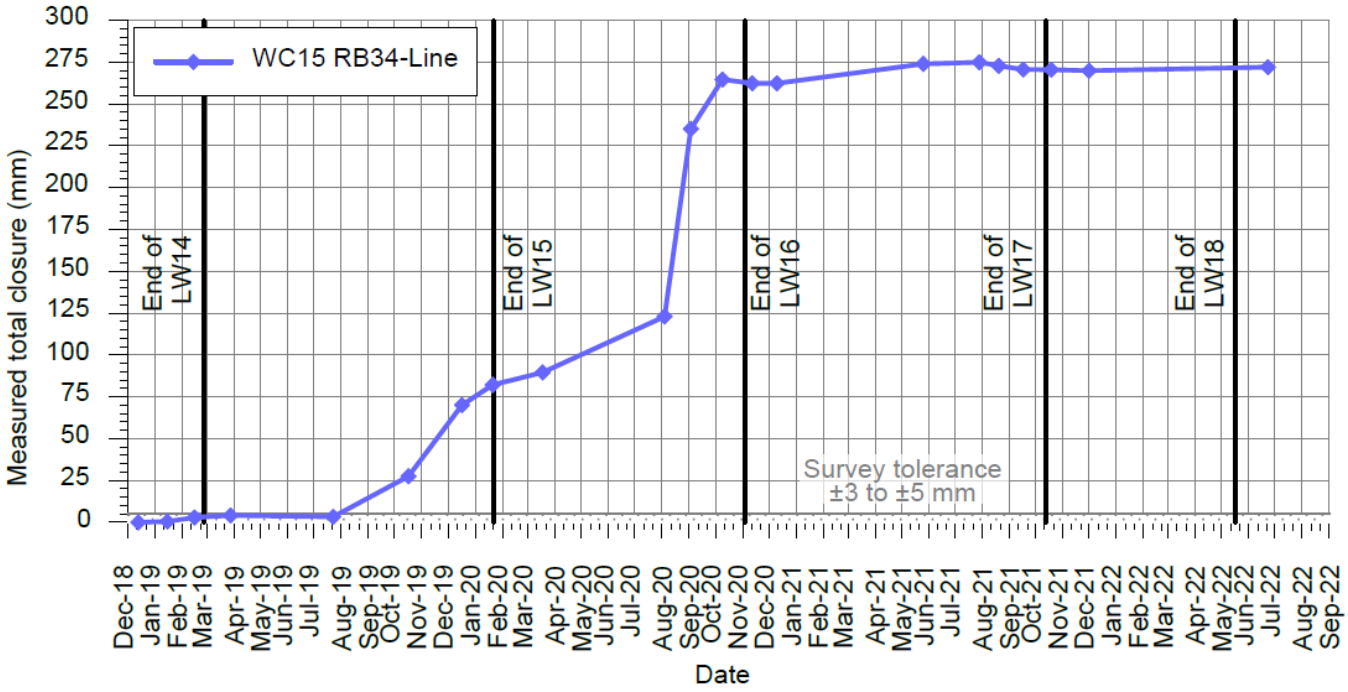

Figure 6: Measured cumulative closure for the WC15 RB34-Line due to Longwall 14 to Longwall 18 (Source: Attachment B).

2.4 Wongawilli Creek - Waterfall 54

The mine subsidence effects for Waterfall 54 (WF54) along Wongawilli Creek have been measured by IMC using 2D survey techniques using the WF54 A-Line, B-Line and C-Line. The ground movements measured at monitoring lines WF54 A-Line, WF54 B-Line and WF54 C-line are less than the predicted values. Time Domain Reflectometry (TDR) monitoring was carried out in borehole S2478 near the waterfall. The TDR data indicated a localised movement occurred below the Hawkesbury sandstone (below the overhang of the waterfall) during the mining of Longwall 17. This localised movement is consistent with the period when closure was developing during the later stages of Longwall 17. There were no localised movements identified in the TDR data during the mining of Longwall 18.

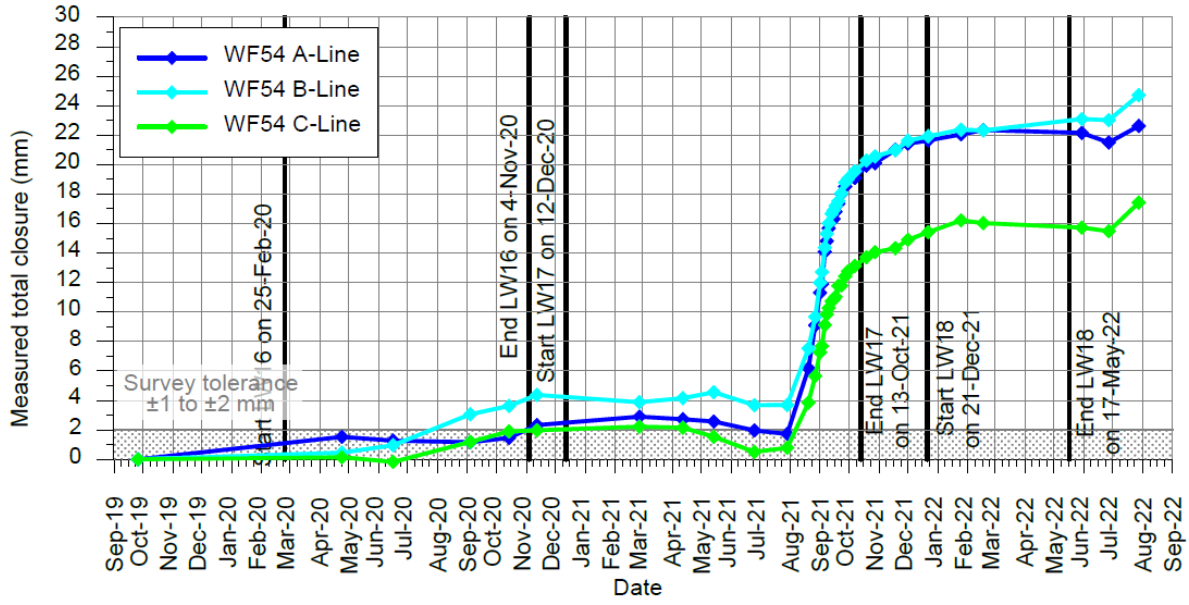

Figure 7: Measured accumulative closure for WF54 A-Line to C-Line (Source: Attachment B).

2.5 Swamp 35A Cross Line

The mine subsidence movements across swamp 35A have been measured using 2D survey techniques. Other swamp monitoring lines are located outside the zone of influence for this longwall. The measured closure at the SW35A-Line is less than the predicted value.

2.6 Dendrobium Area 3B 3D and the Avon Dam 3D monitoring points

The far-field horizontal movements near Longwall 18 have been measured using DA3B 3D monitoring points and the Avon Dam 3D monitoring points (Figure 1). The accuracies of the measured absolute positions (i.e. Eastings and Northings) are in the order of ±20 mm. The vectors of incremental horizontal movement above Longwall 18 are orientated towards the south. The greatest movements have been measured directly above Longwall 18. Only low level incremental horizontal movements have been measured outside the extents of the mining area. The comparison between the maximum measured incremental horizontal movements at the DA3B 3D and Avon Dam 3D monitoring points with those previously measured in Dendrobium Area 1 (DA1 3D), Dendrobium Area 2 (DA2 3D) and Dendrobium Area 3A (DA3A 3D), as well as other collieries in the Southern Coalfield, is provided in Figure 9. The mean and the 95 % confidence level for the 3D monitoring data at Dendrobium Mine are also shown in figure.

The measured incremental horizontal movements resulting from the extraction of Longwall 18 are within the range of those measured at similar distances from previously extracted longwalls at Dendrobium Mine and elsewhere in the Southern Coalfield.

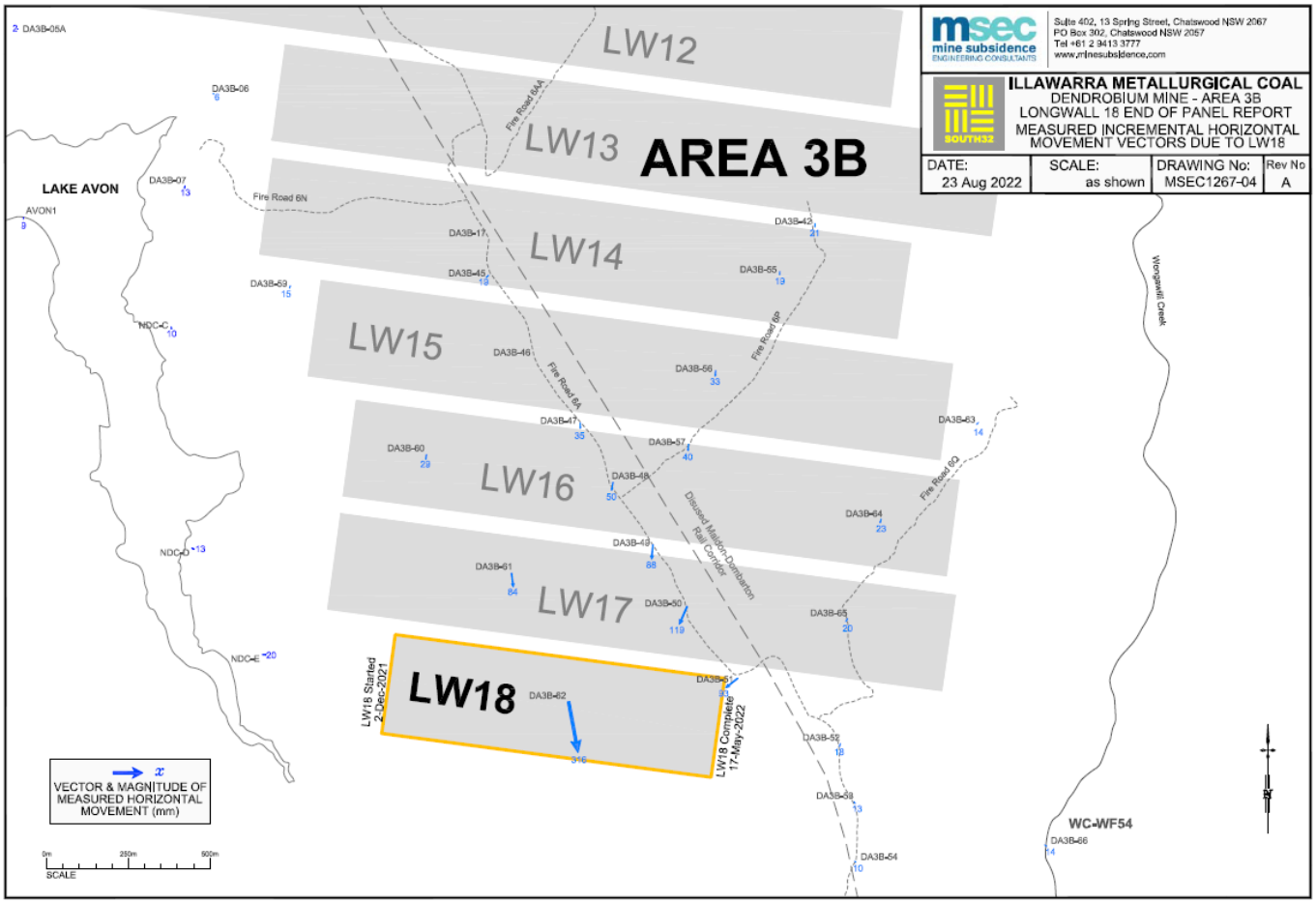

Figure 8: Incremental horizontal movement vectors following the extraction of Longwall 18. (Source: Attachment B).

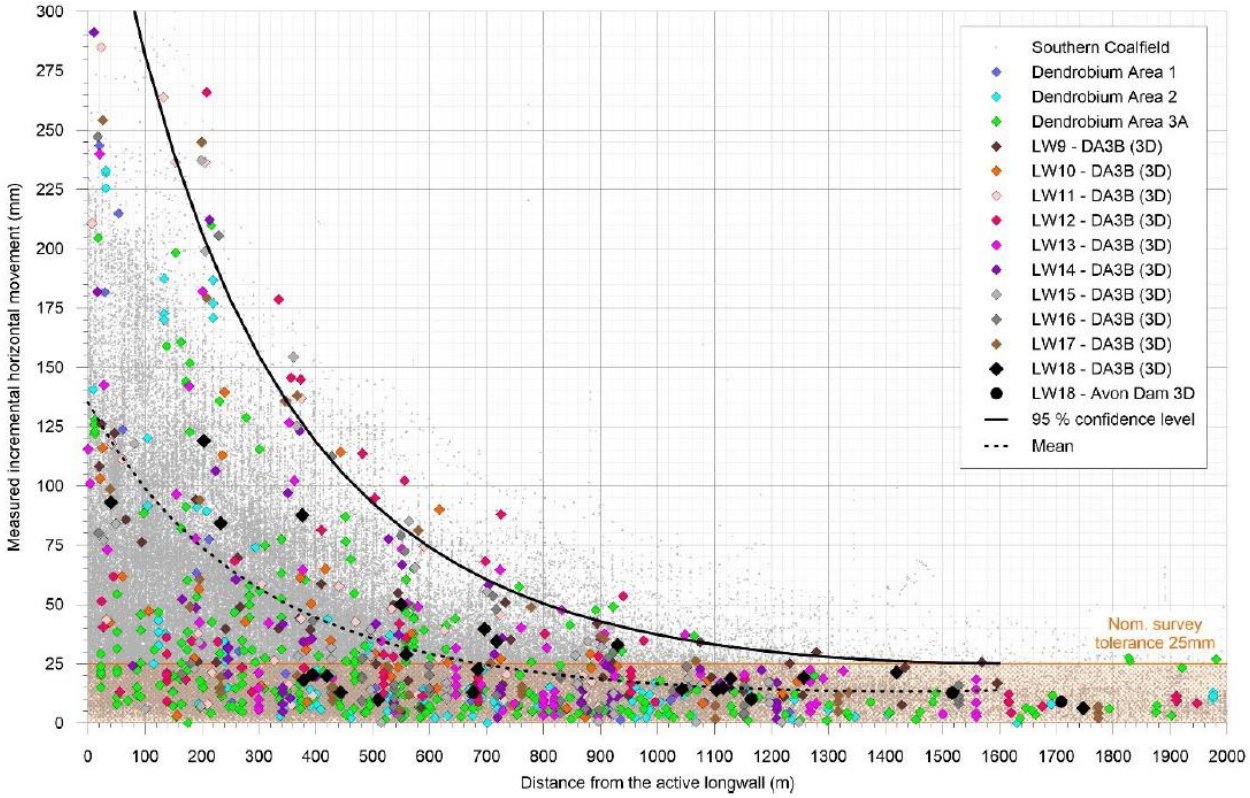

Figure 9: Measured incremental horizontal movements at Dendrobium Mine. (Source: Attachment B).

2.7 Airborne Laser Scanner (ALS) / LiDAR Surveys

The changes in surface level due to the extraction of Longwall 9 to Longwall 18 have been measured using Airborne Laser Scanning (ALS) / Light Detection and Ranging (LiDAR) surveys. The original survey carried out in January 2013 (i.e. prior to the extraction of Longwall 9) does not cover the full extent of Longwall 18. Hence, the survey carried out in January 2016 (i.e. prior to the mining of Longwall 12) has been adopted as the base survey. The post mining surface level contours have been determined from the subsequent surveys carried out after the completion of each longwall. The changes in surface level were determined by calculating the differences between pre-mining surface levels and post-mining surface levels, incrementally (Figure 10), and cumulatively (Figure 11).

The profiles of the measured changes in surface level reasonably match the predicted profiles of vertical subsidence along each of the cross-sections and long-section (Figure 12 to Figure 13). The maximum measured changes in surface level above each of the longwalls are less than the maximum predicted values. Also, the measured changes in surface level above each of the chain pillars are similar to or less than the predicted values in these locations.

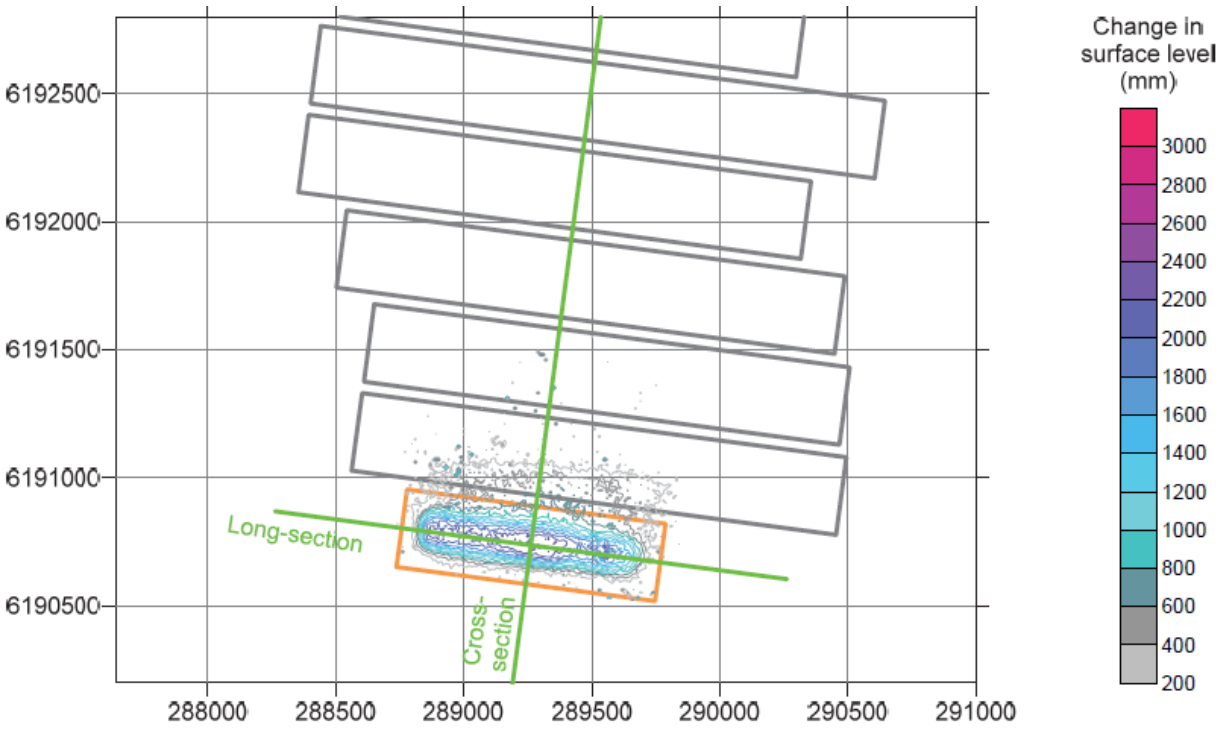

Figure 10: Measured incremental changes in surface level due to the extraction of Longwall 18. (Source: Attachment B).

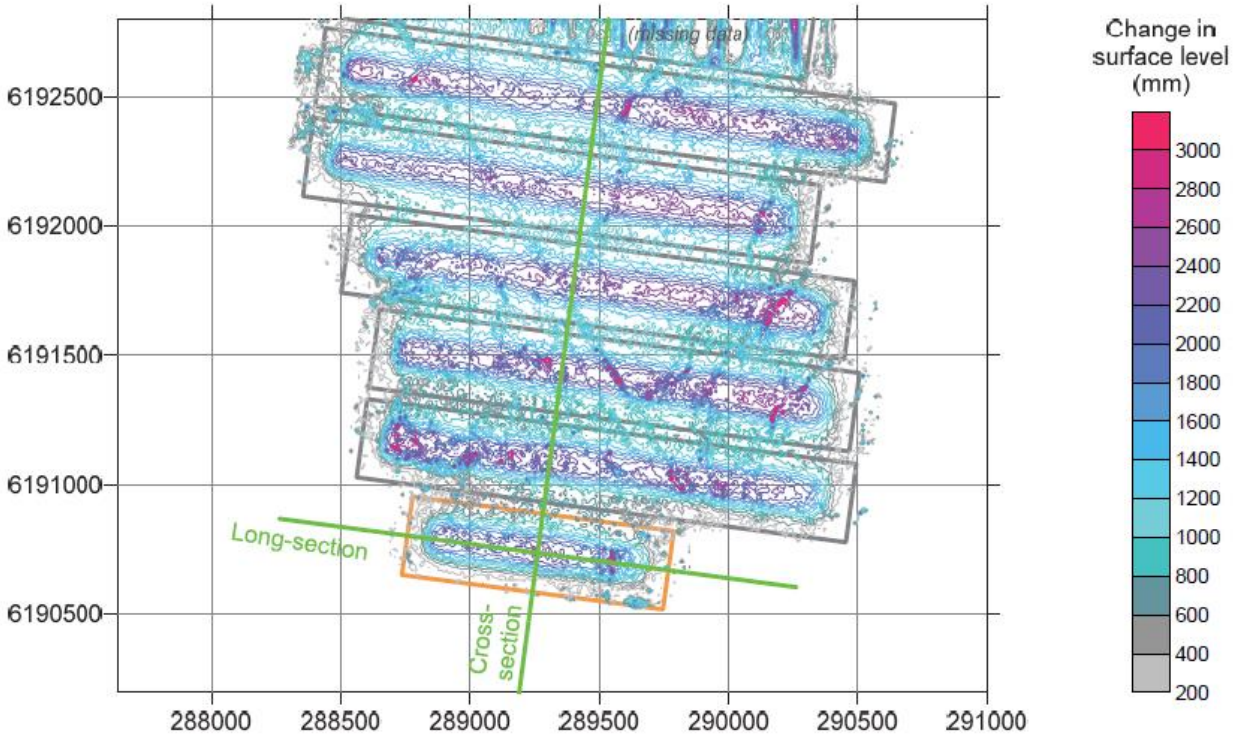

Figure 11: Measured cumulative changes in surface level due to the extraction of Longwall 12 to Longwall 18. (Source: Attachment B).

The measured change in surface level along Long-section 1 (Figure 13) is greater than the predicted vertical subsidence above the commencing end of Longwall 18 (i.e. left side of figure). However, this may be partly due

to the surveying tolerance and the effects of the horizontal movements and sloping terrain on the LiDAR surveys. The ground directly above the commencing end of Longwall 18 has moved towards the longwall (i.e. following the extraction face). The natural surface dips towards the west in this location (i.e. towards Avon Dam). The mining-induced horizontal movement, therefore, results in the measured changes in level at a fixed position to be greater than the true vertical subsidence above the commencing end of Longwall 18. There are localised areas outside of the longwalls where the measured changes in surface level exceed the predicted vertical subsidence. However, these are artefacts of the LiDAR surveys and are not real movements. Elsewhere, the low-level movements are in the order of accuracy of the measurement method. It is considered that the subsidence movements measured using the LiDAR surveys are consistent with the predicted subsidence movements.

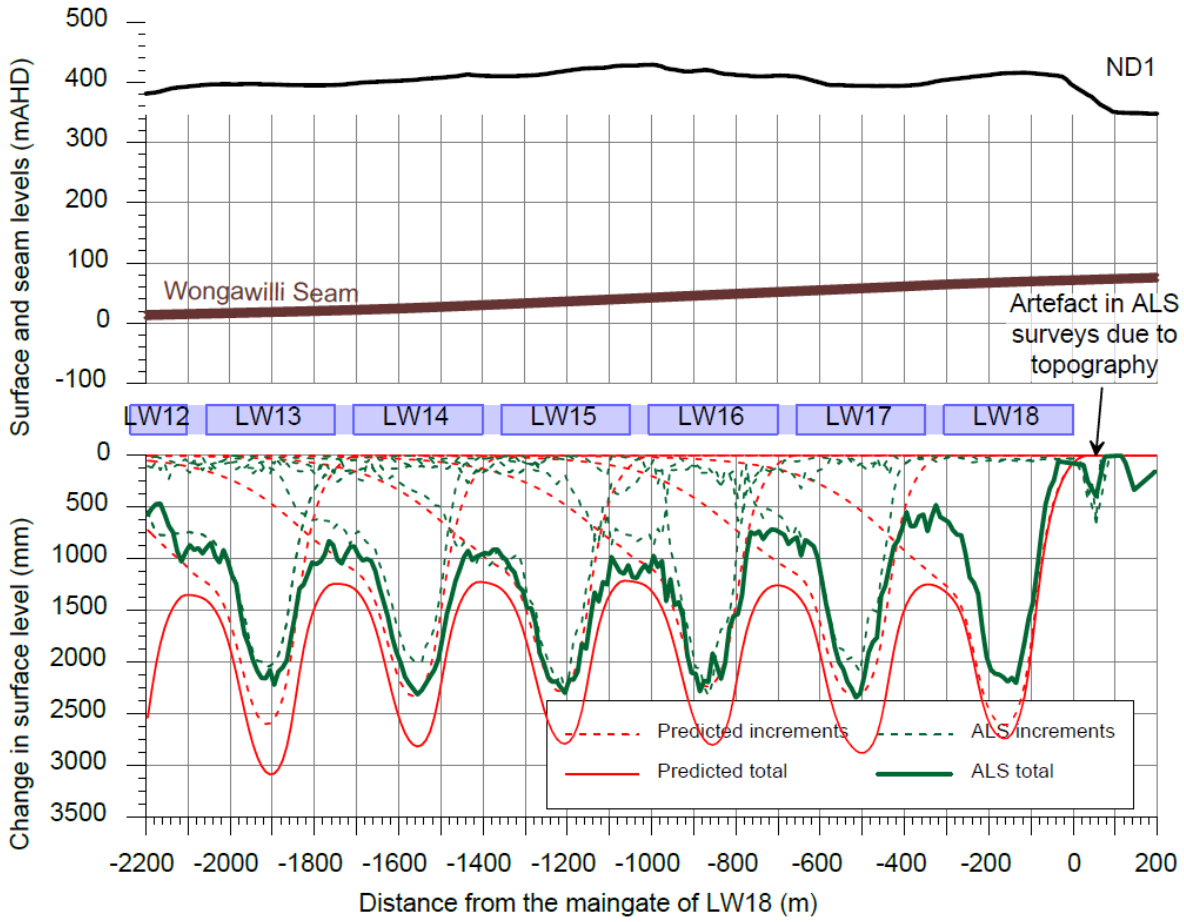

Figure 12: Measured changes in surface level and predicted vertical subsidence along Cross-section. (Source: Attachment B).

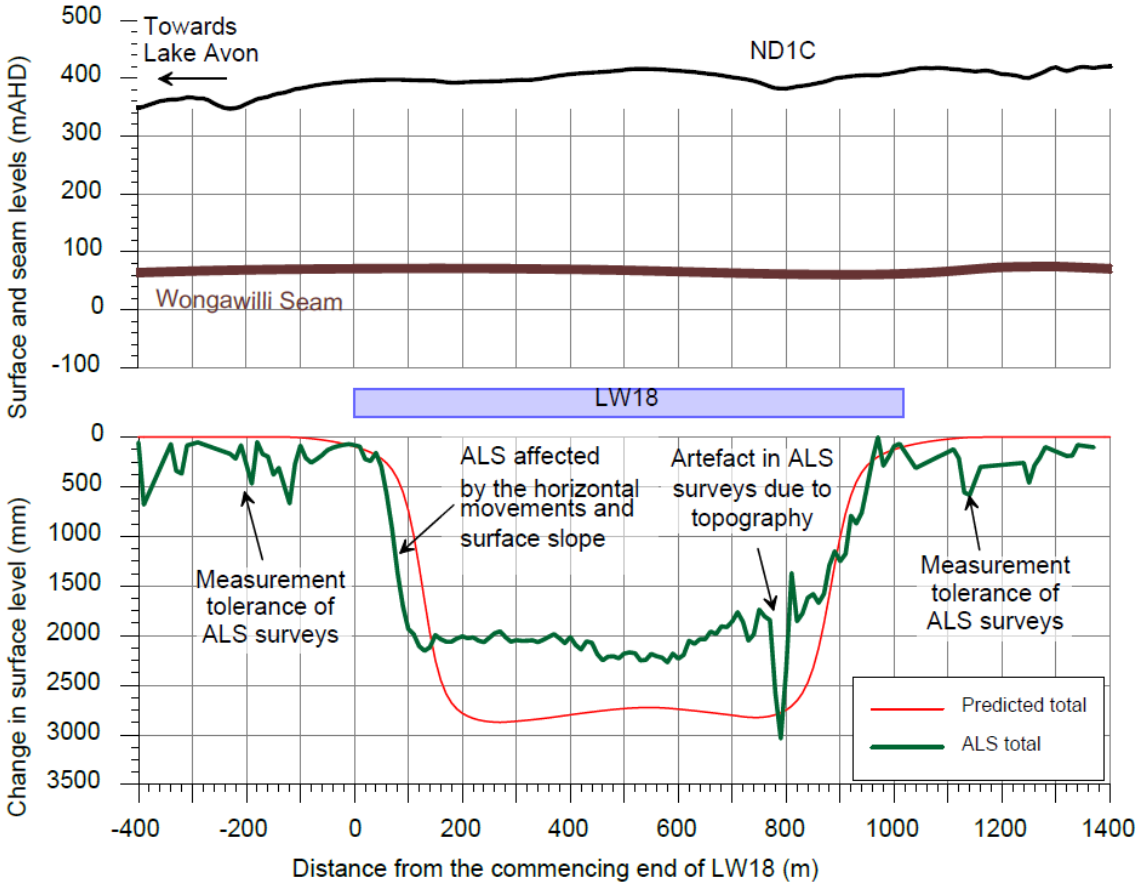

Figure 13: Measured changes in surface level and predicted vertical subsidence along long-section. (Source: Attachment B).

3 IMPACTS TO NATURAL FEATURES

During the extraction of Longwall 18, 24 new surface impacts were identified. These impacts are labelled as *DA3B_LW18_001* to *DA3B_LW18_024*.

The monitoring program for Longwall 18 was conducted in accordance with the SMP, Watercourse Impact Monitoring Management and Contingency Plan (WIMMCP) and Swamp Impact Monitoring Management and Contingency Plan (SIMMCP). The monitoring program is outlined in Section 6. The results of the IMCEFT monitoring are provided in **Attachment C1**; the impact reports submitted during the extraction of Longwall 18 are provided in **Attachment C2**. The results of monitoring undertaken by specialist consultants are provided in **Attachments D to G**. Figure 17 illustrates the location of surface impacts identified during the extraction of Longwall 18.

3.1 Landscape Features

Subsidence includes vertical and horizontal movement of the land surface, which can result in surface and subsurface cracking, uplifting, buckling, dilation and tilting. These impacts can affect watercourse hydrology and morphology, swamp hydrology and ecological function, and other landscape features by means of surface cracking, which can lead to erosion and rockfalls. Potential mine subsidence impacts within DA3B are discussed in the DA3B SMP, WIMMCP and SIMMCP.

An overview of impacts observed during the extraction of Longwall 18 is provided in the following sections. For specific details on the impacts, refer to the relevant impact reports (**Attachment C2**).

3.1.1 Impacts to First and Second Order Streams

Impacts recorded to first and second order streams are presented below (Table 3)

Table 3: Summary of impacts to first and second order streams

Site ID	Easting	Northing	Impact Type	Feature Affected	IdentificationDate	TriggerLevel	Description	Refer to Impact Report/sDated
DA3B_LW18_024	288499	6191616	Iron Staining	LA3	16/08/2022	1	Iron staining in tributary LA3	19/8/2022
*DA3B_LW17_041**	290813	6190391	Rockfall and Iron Staining	Waterfall 54	2/08/2022	Exceeding Prediction	Rockfall to Waterfall 54	8/08/2022

** DA3B_LW17_041 has been included in this report as the impact was identified after the submission of the Longwall 17 End of Panel report.*

Photo 1: *DA3B_LW18_024*, Iron Staining in tributary LA3, taken on 16/08/2022.

Photo 2: *DA3B_LW17_041*, Rockfall and Iron Staining at Waterfall 54, taken on 2/08/2022.

3.1.2 Impacts to Other Landscape Features

Impacts recorded on steep slopes, steps and general landscape features are presented below (Table 4).

Table 4: Summary of Impacts to other landscape features.

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/sDated
DA3B_LW18_001	288784	6191476	Rock Fracturing, Uplift and Fragmentation.	Rock Outcrop	14/12/2021	1	Rock fracturing to a rock outcrop to the south of Swamp 23.	15/12/2021
DA3B_LW18_002	288976	6190704	Rock Fracturing	Rock Outcrop/ Steep Slope	31/01/2022	1	Rock fracturing and soil cracking to a rock outcrop/steep slope west of Fire Road 6A.	31/01/2022
DA3B_LW18_003	288940	6190704	Rock Fracturing, Uplift and Soil Cracking	Rock Outcrop	31/01/2022	2	Rock fracturing to a rock outcrop west of Fire Road 6A.	31/01/2022
DA3B_LW18_004	288864	288948	Rock Fracturing & Uplift	Rock Outcrop	9/02/2022	1	Rock fracturing to a rock outcrop west of Fire Road 6A.	9/02/2022
DA3B_LW18_005 (Update)	288816	6190861	Rockfall	Steep Slope/ Step	9/02/2022	2	Displacement between rock/soil and soil cracking at a steep slope west of Fire Road 6A.	9/02/2022 & 1/07/2022
DA3B_LW18_006	288948	6190672	Rockfall	Steep Slope/Step	15/02/2022	2	Soil cracking to bushland near an access track west of Fire Road 6A.	16/02/2022
DA3B_LW18_007	288950	6190822	Rock Fracturing	Rock Outcrop	8/06/2022	1	Rock fracturing to rock outcrop west of Fire Road 6A.	15/06/2022

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/sDated
DA3B_LW18_008	288822	6190753	Soil Cracking	Bushland	9/06/2022	2	Soil cracking near access track west of Fire Road 6A.	15/06/2022
DA3B_LW18_009	289595	6190657	Rock Displacement, Fracturing and Fragmentation	Rock Outcrop	9/06/2022	2	Rock fracturing, displacement and fragmentation in bushland near NDC1.	15/06/2022
DA3B_LW18_010	289751	6190685	Rockfall and Fragmentation	Cliffline	10/06/2022	1	Rockfall at 7m high cliffline, west of Fire Road 6A.	15/06/2022
DA3B_LW18_011	289776	6190685	Rockfall	Rock Outcrop	10/06/2022	1	Rockfall to 4m high rock outcrop, west of Fire Road 6A.	15/06/2022
DA3B_LW18_012	288802	6190825	Soil Cracking	Bushland	30/06/2022	2	Soil cracking near access track west of Fire Road 6A.	1/07/2022
DA3B_LW18_013	289038	6191123	Rock Fracturing and Fragmentation	Steep Slope/Step	16/08/2022	1	Rock fracturing and fragmentation to steep slope/step north of LA2.	19/08/2022
DA3B_LW18_014	288978	6191094	Rock Fracture	Steep Slope/Step	16/08/2022	2	Rock fracture to steep slope/step north of LA2.	19/08/2022
DA3B_LW18_015	288920	6191077	Rock Fracturing	Steep Slope/Step	16/08/2022	1	Rock fracturing to steep slope/step north of LA2.	19/08/2022
DA3B_LW18_016	288886	6191095	Rock Fracturing	Steep Slope/Step	16/08/2022	2	Rock fracturing to steep slope/step north of LA2.	19/08/2022

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/sDated
DA3B_LW18_017	288877	6191083	Rock Displacement and Rockfall	Steep Slope/Step	16/08/2022	1	Rock displacement and rockfall to steep slope/step north of LA2.	19/08/2022
DA3B_LW18_018	288841	6191078	Rock Fracturing and Rockfall	Steep Slope/Step	16/08/2022	1	Rock fracturing and rockfall to steep slope/step north of LA2.	19/08/2022
DA3B_LW18_019	288821	6191105	Rock Fracture	Steep Slope/Step	16/08/2022	1	Rock fracture to steep slope/step north of LA2.	19/08/2022
DA3B_LW18_020	288808	6191114	Rockfall	Steep Slope/Step	16/08/2022	1	Rockfall to steep slope/step north of LA2.	19/08/2022
DA3B_LW18_021	288826	6191147	Rock Fracturing	Rock Outcrop	16/08/2022	2	Rock fracturing to rock outcrop north of LA2.	19/08/2022
DA3B_LW18_022	288932	6191153	Rockfall	Steep Slope/Step	16/08/2022	1	Rockfall to steep slope/step north of LA2.	19/08/2022
DA3B_LW18_023	288971	6191224	Soil Cracking	Bushland	16/08/2022	2	Soil cracking in bushland north LA2.	19/08/2022

Photo 3: *DA3B_LW18_001,* Rock fracturing south of Swamp 23. Taken on 14/12/2021.

Photo 4: *DA3B_LW18_002,* Rock fracturing and soil cracking west of Fire Road 6A. Taken on 31/01/2022.

Photo 5: *DA3B_LW18_003,* rock fracturing west of Fire Road 6A. Taken on 31/01/2022.

Photo 6: DA3B_LW18_004, Rock fracturing west of Fire Road 6A. Taken on 30/06/2022.

Photo 7: DA3B_LW18_005, Displacement between rock/soil and soil cracking west of Fire Road 6A. Taken 30/6/2022.

Photo 8: *DA3B_LW18_006,* Soil cracking to bushland near access track west of Fire Road 6A. Taken on 21/06/2022.

Photo 9: *DA3B_LW18_007,* rock fracturing west of *Fire Road 6A*. Taken on 8/06/2022.

Photo 10: *DA3B_LW18_008,* Soil cracking near access track west of Fire Road 6A. Taken on 9/06/2022.

Photo 11: *DA3B_LW18_009,* rock fracturing, displacement and fragmentation in bushland near NDC1. Taken on 09/06/2022.

Photo 12: DA3B_LW18_010, Rockfall at 7m high cliffline, west of Fire Road 6A. Taken on 10/06/2022.

Photo 13: DA3B_LW18_011, Rockfall to 4m high rock outcrop, west of Fire Road 6A. Taken on 10/06/2022.

Photo 14: DA3B_LW18_012, Soil cracking near access track west of FR6A. Taken 30/6/2022

Photo 15: DA3B_LW18_013, Rock fracturing and rock fragmentation, northern slope of LA2 valley. Taken 16/8/2022.

Photo 16: DA3B_LW18_014, Rock fracturing and rock fall, northern slope of LA2 valley. Taken 16/8/2022.

Photo 17: DA3B_LW18_015, Rock fracturing, northern slope of LA2 valley. Taken 16/8/2022.

Photo 18: DA3B_LW18_016, Rock fracturing, northern slope of LA2 valley. Taken 16/8/2022.

Photo 19: DA3B_LW18_017, Rock displacement and rock fall, northern slope of LA2 valley. Taken 16/8/2022.

Photo 20: DA3B_LW18_018, Rock fracturing and rock fall, northern slope of LA2 valley. Taken 16/8/2022.

Photo 21: DA3B_LW18_019, Rock fracturing, northern slope of LA2 valley. Taken 16/8/2022.

Photo 22: DA3B_LW18_020, Rock fall, northern slope of LA2 valley. Taken 16/8/2022.

Photo 23: DA3B_LW18_021, Rock fracturing, Rock outcrop north of LA2 valley. Taken 16/8/2022.

Photo 24: DA3B_LW18_022, Rock fall, northern slope of LA2 valley. Taken 16/8/2022.

Photo 25: DA3B_LW18_023, Soil cracking, bushland north of LA2 valley. Taken 16/8/2022.

3.2 Surface Water Quality

The monitoring of water quality parameters provides a means of detecting and assessing the effects of streambed fracturing or induction of ferruginous springs. Monitoring includes measurement of field parameters such as pH, EC, DO, oxygen reduction potential (ORP) and a suite of laboratory-tested analytes. At *LA4_S1*, a TARP level of Exceeding Prediction was recorded for pH and EC, and a Level 1 TARP for DO (Table 5).

Table 5: Summary of water quality TARP triggers during the extraction of Longwall 18.

Monitoring Site	Observation	Water Quality Trigger
LA4_S1	EC	Exceeding Prediction
	pH	Exceeding Prediction
	DO	Level 1

Rainfall during Longwall 18 extraction was well above average, totalling 2281 mm in the calendar year to the end of the longwall. Extremely heavy rainfall was experienced in March 2022 when 1010 mm was recoded in a single month. This follows similarly high rainfall in 2020 (1436 mm) and 2021 (1448 mm) due to sustained La Nina conditions over that period. As a result, there has been a full recovery in stream flow, shallow groundwater levels and soil moisture across all catchments since the severe drought of 2017-2019.

At many stream monitoring sites including reference sites, water electrical conductivity (EC) has decreased over the last three years due to higher-than-average rainfall and significant increase in runoff compared with the previous two years. The decreasing trend follows slightly more saline conditions at most locations during the 2017-2019 drought which resulted in low flows and evaporative concentration of salts. Similarly, DO has trended higher or remained stable over the reporting period due to higher flows and stream turbulence.

Anomalous water quality effects are noted in watercourses that have been directly mined under by previous longwalls (e.g. WC21, SC10C, LA4, DCC). Those effects include transient or persistent increases in EC, increases (or decreases) in pH and increases in dissolved metal concentrations such as Fe, Mn, Al and Zn. Water quality TARPs were triggered at Lake Avon tributary site *LA4_S1* for EC, pH and DO.

Iron staining in creek beds is commonly associated with watercourses that have been directly mined beneath or are within the mining area of influence. Over the last two years, new or recurrent iron staining has been noted on Wongawilli Creek, WC21, LA5 and SC10C. The observations of iron staining are likely related to recovery of groundwater levels and the reactivation of iron-rich springs near creek channels.

Further details are presented in **Attachment D**.

3.3 Surface Water Hydrology

The four surface water hydrology assessment methods are as follows:

(A) General hydrological behaviour compared with Reference Sites,

(B) The frequency and duration of ecologically-significant cease-to-flow events compared with ReferenceSites;

(C) Changes to median flow compared with Reference Sites which is now the agreed measure of the water resource availability in each sub-catchment; and

(D) Comparison of qualitative flow data from gauging stations and semi-quantitative field observations by IMCEFT along the "middle reach" of Wongawilli Creek.

Table 6 summarises these surface water hydrology assessments at monitoring sites against the TARPs.

The assessments indicate that sub-catchments in the upper part of the Donalds Castle Creek catchment (i.e. *DC13S1* and *DCS2*) have been and continue to be affected by mining, as are the tributaries LA4, LA3 and LA2 of Lake Avon. The findings for *DC13S1*, *DCS2* (both at Level 3 for all three flow assessments) are similar to those for the EoP report for Longwalls 15 to Longwall 17.

Similarly, the flow characteristics at *WC21S1* and *WC15S1* within the Wongawilli Creek catchment have altered as a result of mining, with these sites at Levels 2 or 3 for the three assessments. As with the sub-catchments above, the effects at WC21 and WC15 are similar to those for the previous EoP reports. Despite Longwall 16 terminating within 50m of WC12, and the end of Longwall 17 mining under WC12, no mining-related effects are discernible beyond natural variability/method accuracy.

As in recent EoP reports, analysis indicates that mild mining effects are probable at the Donalds Castle Creek downstream monitoring site (*DCU*). Specifically, the TARP assessments indicate that the general pattern of flow (Assessment A) and the median flows (Assessment C) do not trigger, which suggest that any mining effects or impacts on those indicators are of similar magnitude or less than natural variability. However, the new Assessment B, which examines cease-to-flow duration and frequency, indicates that the watercourse at *DCU* has been experiencing a mild increase in the number of cease-to-flow days compared to the Reference sites (TARP Level 1).

Changes to stream flow characteristics are not evident at the downstream gauge on Wongawilli Creek Lower (*WWL*), despite mining-related effects being clear and significant at upstream tributaries (e.g. WC21, WC15). This suggests that some or all flow lost in headwater catchments is returned downgradient, or that upstream diversions or losses are not significant in relation to the larger catchment water balance given the natural variability and the accuracy of flow measurements. These possible reasons are even more relevant at *DCU*, where the losses identified in upstream sites *DC13S1* and *DCS2* are 40-60% of median flow at Q50. Such losses should be clearly apparent at *DCU* if they were transmitted downstream, but the assessment has not detected a change in median flow at Q50 beyond natural variability (i.e. variability at two Reference sites).

Post-mining behaviour of water levels at WF54 was consistent with pre-mining record, and assessment in the Longwall 17 EoP report found that that Longwall 17 did not have an effect on water levels at the site (either no effect or an effect that cannot be discerned beyond natural variability). However, further analysis suggests that there has been a change in relationship between WF54 pool levels and those at WWU since mid-December

2021. The reason for this change is currently unclear but appears to correlate with high rainfall events. The changes are unlikely related to mining however further investigation is underway.

Analysis of available surface water flow observation records for Wongawilli Creek did not trigger TARP Assessment D for any of the months assessed during the Longwall 18 period.

Water flow performance measures were met for Longwall 18 (Table 7). Further details are presented in **Attachment D**.

Table 6: Summary of Surface Water flow triggers for Longwall 18.

Site	Watercourse	Catchment Mined under?	Position of sub-catchment in relation to mining	A) Low flow Q%ile outside Reference Site Q%ile	B) Change in cease-to-flow frequency (beyond natural)	C) Change in median flow,Q50 (beyond natural)	Comment
DC13S1	DC13	Yes	Above LWs	Level 3	Level 2	Level 3	Similar to LW14-17.
DCS2	Donalds Castle Creek	Yes	Above LWs	Level 3	Level 3	Level 3	Similar to LW14-17.
DCU	Donalds Castle Creek	Yes	Downstream	Not triggered	Level 1	Not triggered	Similar to LW14-17. Rainfall-runoff modelling supports this finding.
WC21S1	WC21	Yes	Above LWs	Level 3	Level 1	Level 3	Similar to LW14-17, slight improvement in Assessment B..
WC15S1	WC15	Yes	Above LWs	Level 3	Level 2	Level 3	Similar to LW15-17. Flow monitoring method means that Method B assessment assess low flows, not true ‘cease-to-flow’.
WC12S1	WC12	Yes	Above LWs	Not triggered	Not triggered	Not triggered	Second panel under catchment. No discernible effect. Rainfall-runoff modelling suggests **Level 1** impact.
WWL	Wongawilli Creek	Yes	Downstream	Not triggered	Not triggered	Not triggered	Similar to LW14-17. Rainfall-runoff modelling supports this finding.
LA4S1	LA4	Yes	Above LWs	Level 3	Level 3	Level 3	Similar to LW14-17, with improved data availability. Flow monitoring method means that Method B assessment assess low flows, not true ‘cease-to-flow’.
LA3S1	LA3	Yes	Above LWs	Level 3	Level 3	Level 3	Similar to LW16-17.
LA2S1	LA2	Yes	Above LWs	Level 2	Not triggered	Level 3	Pattern of flow changed during LW18, but broadly similar to LW17.
ND1S1	ND1	Yes	Headwater	Not triggered	Not triggered	Not triggered	LW18 mines under part of ND1 tributaries. No discernible effects. However, rainfall-runoff modelling suggests **Level 3** impact.

Site Watercourse		Comment
Wongawilli Creek	Not triggered	Refer to Performance Measures

Table 7: Summary of surface water Performance Measures for Longwall 18.

Wongawilli Creek – minor environmental consequences	**This Performance Measure is met.**
Donalds Castle Creek – minor environmental consequences	**This Performance Measure is met.**
Avon Dam – negligible reduction in the quantity of surface water inflows to Avon Dam	**This Performance Measure is met.**
Cordeaux River – negligible reduction in the quantity if surface water inflow to the Cordeaux River at its confluence with Wongawilli Creek.	**This Performance Measure is met.**

Further details are presented in **Attachment D.**

3.4 Deep Groundwater Hydrology

Groundwater monitoring at Dendrobium Mine is conducted in accordance with the "Dendrobium Colliery Area 3B SMP Groundwater Management Plan" (South32, 2012) and the Area 3B Subsidence Management Plan (BHP Billiton, 2015). The aims of the Groundwater Management Plan are to:

- Monitor groundwater levels and quality, commencing at least one year prior to mining affecting the system;
- Project potential groundwater changes during mining (short term) and post-mining (long term) with particular attention to the effect of changes to groundwater regime, impact on the catchment yield and interaction with the stored waters;
- Identify hydraulic characteristics of overlying and intercepted groundwater systems, and determine changes to groundwater systems due to coal extraction and dewatering operations;
- Report any pumping tests and groundwater/surface water simulation studies; and
- Collect water level data from all agreed groundwater-monitoring locations.

Further details are presented in **Attachment E.**

3.4.1 Mine Water Balance

The System Control and Data Acquisition (SCADA) system calculates a daily Mine Water Balance. The Water Balance is an accurate measure of all water that enters, circulates and leaves the mine, including via air moisture and coal moisture content. Mine water seepage (groundwater inflow), which cannot be directly measured, is determined by mass balance for each goaf and is therefore known to a reasonable accuracy. Key metrics of the Mine Water Balance are reported against TARP levels to Dams Safety NSW Monthly.

The average daily inflow to Area 3B during Longwall 18 extraction was 4.5 ML/day which represents 50% of total mine inflow for the period (a similar proportion to Longwall 16). Compared with the previous longwall, the total mine inflow increased by 11% whereas the inflow in Area 3B decreased by 14%. The increase in total mine inflow is likely due to very high rainfall during the longwall period, while the apparent decline in area 3B inflow is due to a pause in pumping from the area in March-April 2022.

Groundwater ingress to Area 3B increased steadily since the start of mining in that area (2013), initially correlating with the total area mined. Inflows to Area 3B plateaued and declined between 2017 and 2020, corresponding to the severe drought in south eastern Australia during that time. Since the start of 2020, the water balance for Area 3B has trended higher, correlating with the higher-than-average rainfall over the last two years. As of Longwall 12, peaks in inflow to Area 3B appear to correlate with periods of high rainfall with a lag time of between two and three months. Prior to Longwall 12, the influence of rainfall on the water balance was less distinct.

The modern water component in mine inflow is monitored by analysing tritium in samples collected from goaf inflow and development seepage water samples. The results are reported monthly to Dams Safety NSW. Tritium decays exponentially according to its half-life (12.32 years) and is typically only detectable in surface water samples and in groundwater that recharged within 4 to 5 half-lives (50 to 70 years). Detection of tritium above

deep groundwater baseline levels in mine inflow samples would indicate a component of modern water in the sample (as it does for samples from Area 2).

Tritium in samples collected from Area 3B goaf outflow is typically within or close to baseline concentrations in deep groundwater, implying that the component of modern water in mine inflow to Area 3B is very low. However, analysis and reporting of results from ANSTO can take 6 to 12 months. The most recent analysis of inflow water from Area 3B is of a sample collected on 21/10/2021, 6 weeks prior to the start of Longwall 18. The latest sample contained tritium at 0.15 TU, within the range of deep groundwater.

Carbon-14 (14C) has been analysed in mine water, groundwater and surface water samples since 2020 as an additional indicator of modern water. 14C is a radioactive isotope of carbon with a half-life of 5,730 years. All samples collected from the Area 3B goaf outflow tank (DWS203) have low percentage modern carbon (≤ 3.1%) which, together with low corresponding tritium concentrations, implies that inflow to Area 3B is dominated by deep, old groundwater sources with a very small proportion of modern water.

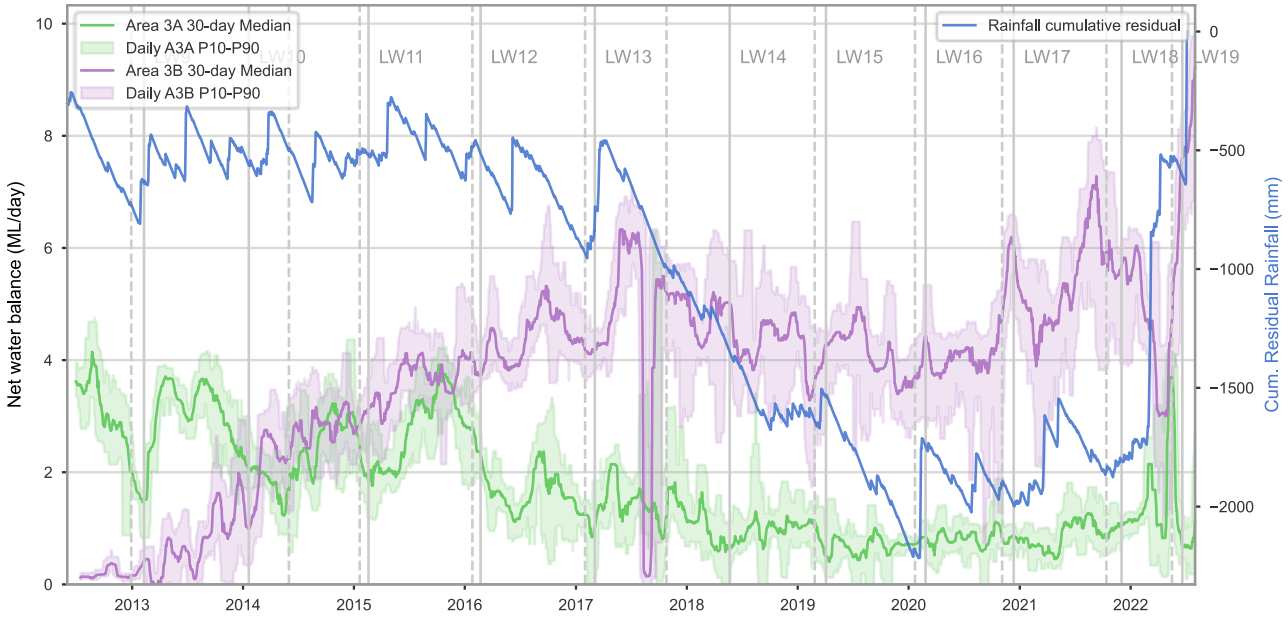

Figure 14: Groundwater inflow to the mine for DA3A and DA3B (ML/d).

3.4.2 Deep Groundwater Levels

Mining of Longwall 18 resulted in continued depressurisation of the target coal seam and overlying strata in general agreement with numerical model predictions. Importantly, for piezometers installed in the barrier zone between Lake Avon and Area 3B, observed groundwater drawdown is generally less than predicted. As expected, the greatest depressurisation is within the Wongawilli Coal Seam and deeper strata, and decreases with height above the seam.

Since 2018, IMC has carried out investigation drilling above extracted longwalls (Longwalls 6, 7, 12, 13, 14, 15, 16, 17 and 18) to characterise the height of fracturing and assess groundwater conditions in strata above the longwall goaf. In both Areas 3A and 3B, mining-induced fracturing, including high-angle fracturing is highly variable but appears to extend to the surface. Piezometers installed after longwall extraction indicate significant

depressurisation throughout all strata and throughout the Hawkesbury Sandstone in most holes.

Holes in both areas show positive pressure heads in some sensors in the upper Colo Vale Sandstone and Bald Hill Claystone and evidence for localised perching and groundwater recovery which continued in 2022. Drawdown in the Hawksbury Sandstone reduces with distance and is typically negligible at distances greater than 1.2km from the goaf footprint.

Piezometers located to the north and west, and within 1 km of the longwall footprint show a gradual decline in groundwater pressures in most strata with the rate of decline increasing with depth and proximity to the longwall. Those observations are consistent with the gradual expansion of a drawdown cone away from the mine and are in line with numerical modelling predictions. The most strongly affected strata are within 500 m of extracted longwalls

A hydrogeological investigation of the Elouera fault was carried out by IMC to assess the structural and hydrogeological characteristics of the Elouera Fault zone, and its potential to provide a connection between Lake Avon and the proposed longwalls. Seven inclined cored holes were drilled at three sites along the fault, four of which intersect the fault plane. IMC carried out a detailed hydrogeological investigation of the fault prior to Longwall 18 which concluded that the fault was unlikely to form a conduit to flow. Subsequent monitoring confirms this to be the case. No anomalous inflow was associated with structures intersected during Longwall 18 extraction. TDR monitoring shows no evidence for movement on the fault plan during or after Longwall 18. Piezometers installed within and across the fault show no anomalous drawdown within the fault core, indicating that the fault is not anomalously conductive along the fault plane.

3.4.3 Avon Dam Baseflow Loss

Piezometers in the Lake Avon barrier zone show widespread depressurisation of all strata in response to mining in Area 3B, as predicted in numerical groundwater models. The observed levels imply hydraulic gradients away from the lake and towards the mine adjacent to extracted longwalls. Seepage losses from Lake Avon have been estimated by regional and local scale numerical models to be in the range 0.09 to 0.89 ML/day as at the end of Longwall 18. The estimates are within the tolerable loss limit of 1 ML/day prescribed by Dams Safety NSW and supported by the low levels of tritium and 14C in mine inflow water in Area 3B.

3.4.4 Groundwater Chemistry

Previous reviews have shown that there is no clear spatial pattern in the distribution of groundwater quality in HBSS and BGSS bores. Groundwater salinity measured using electrical conductivity (EC) for all samples collected from monitoring bores in DA3A and DA3B, the groundwater salinity tends to increase with depth. Due to frequent catchment closures not all bores were accessed for sampling during Longwall 18. However, of the samples collected all are within 20% of the previous groundwater sample. Declining EC was reported in two monitoring bores located adjacent to Lake Avon (S2314_75m and S2436_35m) following Longwall 17. A review of water chemistry and isotopic data following Longwall 18 finds that the trend is not continuing. There is no adverse trend in isotopic indicators of groundwater age (14C and Tritium).

3.5 Impacts to Upland Swamps

3.5.1 Shallow Groundwater and Soil Moisture

Trigger levels for changes to groundwater and soil moisture levels at surface and near-surface monitoring sites at DA3B swamps have been established within the SIMMCP for Area 3B (South32, 2020b). Shallow groundwater level and soil moisture characteristics have been identified as an indicator of potential changes in ecosystem functionality of Upland Swamps.

Changes to groundwater are reported when measurements of water level drop below baseline levels or when rates of recession exceed those recorded during baseline monitoring. Groundwater level hydrographs for each shallow piezometer are presented in **Attachment D**. Each hydrograph is plotted with ground elevation and the elevation of the piezometer base, longwall timing, groundwater level recession rate (in mm/day), and the dates that longwalls pass under (if relevant) a piezometer. Assessment of mining effects is based on these hydrographs.

The soil moisture TARP has been assessed by comparing the moisture content of the soil profile during the longwall assessment period against that of the baseline period. If the average soil moisture level drops below the minimum level recorded during the baseline period, a TARP is triggered. Shallow groundwater at all reference sites recovered after the 2017-2019 drought as a result of higher-than-average rainfall from 2020 to 2022.

Longwall 18 passed beneath, or within 400m of Swamps 14, 149, 35a/b, 150, 151. It was predicted that swamps 14, 149 and 35a/b would be affected by mine subsidence due to mining in DA3B (South32 2020b). Soil moisture and shallow groundwater assessments for these swamps are summarised in Table 8 and Table 9.

Trigger levels are assessed differently by the IMCEFT and HGEO. The IMCEFT report triggers when groundwater or moisture decrease below the baseline level during the mining period whilst the HGEO assessment is conducted following the completion of Longwall 18 and considers other factors such as longer-term climatic conditions and reference swamp comparisons.

Further details are presented in **Attachment D**.

Table 8: Summary of soil moisture level TARP status at Longwall 18 impact sites.

Swamp	Sensors and TARP triggers			HGEO Comment	IMCEFT TARP Level	HGEO TARP Level
	Not Triggered	Triggered	Not within mine influence			
14		14_S01 14_S02		Soil moisture at S14_S01 below baseline in contrast to recovery at reference swamps 22, 85 and 86. S14_S02 shows lower moisture levels and durations compared with baseline and reference swamps.	Level 3	Level 3
35a	35a_S01			No TARP trigger.	No Trigger	No Trigger
149	S149_01			Installed in 2021. Insufficient baseline. No apparent effects	No Trigger	No Trigger
150	S150_01			No TARP trigger	No Trigger	No Trigger
151	S151_01			No TARP Trigger	No Trigger	No Trigger

Table 9: Summary of shallow groundwater level TARP status at Longwall 18 impact sites.

SWAMP	PIEZOMETERS WITH AN OBSERVED RESPONSE			HGEO COMMENT	IMCEFT TARP LEVEL	HGEO TARP LEVEL
	YES	UNCLEAR	NO			
14	01, 02			Evidence for impact to swamp groundwater levels at 14_01 and 14_02 following Longwalls 16 and 15 respectively. Effects confirmed in post-Longwall 17 assessment. No further effects related to Longwall 18.	Level 3	Level 3
35a			35a_01	No evidence of mining effects from Longwall 17 or 18.	No Trigger	No Trigger
35b			35b_01	No evidence of mining effects from Longwall 18	No Trigger	No Trigger
149				No data available due to shallow soil profile. Swamp likely to be affected.	No Trigger	No Trigger
150/151			150_01 151_01	Piezometers installed in 2021; No evidence of mining effects from Longwall 18.	No Trigger	No Trigger

3.5.2 Erosion in Upland Swamps

The SIMMCP describes the monitoring and assessment to determine any areas of erosion in swamps resulting from mining. Mining induced tilting, cracking, desiccation and/or changes in vegetation health that could result in increased runoff and erosion, which intern could alter water distribution in the swamp. TARPs have been established within the SIMMCP (See Appendix A: Table 19).

Impact assessment of Upland Swamp erosion includes analyses of ALS/LiDAR results, combined with infield observations. ALS results found apparent localised movements in Swamp 35a and Swamp 151. These points were inspected infield with no erosion or subsidence related impacts identified. These apparent localised movements are likely to be due to the effects of the horizontal movements and sloping terrain on the ALS surveys.

3.6 Terrestrial Ecology

Niche Environmental and Heritage (Niche) was commissioned by South32 to undertake terrestrial ecology monitoring for 2022 which will be included in an annual report in early 2023. This report will include assessment of features within the Longwall 18 mining area. The Terrestrial Ecology Monitoring Program Annual Report 2021 has been included in this EoP report, with a summary presented below.

Ecological values and indicators which are currently being monitored include: Coastal Upland swamps (Swamp extent, Species composition and Total species richness (TSR)) and Amphibians (Littlejohn's Tree Frog) (Population attributes and Habitat such as breeding pool characteristics).

In 2020, visual trends of drying (or areas of die-back) were observed at Impact swamps that have been directly mined beneath during field survey, and in the UAV imagery. Cumulative impacts have been observed at a number of Impact Upland Swamps, which show stronger trends of statistically significant decline in TSR over time and statistically significant changes to composition, with ‘wetter’ species becoming less common post impact, suggesting a loss of species that prefer moist soils. Some swamps show a loss of species over time, with limited recruitment of new species. For Area 3B, TARPS were triggered for five Upland Swamps. The increase in TARP triggers in Area 3B in 2021 is due to a continuation of trends observed across consecutive years, but largely a result of re-assessment of the complete LiDAR dataset that was not possible in 2020 (Table 17).

The Control creeks for Littlejohn’s Tree Frog (LJTF) monitoring in general were found to have a higher quality of breeding habitat for LJTF and were presumably chosen at the beginning of the program due to the known population of breeding adult records of LJTF and habitats. The 2021 analysis identified that where pre-mining frog detection data is available, detection was significantly lower at impact transects than the controls, indicating this disparity in control and impact transect pre-dates mining effects. Analysis in 2021 identified a statistically significant relations between flocculant and the detection of the Adult and Eggmass lifecycle stages and that flocculant is more likely to occur at post-mining transects. for Area 3B five tributaries: WC15, DC(1), DC13, WC21 and LA2 had triggered a TARP. These tributaries are consistent with that of 2020, with LA2 being the only additional tributary to trigger a TARP level in 2021 (Table 18)

Assessment of terrestrial ecology is included in the Terrestrial Ecology Monitoring Program Annual Report 2021 (**Attachment H**).

3.7 Aquatic Ecology

Cardno was commissioned by South32 to undertake a review of aquatic flora and fauna in relation to the extraction of Longwall 18. Cardno has been undertaking ongoing monitoring of watercourses within the DA3B mining area including. Lake Avon Tributary LA2, Native Dog Creek and Native Dog tributaries ND1, ND2, ND1A, ND1B and ND1C. The overall objective of the monitoring is to determine whether the extent and nature of observed impacts, primarily subsidence-induced fracturing of bedrock, diversion and loss of aquatic habitat, are consistent with the predictions made in the Aquatic Flora and Fauna Assessment (AFFA) (Cardno Ecology Lab 2012) and DA3B SMP (BHPBIC 2012).

The monitoring requirements recommended in the AFFA for DA3B and included in the SMP for DA3B incorporates a Before, After, Control, Impact (BACI) sampling design. The program monitors mine subsidence impacts on the aquatic environment with collection of at least two years of baseline data followed by monitoring during extraction, and at least two years of post-extraction monitoring. The following indicators were monitored at impact and control sites within and outside the SMP area for DA3B as a measure of aquatic health:

- Aquatic habitat condition - using a modified version of the Riparian, Channel and Environmental Inventory method (RCE) (Chessman et al. 1997);
- Macroinvertebrates, including threatened species of dragonfly (Adams emerald dragonfly and Sydney hawk dragonfly) - using AUSRIVAS and standardised artificial collectors;
- Limited in-situ water quality – using a portable probe; and
- Fish abundance using backpack electrofishing and bait traps.

Table 10 compares the predicted impacts against the observed impacts and Table 11 summarises the aquatic ecology assessment against the TARPS.

Further details of the Aquatic Ecology Assessment methodology can be found in **Attachment F.**

Table 10: Summary of predicted and observed impacts to aquatic ecology associated with Longwall 18.

Attribute	Predicted Physical Impacts	Predicted Impacts on Aquatic Ecology	Observed Impacts to Aquatic Ecology
Wongawilli Creek			
Ponding, flooding and scouring of stream banks due to tilt	No significant change predicted.	No measurable effects due to tilt.	None identified by IMCEFT during extraction of Longwall 18.
Fracturing of bedrock and diversion of surface flows	No significant fracturing resulting in surface water flow diversions. Minor, isolated fractures of the streambed may occur within 400 metres from the proposed Longwalls. Minor fracturing of the creek bed and subsequent diversion of flows would not have significant geochemical effects. Formation of ferruginous springs is unlikely, but could occur at the margins or upslope of swamps (Ecoengineers 2011).	No significant changes in the quantity or quality of permanent aquatic habitat due to fracturing of bedrock and diversion of surface flows	No reductions in pool water levels and flow or changes in water quality observed by South32 during extraction of Longwall 18, and, thus no suggestion of impacts occurring to aquatic habitat and biota. No changes to existing iron straining attributed to Longwall 18. No impacts to water quality observed in Wongawilli Creek.

Attribute	Predicted Physical Impacts	Predicted Impacts on AquaticEcology	Observed Impacts to Aquatic Ecology
Donalds Castle Creek and Tributaries			
Ponding, flooding and scouring of stream banks due to tilt	Reversals in grade may occur along Tributary WC21, adjacent to the tailgates of Longwalls 10 and 11. These could result in small increases in the levels of ponding, flooding and scouring of stream banks in highly localised areas along the tributaries. The impacts resulting from such changes are expected to be small relative to those that occur naturally during floods.	Localised changes in habitat availability and connectivity may occur along the tributaries due to tilt, but will be difficult to detect because of the large variability in natural flows within these ephemeral systems.	No impacts observed due to tilt.
Fracturing of bedrock and diversion of surface flows	Fracturing of the bedrock is likely to occur. In ephemeral creeks with alluvial deposits, fractures are likely to be in-filled by deposits during flow events. In areas with exposed bedrock, some diversion of surface flows into underlying strata and drainage of pools may occur, particularly during low flows. It is unlikely, that this would result in a significant impact on the overall quantity or quality of water flowing from the catchment.	There is unlikely to be any significant long-term changes in the quantity, quality or connectivity of aquatic habitats. Any losses of habitat and connectivity that do occur would be minor, localised and transient.	None observed in Wongawilli Creek, Donalds Castle Creek, or tributaries of these creeks or Lake Avon during extraction of Longwall 18. Some reductions in pool water levels in ND1C and LA2. Changes to water quality observed in LA4 and iron staining in LA3 are not expected to have resulted in significant impact to aquatic biota or habitat. The reductions in pool water levels in NDC1 and LA2 would have negligible impacts to aquatic habitat and biota at the scale of the Native Dog Creek and Lake Avon catchments

Table 11: Summary of Aquatic Ecology TARP sites and their respective trigger levels.

TARP	Wongawilli Creek	Donalds Castle Creek	WC21
Level 1 – Reduction in aquatic habitat for 1 year	Not triggered	Triggered September 2014	Triggered December 2014
Level 2 – Reduction in aquatic habitat for 2 years following the active subsidence period (i.e. when a longwallwithin 400m of a feature, such as a creek, is completed)	Not triggered	Triggered 24 October 2015	Triggered 20 January 2017
Level 3 – Reduction in aquatic habitat for >2 years or complete loss of habitat following the active subsidenceperiod	Not triggered	Triggered During 2017 Aquatic Ecology Surveys(Cardno 2018)	Triggered During 2017 Aquatic Ecology Surveys(Cardno 2018)

3.8 Cultural Heritage

Following the extraction of Longwall 18, an inspection of Aboriginal cultural heritage sites within the Longwall 18 study area (as defined in Niche 2022; **Attachment G**) was conducted, on 24 June 2022 (Figure 15).

Three Aboriginal cultural heritage sites for Longwall 18 were visited: Upper Avon 36, Dendrobium 7 and Dendrobium 8. Aboriginal cultural heritage site Dendrobium 7 displayed evidence of horizontal cracking not previously mentioned in Biosis baseline recording reports (2013). Photographic evidence provides confirmation that the cracking was in place prior to the extraction of Longwall 18. No impacts related to the extraction of Longwall 18 were observed.

Further details of the methodology and TARPS used by Niche for the Aboriginal Cultural Heritage Assessment can be found in **Attachment G**.

Table 12: Aboriginal cultural heritage sites status following the extraction of Longwall 18.

AHIMS Number	Site Name	Observed Subsidence Related Changes
52-2-1772	Upper Avon 36	No impacts related to the extraction of Longwall 18 were observed.
52-2-2248	Dendrobium 7	No impacts related to the extraction of Longwall 18 were observed. three vertical cracks are visible on the back centre wall, at 11.5m, 12.13m and 12.98m. No written confirmation of the cracks is outlined in any previous reports, though images in the Biosis baseline report as well as images provided by IMC provide evidence of cracking prior to Longwall 18 extraction.
52-2-3068	Dendrobium 8	No impacts related to the extraction of Longwall 18 were observed.

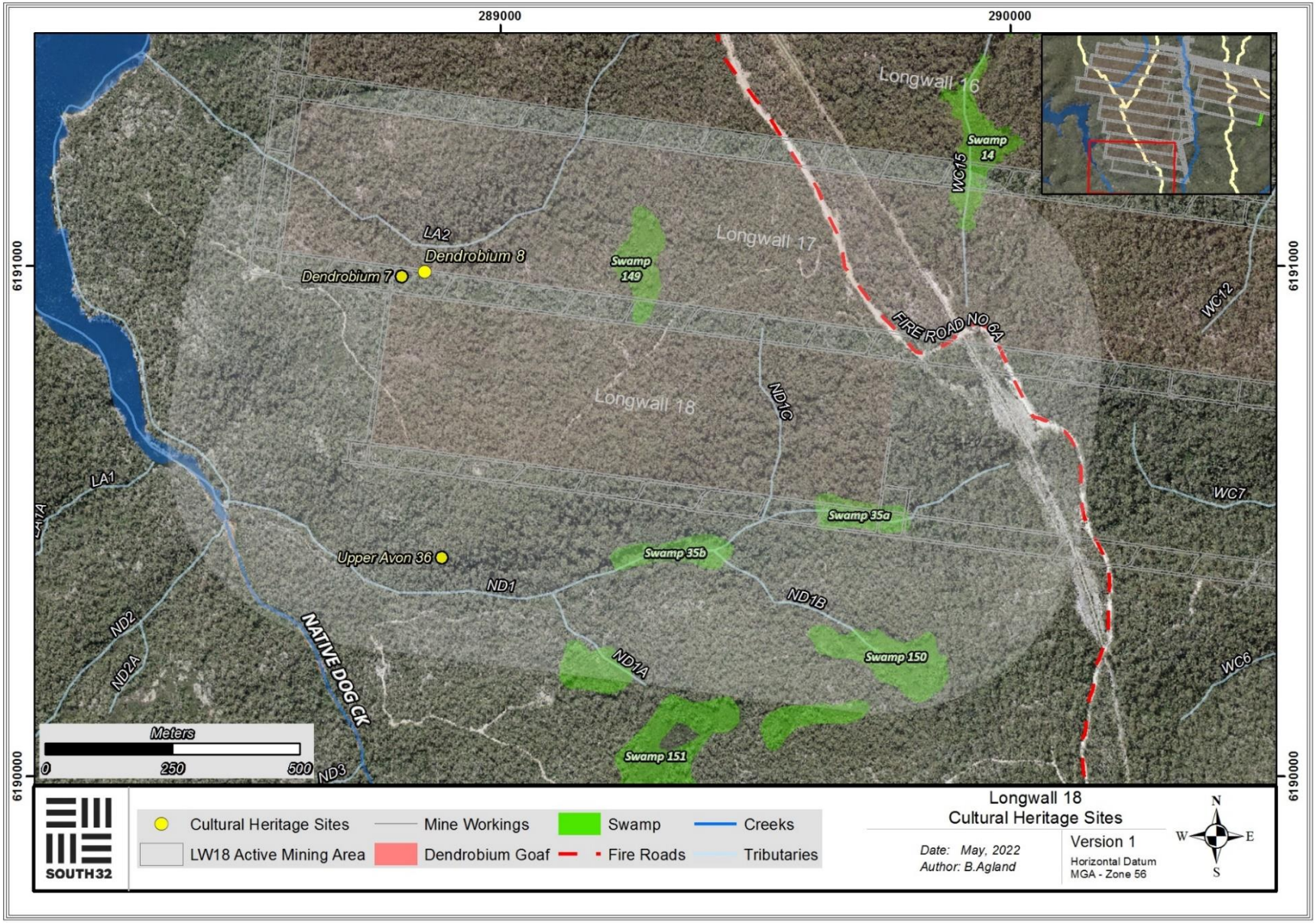

Figure 15: Aboriginal Cultural Heritage sites within the Longwall 18 study area.

4 IMPACTS TO BUILT FEATURES

The built features in proximity to Longwall 18 are shown in Attachment B and include: fire trails and other access tracks, disused Maldon-Dombarton Railway Corridor, survey control marks; and Avon Dam.

Cordeaux Dam Wall is located more than 5 km north of Longwall 18, at its closest point. The Upper Cordeaux No.2 Dam Wall is located more than 6 km south-east of Longwall 18, at its closest point. It is unlikely these dam walls would experience any measurable far-field horizontal movements resulting from Longwall 18 and, therefore, they have not been assessed further.

No impacts were observed on built features during the extraction of Longwall 18. It has been considered that the observed impacts on the surface infrastructure, due to the mining of Longwall 18, are similar to or less than the predicted.

Table 13: Summary of predicted impacts in comparison to observed impacts relevant to Longwall 18.

Built feature	MSEC assessed impacts	Reported impacts
Fire trails and four-wheel drive tracks	Cracking of unsealed road surfaces	No cracking observed along the fire trails and four-wheel drive tracks due to the mining of Longwall 18. However, cracking observed in bushland near the trails and tracks, with widths typically ranging between 10mm and 200mm refer to the IMC landscape report for further details
Disused Maldon-Dombarton Railway	Possible fracturing of rock cuttings, spalling, and/or mobilisation of rockjoints	No reported impacts on the railway corridor due to the mining of Longwall 18
Avon Dam	Adverse impacts not anticipated	No reported impacts on the dam wall. Refer to associated groundwater report for details on impacts to the stored water
Survey control marks	Vertical and horizontal movements which could require re-establishment	No reported damage to the survey control marks.

4.1 Level 1 Surface Cracking

No Level 1 impacts were observed during the extraction of Longwall 18 to built features.

4.2 Level 2 Surface Cracking

No Level 2 impacts were observed during the extraction of Longwall 18 to built features.

5 Additional Observations

5.1 LA5 Iron Staining

DA3B_LW17_025 is an iron staining impact, reported in the Longwall 17 EoP report. It has been included here again, with further information below, as per agency recommendations from the Longwall 17 End of Panel report.

LA5 is a small tributary of Lake Avon, immediately to the west of LA4, that flows southward from DA3B mining operations. The upper reaches of the LA5 sub catchment were mined beneath by Longwall 12 in March 2016. No surface impacts have been observed in LA5 prior to this. During an inspection on 1 July 2021, iron staining was observed at site LA5_S1, extending into Lake Avon. During the latest inspection of the tributary, iron was recorded as extending for 55m downstream from the source (Figure 16). No visible iron was observed at the LA5 outflow point to Lake Avon (Photo 26 and Photo 27).

Photo 26: *DA3B_LW17_025*, Iron Staining in tributary LA5, Base of Waterfall_1, taken on 26/09/2022.

Photo 27: *DA3B_LW17_025*, Iron Staining at outflow of tributary, Pool_1, taken on 26/09/2022.

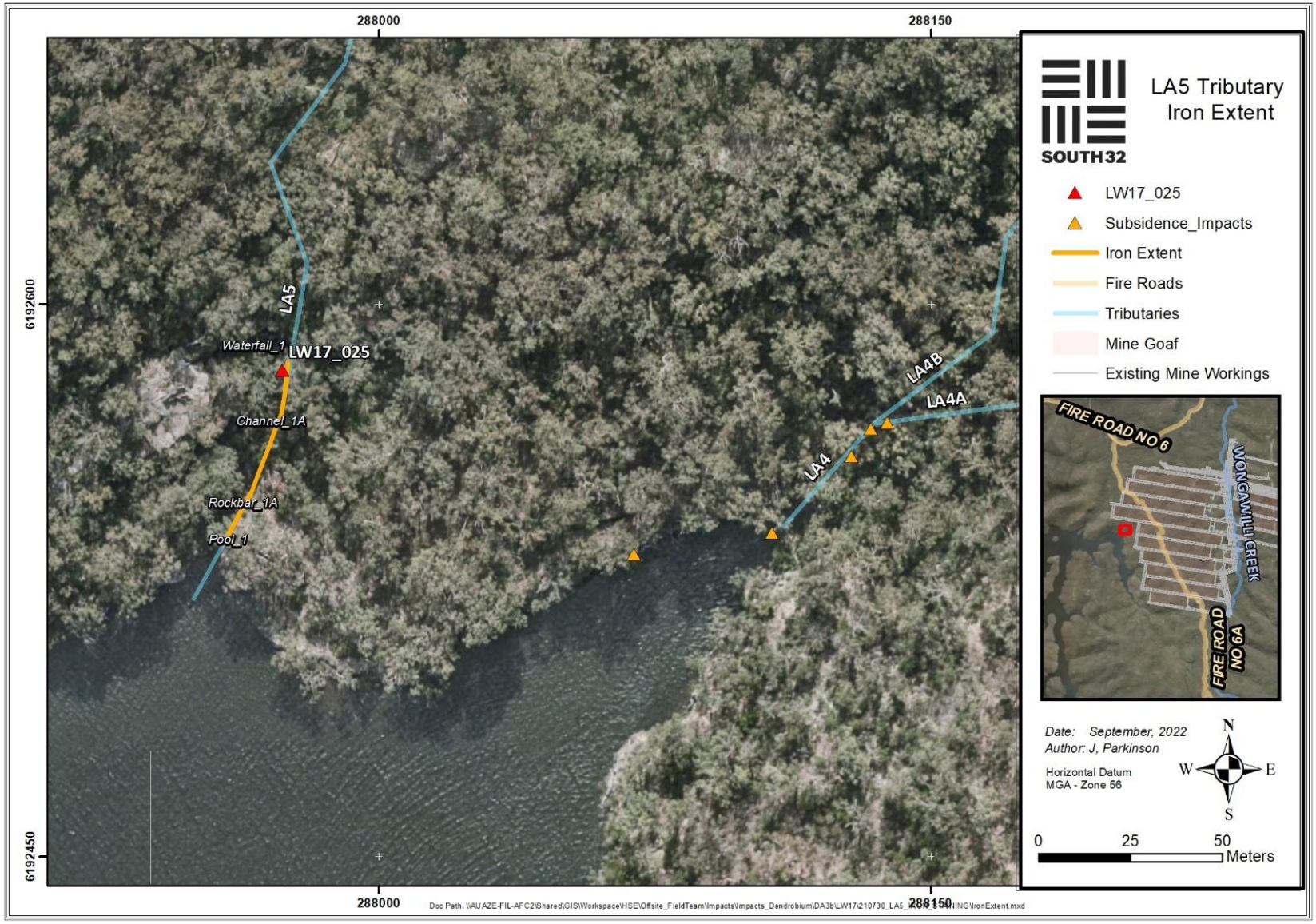

Figure 16: DA3B_LW17_025, Iron staining in tributary LA5, taken on 26/9/02022.

6 SUMMARY OF TARP TRIGGERS

A summary of TARP triggers during the extraction of Longwall 18 is presented below in Table 16; additionally, an overview of Longwall 18 surface impacts and triggers ispresented in Figure 17.

Table 14: Summary of TARP Triggers during the extraction of Longwall 18.

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW17_041	Rockfall and Iron Staining	Waterfall 54	2/08/2022	Exceeding Prediction	Rockfall to Waterfall 54	8/08/2022
DA3B_LW18_001	Rock Fracturing, Uplift and Fragmentation.	Rock Outcrop	14/12/2021	1	Rock fracturing to a rock outcrop to the south of Swamp 23.	15/12/2021
LA4_S1	Water Quality Trigger	LA4	17/12/2021	1	Trigger for dissolved oxygen at LA4_S1.	22/12/2021
LA4_S1	Water Quality Trigger	LA4	17/12/2021	Exceeding Prediction	Trigger for pH at LA4_S1.	22/12/2021
LA4_S1	Water Quality Trigger	LA4	17/12/2021	Exceeding Prediction	Trigger for electrical conductivity at LA4_S1.	22/12/2021
DA3B_LW18_002	Rock Fracturing	Rock Outcrop/ Steep Slope	31/01/2022	1	Rock fracturing and soil cracking to a rock outcrop/steep slope west of Fire Road 6A.	31/01/2022
DA3B_LW18_003	Rock Fracturing, Uplift and Soil Cracking	Rock Outcrop	31/01/2022	2	Rock fracturing to a rock outcrop west of Fire Road 6A.	31/01/2022
DA3B_LW18_004	Rock Fracturing & Uplift	Rock Outcrop	9/02/2022	1	Rock fracturing to a rock outcrop west of Fire Road 6A.	9/02/2022
DA3B_LW18_005 (Update)	Rockfall	Steep Slope/ Step	9/02/2022	2	Displacement between rock/soil and soil cracking at a steep slope west of Fire Road 6A.	9/02/2022 & 1/07/2022

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW18_006	Rockfall	Steep Slope/Step	15/02/2022	2	Soil cracking to bushland near an access track west of Fire Road 6A.	16/02/2022
DA3B_LW18_007	Rock Fracturing	Rock Outcrop	8/06/2022	1	Rock fracturing to rock outcrop west of Fire Road 6A.	15/06/2022
DA3B_LW18_008	Soil Cracking	Bushland	9/06/2022	2	Soil cracking near access track west of Fire Road 6A.	15/06/2022
DA3B_LW18_009	Rock Displacement, Fracturing and Fragmentation	Rock Outcrop	9/06/2022	2	Rock fracturing, displacement and fragmentation in bushland near NDC1.	15/06/2022
DA3B_LW18_010	Rockfall and Fragmentation	Cliffline	10/06/2022	1	Rockfall at 7m high cliffline, west of Fire Road 6A.	15/06/2022
DA3B_LW18_011	Rockfall	Rock Outcrop	10/06/2022	1	Rockfall to 4m high rock outcrop, west of Fire Road 6A.	15/06/2022
DA3B_LW18_012	Soil Cracking	Bushland	30/06/2022	2	Soil cracking near access track west of Fire Road 6A.	1/07/2022
DA3B_LW18_013	Rock Fracturing and Fragmentation	Steep Slope/Step	16/08/2022	1	Rock fracturing and fragmentation to steep slope/step	19/08/2022
DA3B_LW18_014	Rock Fracturing	Steep Slope/Step	16/08/2022	2	Rock fracture to steep slope/step north of LA2.	19/08/2022
DA3B_LW18_015	Rock Fracturing	Steep Slope/Step	16/08/2022	1	Rock fracturing to steep slope/step north of LA2.	19/08/2022
DA3B_LW18_016	Rock Fracturing	Steep Slope/Step	16/08/2022	2	Rock fracturing to steep slope/step north of LA2.	19/08/2022
DA3B_LW18_017	Rock Displacement and Rockfall	Steep Slope/Step	16/08/2022	1	Rock displacement and rockfall to steep slope/step north of LA2.	19/08/2022

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW18_018	Rock Fracturing and Rockfall	Steep Slope/Step	16/08/2022	1	Rock fracturing and rockfall to steep slope/step north of LA2.	19/08/2022
DA3B_LW18_019	Rock Fracturing	Steep Slope/Step	16/08/2022	1	Rock fracture to steep slope/step north of LA2.	19/08/2022
DA3B_LW18_020	Rockfall	Steep Slope/Step	16/08/2022	1	Rockfall to steep slope/step north of LA2.	19/08/2022
DA3B_LW18_021	Rock Fracturing	Rock Outcrop	16/08/2022	2	Rock fracturing to rock outcrop north of LA2.	19/08/2022
DA3B_LW18_022	Rockfall	Steep Slope/Step	16/08/2022	1	Rockfall to steep slope/step north of LA2	19/08/2022
DA3B_LW18_023	Soil Cracking	Bushland	16/08/2022	2	Soil cracking in bushland north LA2.	19/08/2022
DA3B_LW18_024	Iron Staining	LA3	16/08/2022	1	Iron Staining in tributary LA3	19/08/2022
Swamp 15A(2)	Terrestrial Ecology (Flora)	Swamp 15A(2)	N/A	2	A statistically significant difference in Species composition.	Niche (2022)
Swamp 15B	Terrestrial Ecology (Flora)	Swamp 15B	N/A	2	A statistically significant difference in Total species richness.	Niche (2022)
				2	A statistically significant difference in Species composition.	
Swamp 13	Swamp Size	Swamp 13	N/A	1	Two years of decline in total swamp extent greater than the mean (±SE) decline of the control group.	Niche (2022)

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
Swamp 1A	Ecosystem Function	Swamp 1A	N/A	1	Trending decline Tea-tree Thicket for two consecutive monitoring periods greater than the control group.	Niche (2022)
Swamp 1B	Terrestrial Ecology (Flora) & Swamp Extent & Ecosystem Function	Swamp 1B	N/A	1	A statistically significant difference in Total species richness.	Niche (2022)
				Exceeding expectation	A statistically significant difference in Species composition.	
				2	Three years of decline in total swamp extent greater than the control group.	
				1	Decline in Tea-tree Thicket for two consecutive monitoring periods greater than the control group.	
Swamp 5	Ecosystem Function	Swamp 5	N/A	2	Decline in Tea-tree Thicket for three consecutive monitoring periods greater than the control group.	Niche (2022)
Swamp 23	Terrestrial Ecology (Flora) & Swamp Extent	Swamp 23	N/A	2	A statistically significant difference in Total species richness.	Niche (2022)
				1	Two years of decline in total swamp extent greater than the mean (±SE) decline of the control group.	
LA2	Terrestrial Ecology (Fauna)	LA2	N/A	1	Reduction in habitat (reduction in aquatic habitat, contrary to that observed at the controls) for 1 year following the active subsidence period.	Niche (2022)
DC(1)	Terrestrial Ecology (Fauna)	Donalds Castle Creek	N/A	3	Reduction in habitat (dry pools for extended times) for more than 2 years following the active subsidence period.	Niche (2022)

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DC13	Terrestrial Ecology (Fauna)	DC13	N/A	3	Continued reduction in habitat (fractured bedrock) for more than 2 years following the active subsidence period.	Niche (2022)
WC15	Terrestrial Ecology (Fauna)	WC15	N/A	2	Reduction in habitat (dry pools for extended time and bedrock cracking) for 2 years following the active subsidence period.	Niche (2022)
WC21	Terrestrial Ecology (Fauna)	WC21	N/A	3	Continued reduction in habitat (fractured bedrock) for more than 2 years following the active subsidence period.	Niche (2022)
SC10C	Terrestrial Ecology (Fauna)	SC10C	N/A	2	triggered due to appearance at SC10C (fractured bedrock and iron flocculant) and habitat unlikely to naturally regenerate within the monitoring period.	Niche (2022)
SC10(1)	Terrestrial Ecology (Fauna)	SC10	N/A	2	triggered due to appearance at SC10(1) (fractured bedrock and iron flocculant present at 13 of the 14 pools recorded) and habitat unlikely to naturally regenerate within the monitoring period.	Niche (2022)
WC17	Terrestrial Ecology (Fauna)	WC17	N/A	2	triggered due to appearance at WC17 (iron flocculant and fractured bedrock) and habitat unlikely to naturally regenerate within the monitoring period.	Niche (2022)

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
Donalds castle Creek	Aquatic Ecology	Donalds castle Creek	N/A	3	Reduction in aquatic habitat for >2 years or complete loss of habitat following the active subsidence period	Cardno (2022)
WC21	Aquatic Ecology	WC21	N/A	3	Reduction in aquatic habitat for >2 years or complete loss of habitat following the active subsidence period	Cardno (2022)
DC13S1	Surface Water Hydrology	DC13	N/A	3	General Hydrological behaviour	HGEO (2022)
				2	Changes in cease-to-flow frequency (below natural)	
				3	Changes to median flow	
DCS2	Surface Water Hydrology	Donalds Castle Creek	N/A	3	General Hydrological behaviour	HGEO (2022)
				3	Changes in cease-to-flow frequency (below natural)	
				3	Changes to median flow	
DCU	Surface Water Hydrology	Donalds Castle Creek	N/A	1	Changes in cease-to-flow frequency (below natural)	HGEO (2022)
WC21S1	Surface Water Hydrology	WC21	N/A	3	General Hydrological behaviour	HGEO (2022)
				1	Changes in cease-to-flow frequency (below natural)	
				3	Changes to median flow	
WC15S1	Surface Water Hydrology	WC15	N/A	3	General Hydrological behaviour	HGEO (2022)
				2	Changes in cease-to-flow frequency (below natural)	
				3	Changes to median flow	
LA4S1	Surface Water Hydrology	LA4	N/A	3	General Hydrological behaviour	HGEO (2022)
				3	Changes in cease-to-flow frequency (below natural)	

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
				3	Changes to median flow	
LA3S1	Surface Water Hydrology	LA3	N/A	3	General Hydrological behaviour	HGEO (2022)
				3	Changes in cease-to-flow frequency (below natural)	
				3	Changes to median flow	
LA2S1	Surface Water Hydrology	LA2	N/A	2	General Hydrological behaviour	HGEO (2022)
				3	Changes to median flow	
Swamp 14 (HGEO)	Soil Moisture	Swamp 14	N/A	3	saturation of swamp sediments to levels similar to the baseline following high rainfall; however, recession rates remain higher than the baseline. (14_01 and 14_02 are outside of the Longwall 18 study area but the swamp boundary is)	HGEO (2022)
	Shallow Groundwater			3		

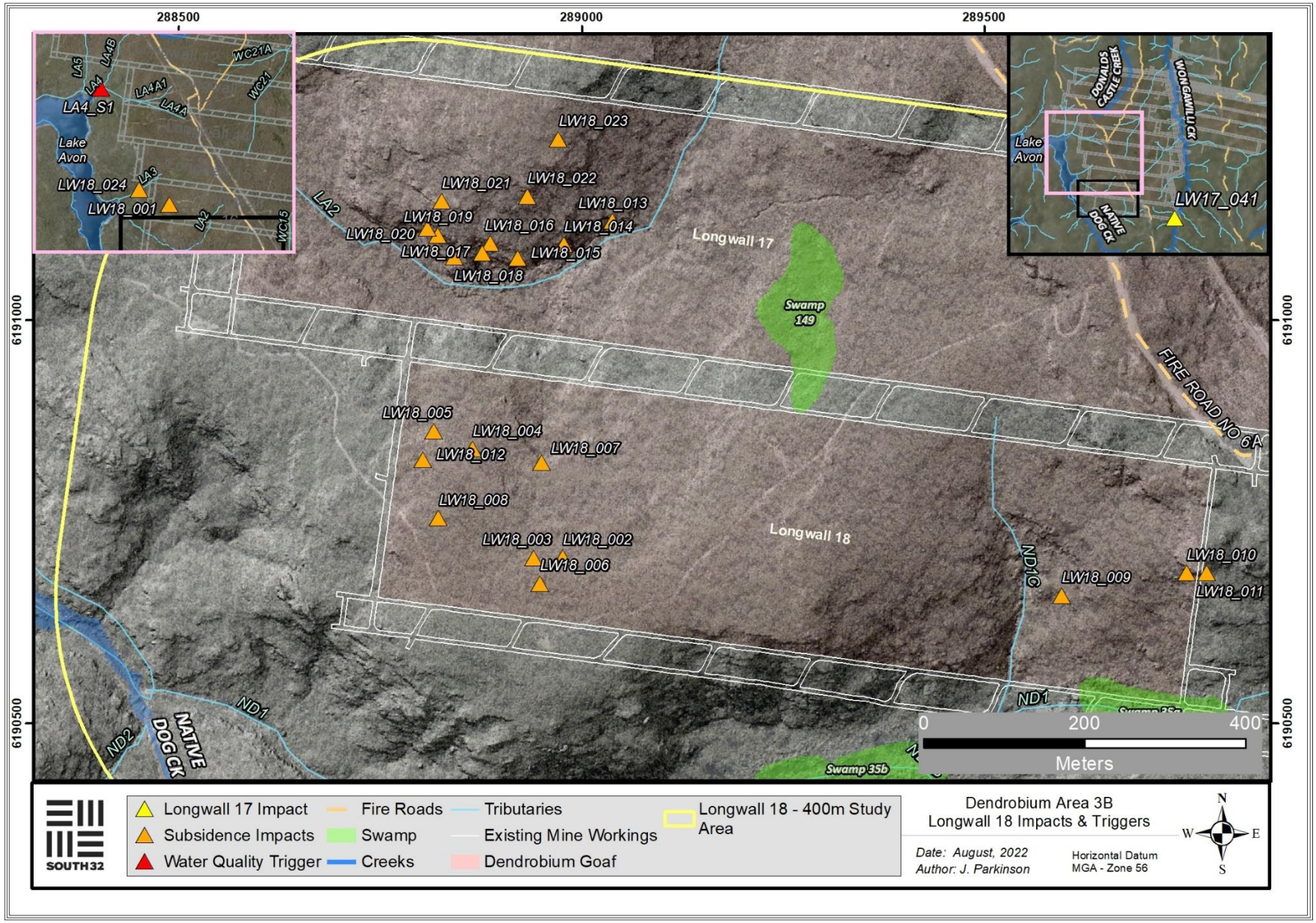

Figure 17: Overview of surface impacts observed during the extraction of Longwall 18.

7 LONGWALL 18 MONITORING PROGRAM

Table 15: Summary of monitoring sites associated with the extraction of Longwall 18. Recommended monitoring sites associated with the extraction of Longwall 19 are also included.

Aspect	Monitoring Sites Associated with Longwall 18	Monitoring Frequency	Recommended Future Monitoring for Longwall 19
Watercourses	**Observational, photo point and water monitoring**		
	• Donalds Castle Creek • Lake Avon • LA2 • LA3 • Swamp 23 • Swamps 13 and 14 • WC12, WC15 and WC21 • Wongawilli Creek • WC6, WC7, WC8, WC9 • Swamp 35a/b • Swamp 149, 150, 151 • Native Dog Creek • ND1, ND1C	Monthly 2 years pre and post mining, weekly when longwall is within 400m of monitoring site. Reference sites 6 monthly. SLMMP Sites: pre and post mining, monthly when longwall is within 400m of monitoring site.	Longwall 19 Monitoring • Wongawilli Creek • Sandy Creek • SC10 • SC10B • SC10C • WC13 • WC13A • WC14 • WC15 • WC17 • WC17B Dendrobium Area 3B (post-mining for 2 years) • LA2 • LA3 • ND1 • ND1A • ND1B • ND1C • ND2 • WC12 • WC15 • WC7
	Water Quality		
	Wongawilli Creek • WWU1 (Wongawilli Creek headwaters) • WWU4 (Wongawilli Creek upstream) • WC_Pool 104 (Wongawilli Creek adjacent to LW17) • WC_Pool 87 (Wongawilli Creek adjacent to LW15) • WC_Pool 69 (Wongawilli Creek adjacent to LW12) • WWM2 (Wongawilli Creek adjacent to LW11) • WC_Pool 49 (Wongawilli Creek downstream of LW9) • WC_FR6 (Wongawilli Creekdownstream) • WC21_Pool 5 (Wongawilli Creek tributary downstream of mining)	Monthly monitoring pre, during and post mining for two years.	Longwall 19 Monitoring • Wongawilli Creek (WC_Channel 14, WC_Pool 53, WC_Pool 55, WC_Pool 69, WC_Pool 72b, WC_Pool 72A) • Sandy Creek (SCk_Rockbar 5, Sandy Creek Arm) • SC10 (SC10_Pool 1, SC10_Rockbar 3, SC10_Pool 4, SC10_Pool 10b, SC10_Pool 11, SC10_Pool14, SC10_Pool 15, SC10_Pool 21, SC10_Pool 23, SC10_Pool 26a, SC10_Pool 29. • SC10C (SC10C_Pool 1, SC10C_Pool 3,

Aspect	Monitoring Sites Associated with Longwall 18	Monitoring Frequency	Recommended Future Monitoring for Longwall 19
	• WC21_Pool 30 (Wongawilli Creek tributaries overmining) • WC21_Pool 53 (Wongawilli Creek tributary overmining) • WC12_Pool 1 (Wongawilli Creek tributary downstream of mining) • WC15_Pool 9 (Wongawilli Creek tributary downstream of mining) **Lake Avon and tributaries** • LA_1, LA1, LA2_Pool 5, LA3_Pool 4 **Donalds Castle Creek:** • DCC_FR6 (Donalds Castle Creek lower) • DC_Pool 22 (Donalds Castle Creek downstream of mining) • DCL3 (Donalds Castle Creek further downstreamsite) **Native Dog Creek** • NDC_Pool 1 • ND1_Pool 2 • ND2_Pool 3 **Reference Site** • LC5_S1 • NDC1 • CR36_S1		SC10C_Pool 5, SC10C_Pool 8, SC10C_Pool 11a) • WC13 (WC13_Pool 1, WC13_Pool 3) • WC14 (WC14_Pool 3, WC14_Pool 16) • WC15 (WC15_Pool 2, WC15_Pool 9) • WC17 (WC17_Pool 0, WC17_Pool 4, WC17_Pool 10, WC17_Pool 12) Dendrobium Area 3B (post-mining for 2 years) • Lake Avon (LA_1, LA1) • LA2 (LA2_Pool 5, LA2_Pool 24, LA2_Pool 25, LA2_Pool 34) • LA3 (LA3_RB4B, LA3_Pool 4) • ND1 (ND1_Pool 2, ND1_Pool 23) • Native Dog Creek (NDC_Pool 1, NDC_Pool 6, NDC_Pool 7, NDC_Pool 15) • ND2 (ND2_Pool 3) • WC12 (WC12_Pool 1, WC12_Pool 12, WC12_Rockbar 18) • WC15 (WC15_Pool 28, WC15_Channel 32A, WC15_Pool 34) • Wongawilli Creek (WC_Pool 87, WC_Pool 104) • WC7 (WC7_Pool 1, WC7_Pool 9, WC7_Pool 14 **Reference Site** • LC5_S1 • CR36_S1 • NDC1
Swamps	**Observational, Photo Point and Water Monitoring**		
	• Swamps 13, 14, 23, 35a/b, 149, 150, 151	Pre and post mining for 2 years, monthly when longwall is within 400 m of monitoring site. Weekly inspection and pool water levels when longwall is within 400 m of monitoring site. Reference sites 6-monthly.	• Swamps 12, 15a, 15b, 34, 95, 146, 148
	Shallow Groundwater Level		

Aspect	Monitoring Sites Associated with Longwall 18	Monitoring Frequency	Recommended Future Monitoring for Longwall 19
	• Swamp 13: 13_01 • Swamp 14: 14_01, 14_02 • Swamp 23: 23_01, 23_02 • Swamp 35a: 35a_01 • Swamp 35b: 35b_01 • Swamp 149: 149_01 • Swamp 150: 150_01 • Swamp 151: 151_01 **Reference Sites** • Swamp 2: 02_S01 • Swamp 7: 07_S05, 07_S06 • Swamp 15A: S15a_S01, S15a_Piezo, S15a_S04, S15a_S06 • Swamp 22: 22_01, 22_02 • Swamp 25: S25_S01 • Swamp 33: S33_S01, S33_S03 • Swamp 84: S84_S02 • Swamp 85: S85_S01, S85_S02 • Swamp 86: S86_S01, S86_S02 • Swamp 87: S87_S01, S87_S02 • Swamp 88: S88_S01, S88_S02	For open hole sites: • Monthly monitoring pre, during and post mining for two years to be reviewed annually • Reference sites 6 monthly For instrumented sites: • Automatic groundwater level monitoring pre, during and post mining (1-hour interval or similar) • Monitoring post mining for five years to be reviewed annually	Longwall 19 Monitoring • Swamp 12: 12_01, 12_03, 12_04 • Swamp 15A: 15a_03, 15a_04, 15a_07, 15a_12, 15a_15, 15a_18, 15a_19 • Swamp 15b: 15b_H1, 15b_H2, 15b_H3, 15b_39 • Swamp 34: 34_01 • Swamp 95: 95_01 • Swamp 146: 146_01 • Swamp 148: 148_01 Dendrobium Area 3B (post-mining for 2 years) • Swamp 14: 14_01, 14_02 • Swamp 23: 23_02 • Swamp 35a: 35a_01 • Swamp 35b: 35b_01 • Swamp 150: 150_01 • Swamp 151: 151_01 **Reference Sites** • Swamp 2: 02_S01 • Swamp 7: 07_S05, 07_S06 • Swamp 22: 22_01, 22_02 • Swamp 25: S25_S01 • Swamp 33: S33_S01, S33_S03 • Swamp 84: S84_S02 • Swamp 85: S85_S01, S85_S02 • Swamp 86: S86_S01, S86_S02 • Swamp 87: S87_S01, S87_S02 • Swamp 88: S88_S01, S88_S02
	Soil Moisture		
	• Swamp 13: S13_S01, S13_S02, S13_S03 • Swamp 14: 14_01, 14_02 • Swamp 23: 23_02 • Swamp 35a: 35a_01 • Swamp 35b: 35b_01 • Swamp 149: 149_01 • Swamp 150: 150_01 **Reference Sites:** • Swamp 2: S02_S01 • Swamp 7: S07_S05, S07_S06 • Swamp 15A: S15a_S01, S15a_Piezo, S15a_S04, S15a_S06 • Swamp 22: 22_01, 22_02	For manually measured sites: • Monthly monitoring for 2 years baseline and post mining and 6-monthly reference sites • Weekly monitoring when longwall is within 400 m of monitoring site For instrumented sites: • Automatic soil moisture monitoring pre, during and post • Monitoring post mining for five years to be reviewed annually	Longwall 19 Monitoring • Swamp 12: 12_01, 12_03, 12_04 • Swamp 15A: 15a_03, 15a_04, 15a_07, 15a_12, 15a_15, 15a_18, 15a_19 • Swamp 15b: 15b_H1, 15b_H2, 15b_H3, 15b_39 • Swamp 34: 34_01 • Swamp 95: 95_01 • Swamp 146: 146_01 • Swamp 148: 148_01 Dendrobium Area 3B (post-mining 2 years) • Swamp 13: 13_03 • Swamp 14: 14_01, 14_02 • Swamp 23: 23_02

Aspect	Monitoring Sites Associated with Longwall 18	Monitoring Frequency	Recommended Future Monitoring for Longwall 19
	• Swamp 24: S24_S01 • Swamp 25: S25_S01 • Swamp 33: S33_S01, S33_S03 • Swamp 84: S84_S02 • Swamp 85: S85_S01, S85_S02 • Swamp 86: S86_S01, S86_S02 • Swamp 87: S87_S01, S87_S02 • Swamp 88: S88_S01, S88_S02		• Swamp 35a: 35a_01 • Swamp 35b: 35b_01 • Swamp 149: 149_01 • Swamp 150: 150_01 • Swamp 151: 151_01 **Reference Sites:** • Swamp 2: S02_S01 • Swamp 7: S07_S05, S07_S06 • Swamp 22: 22_01, 22_02 • Swamp 24: S24_S01 • Swamp 25: S25_S01 • Swamp 33: S33_S01, S33_S03 • Swamp 84: S84_S02 • Swamp 85: S85_S01, S85_S02 • Swamp 86: S86_S01, S86_S02 • Swamp 87: S87_S01, S87_S02 • Swamp 88: S88_S01, S88_S02
Landscape	**Targeted Sites**		
	Cliffs • No Clifflines **Fire Trails** • Fire Road 6A (across active mining area) • Fire Road 6N • Fire Road 6P • Fire Road 6Q Fire Road 6P	Monthly monitoring during any subsidence period. Monitoring to continue 6 monthly for 2 years following the completion of mining.	**Cliffs** • DA3-CF7 • DA3-CF8 • DA3-CF15 • DA3-CF16 • DA3-CF17 • DA3-CF18 **Fire Trails** • Fire Road 6F (across active mining area)
	Inspection of Active Mining Area – Landscape Features, Vegetation, Watercourses		
	Continue monitoring of all mapped cliff, steep slope, watercourse, swamp and firetrail sites in subsidence area. Continue general observation of active mining areas.	Weekly monitoring when longwall extraction is within 400m of feature.	Continue monitoring of all mapped cliff, steep slope, watercourse, swamp and fire trail sites in subsidence area. Continue general observation of active mining areas.

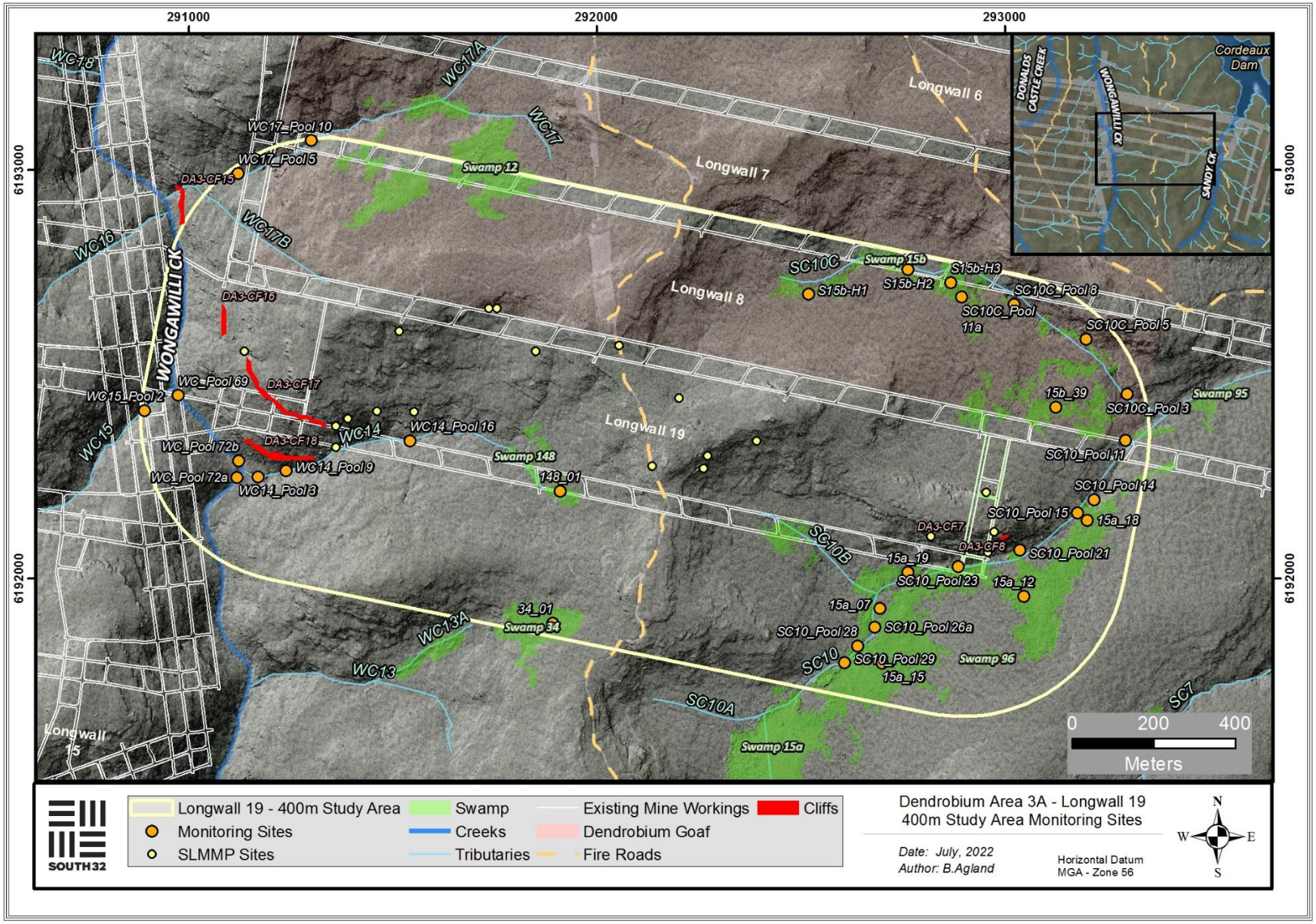

Figure 19: Overview of monitoring sites relevant to Longwall 19 active mining area

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9 APPENDIX A – IMPACTS, TRIGGERS AND RESPONSE

Table 16: Dendrobium Area 3B Landscape TARPs.

Monitoring	Trigger	Action
LANDSCAPE FEATURES		
AREA 2 **Cliffs** • A2-CL1 (above LW4) **Steep Slopes** • A2-SL1 and A2-SL2 (above LWs 4 & 5) **Watercourses** • A2-WC10 and A2-WC11 (above LW3) • A2-WC13 & A2-WC16 (above LWs 4 & 5) **Swamp** • A2-SW1 (above LWs 4 & 5) **4WD Track** • A2-FT1 (above LWs 4 & 5) **Crinanite Surface Extent** • A2-CN1 & A2-CN2 (above LWs 3 & 4) **AREA 3A** **Cliffs** All mapped cliff sites in subsidence area (Refer toDendrobium Area 3A SMP Figures 19.3 for location of sites) **Steep Slopes** All mapped steep slopes in subsidence area *Refer to Dendrobium Area 3A SMP Figures 19.3 for location of sites* **Watercourses/ Swamps** All mapped watercourse and swamps insubsidence area *Refer to Dendrobium Area 3A SMP Figure 19.3*	***Level 1 **** • Rock fall from a cliff which is left mostly intact (<10% length), resulting in insignificant ground disturbance • Surface movement or rock displacement with negligible soilsurface exposed • Crack at the surface, which should not result in any significant erosion or further ground movement • Crack in a fire trail which should not result in erosion orimpede access • Crack or fracture up to 100mm width • Crack or fracture up to 10m length • Erosion in a localised area which would be expected to naturally stabilise without CMA and within the period ofmonitoring	• Continue monitoring program • Report impacts to key stakeholders • Summarise impacts and Report in the End of Panel Report and AEMR
	Level 2 * • Rock fall or overhang collapse at a cliff site, where characteristics of the cliff have changed, and there has beensignificant ground disturbance • Surface movement or rock displacement that has exposedsignificant areas of soil • A crack at the surface, which could result in significanterosion or movement at the surface	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Provide safety signage and barricades as appropriate • Implement approved repairs to ensure safety and serviceability on fire trails • Implement agreed CMAs as approved *Note: CMAs are to be proposed based on appropriate management of environmentaland other consequences of impacts i.e. cracking at the surface with*

Monitoring	Trigger	Action
Fire Trails All mapped fire trails in subsidence area *Refer to Dendrobium Area 3A SMP Figure 19.3* **AREA 3B** **Cliffs** All mapped cliff sites in subsidence area *Refer to Dendrobium Area 3B SMP Figures 18.1for location of sites*	• A crack at the surface with potential risk to safety and/orfauna entrapment • A crack in the fire trail, which could result in significanterosion or impede vehicle access • Crack or fracture between 100 and 300mm width • Crack or fracture between 10 and 50m length • Significant erosion at any location, which is not likely to naturally stabilise within the period of monitoring, or is located in a sensitive area e.g. swamps, creek, lake shore, and may result in increased sediment transport to Cordeaux Dam, or has been previously identified as Level 1, but is not likely to naturally stabilise within the monitoring period	*insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts*
	Level 3 * • Major cliff collapse where the characteristics of the cliff change significantly and there is significant ground disturbance that is unlikely to naturally stabilise within the monitoring period • Crack or fracture over 300mm width • Crack or fracture over 50m length • Mass movement of a slope causing large areas of exposedsoil with potential for further movement	• *Actions as stated for Level 2* • Immediately notify DPIE, DPIM, WaterNSW, resource managers and relevant technical specialists and seek advice on any CMA required • Site visits with stakeholders if required • Review monitoring program and modify if necessary within 1 month • Implement increased monitoring if required within 2 weeks • Develop site CMA in consultation with key stakeholders within 1 month, (pendingstakeholder availability) and seek approvals • Completion of works following approvals • Issue CMA report within 1 month of works completion • Conduct initial follow up monitoring & reporting within 2 months of CMAcompletion

Monitoring	Trigger	Action
		• Review the relevant TARP and Management Plan in consultation with keystakeholders *Note: CMAs are to be proposed based on appropriate management of environmentaland other consequences of impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts*
Sandy Creek Waterfall	***Exceeding Prediction*** • Rock fall at Sandy Creek Waterfall or from its overhang • Structural integrity of the waterfall, its overhang and itspool are impacted • More than negligible cracking within 30 m of the waterfall • More than negligible diversion of water from the lip of thewaterfall	• Actions as stated for Level 3 • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation
TERRESTRIAL FLORA AND FAUNA		
A number of sites located across and around Areas 2, and 3A. Refer Dendrobium Area 3A SMP Figure 21.1, 21.2 and 21.3 General observation of active mining areas	***Level 1 **** • Vegetation impacted by mining (by rockfalls, soil slippage, gas emissions) that is likely to naturally regenerate within the monitoring period	• Continue monitoring program • Report impacts to key stakeholders • Summarise impacts and Report in the End of Panel Report and AEMR
	Level 2 * • Vegetation impacted by mining (by rockfalls, soil slippage, gas emissions) that is unlikely to naturally regenerate within the monitoring period • Statistically significant difference between Before After Control Impact sites as a result of mining	• Actions as stated for Level 1 • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved
	Level 3 * • Vegetation impacted by mining that is not responding to CMAs	• Actions as stated for Level 2 • Immediately notify BCD, DPE, MEG, WaterNSW, other resource managers and relevant technical specialists and seek advice on any CMA required • Site visits with stakeholders if required

Monitoring	Trigger	Action
		• Review monitoring program and modify if necessary within 1 month • Implement increased monitoring if required within 2 weeks • Develop site CMA in consultation with key stakeholders within 1 month, (pending stakeholder availability) and seek approvals • Completion of works following approvals • Issue CMA report within 1 month of works completion • Conduct initial follow up monitoring & reporting within 2 months of CMA completion • Review the relevant TARP and Management Plan in consultation with key stakeholders

Table 17: Dendrobium Area 3B Swamp TARP.

Performance Measures	Potential Impacts	*Performance Triggers*	Management Strategies	Offsets	Other Actions
Negligible erosion of the surface of the swamp	Gully erosion or similar	<u>*Level 1:*</u> The increase in length of erosion within a swamp (compared to its pre-mining length) is **2%** of the swamp length or area; and/or Erosion in a localised area (not associated with cracking or fracturing) which would be expected to naturally stabilise without CMA and within the period of monitoring. <u>*Level 2:*</u> The increase in length of erosion within a swamp (compared to its pre-mining length) is **3%** of the swamp length or area; and/or Soil surface crack that causes erosion that is likely to stabilise within the monitoring period without intervention; and/or Gully knickpoint forms or an existing gully knickpoint becomes active. <u>*Level 3:*</u> The increase in length of erosion within a swamp (compared to its pre-mining length) is **4%** of the swamp length or area; and/or Soil surface crack that causes erosion that is unlikely to stabilise within the monitoring period without intervention. Exceeding Prediction Mining results in the total length of erosion within a swamp (compared to its pre-mining length) to increase **>5%** of the length or area of the swamp compared to any increase in total erosion length in a reference swamp (ie increase in length or area of erosion in an impact swamp less any increase in length or area in erosion in a reference swamp is **>5%**).	a) upfront mine planning b) erosion monitoring (i.e. ALS, observation) c) coir logs d) knickpoint control e) water spreading f) weeding g) fire management h) reporting i) investigation and review j) update future predictions	Offset required **immediately**, if no remediation considered practicable. Offset required **2 years** following remediation, if it is ineffective. This period can be extended to **5 years**, with the agreement of the Secretary.	
Minor changes in the size of the swamps **Minor changes** in the ecosystem functionality of the swamps	Swamp vegetation changes: • Swamp size • Species richness, distribution, composition	**Swamp Size** <u>*Level 1:*</u> A trending decline in the extent of an upland swamp (combined area of groundwater dependent communities) for two consecutive monitoring periods, greater than observed in the Control Group, and exceeding the standard error (SE) of the Control Group. <u>*Level 2:*</u> A trending decline in the extent of an upland swamp (combined area of groundwater dependent communities) for three consecutive	a) upfront mine planning b) vegetation monitoring c) water spreading d) seeding/planting	Offset required **immediately**, if no remediation considered practicable. Offset required **5 years** following	Monitoring period for swamp size is related to capture of Lidar data at the end of each longwall ~ 1 year Triggers for

Performance Measures	Potential Impacts	*Performance Triggers*	Management Strategies	Offsets	Other Actions
No significant change to the composition or distribution of species within the swamps	and diversity • Vegetation sub-communities	monitoring periods, greater than observed in the Control Group, and exceeding the SE of the Control Group. *Level 3:* A trending decline in the extent of an upland swamp (combined area of groundwater dependent communities) for four consecutive monitoring periods, greater than observed in the Control Group, and exceeding the SE of the Control Group. Exceeding Prediction: Mining results in a trending decline in the extent of an upland swamp (combined area of groundwater dependent communities) for five consecutive monitoring periods, greater than observed in the Control Group, and exceeding the SE of the Control Group. **Ecosystem Functionality** *Level 1:* A trending decline in the extent of any individual groundwater dependent community within a swamp for two consecutive monitoring periods, greater than observed in the Control Group, and exceeding the SE of the Control Group. *Level 2:* A trending decline in the extent of any groundwater dependent community within a swamp for three consecutive monitoring periods, greater than observed in the Control Group, and exceeding the SE of the Control Group. *Level 3*: A trending decline in the extent of any groundwater dependent community within a swamp for four consecutive monitoring periods, greater than observed in the Control Group, and exceeding the SE of the Control Group. Exceeding Prediction: Mining results in a trending decline in the extent of a groundwater dependent community within a swamp for five consecutive monitoring periods, greater than observed in the Control Group, and exceeding the SE of the Control Group. **Species Composition and Distribution**	e) weeding f) fauna monitoring g) fire management h) grouting of controlling of controlling rockbars and bedrock base and/or use of other remediation techniques i) reporting j) investigation and review k) update future predictions	remediation, if it is ineffective. This period can be extended to **10 years**, with the agreement of the Secretary.	groundwater decline result in increased intensity and frequency of vegetation monitoring

Performance Measures	Potential Impacts	*Performance Triggers*	Management Strategies	Offsets	Other Actions
		Level 1: A **2%** (or otherwise statistically significant) decline in species richness or diversity during a period of stability or increase in species richness/diversity in reference swamps for **two** consecutive years; and/or *Level 2:* A **5%** (or otherwise statistically significant) decline in species richness or diversity during a period of stability or increase in species richness/diversity in reference swamps for **three** consecutive years. *Level 3:* An **8%** (or otherwise statistically significant) decline in species richness or diversity during a period of stability or increase in species richness/diversity in reference swamps for **four** consecutive years. Exceeding Prediction: Mining results in a **>10%** (or otherwise statistically significant) decline in species richness or diversity during a period of stability or increase in species richness/diversity in reference swamps for **five** consecutive years.			
Maintenance or restoration of the structural integrity of the bedrock base of any significant permanent pool or controlling rockbar within the swamps	Subsidence impacts (i.e. cracking) on bedrock base or controlling rockbar	*Level 1:* Fracturing observed in the bedrock base of any significant permanent pool which results in observable loss of surface water of **10%** compared to baseline for the pool (in addition to any decrease in reference pools). *Level 2:* Fracturing observed in the bedrock base of any significant permanent pool which results in observable loss of surface water of **20%** compared to baseline for the pool (in addition to any decrease in reference pools). *Level 3:* Fracturing observed in the bedrock base of any significant permanent pool which results in observable loss of surface water of **20%** compared to baseline for the pool for **>20%** of the time over a period of 1 year (in addition to any decrease in reference pools). Exceeding Prediction Structural integrity of the bedrock base of any significant permanent pool or controlling rockbar cannot be restored, i.e. pool water level within the swamp after CMAs continues to be **>20%** lower than baseline for **>20%**	a) upfront mine planning b) subsidence monitoring c) surface water monitoring d) groundwater monitoring e) grouting of controlling of controlling rockbars and bedrock base and/or use of other remediation techniques f) CMAs g) reporting	Offset required **immediately**, if no remediation considered practicable. Offset required **2 years** following remediation, if it is ineffective. This period can be extended to **5 years**, with the agreement of the Secretary.	

Performance Measures	Potential Impacts	*Performance Triggers*	Management Strategies	Offsets	Other Actions
		of the time over a period of **1** year.	h) investigation and review i) update future predictions		
Minor changes in the ecosystem functionality of the swamps	Falls in surface or near-surface groundwater levels in swamps N.B. Not linked specifically to a PM and would not be considered a breach if predictions were exceeded.	*Level 1:* Groundwater level lower than baseline level at any monitoring site within a swamp (in comparison to reference swamps); and/or Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at any monitoring site (measured as average mm/day during the recession curve). *Level 2*: Groundwater level lower than baseline level at **50%** of monitoring sites (within 400m of mining) within a swamp (in comparison to reference swamps); and/or Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at a **50%** of monitoring sites (within 400m of mining) within the swamp. *Level 3:* Groundwater level lower than baseline level at **>80%** of monitoring sites (within 400m of mining) within a swamp (in comparison to reference swamps); and/or Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at **>80%** of monitoring sites (within 400m of mining) within the swamp.	a) upfront mine planning b) groundwater monitoring c) implementation of swamp research program d) weeding e) fire management f) reporting g) update future predictions		Triggers for groundwater decline result in increased intensity and frequency of vegetation monitoring and/or further investigations of subsidence impacts on bedrock base and rockbars
Minor changes in the ecosystem functionality of the swamps	Falls in soil moisture levels in swamps N.B. Not linked specifically to a PM and would not be considered a breach if predictions were	*Level 1:* Soil moisture level lower than baseline level at any monitoring sites (within 400m of mining) within a swamp (in comparison to reference swamps). *Level 2:* Soil moisture level lower than baseline level at **50%** of monitoring sites (within 400m of mining) within a swamp (in comparison to reference swamps). *Level 3:* Soil moisture level lower than baseline level at **>80%** of monitoring sites (within 400m of mining) within a swamp (in comparison	a) upfront mine planning b) soil moisture monitoring c) water spreading d) weeding e) fire management f) reporting		Triggers of soil moisture decline result in increased intensity and frequency of vegetation monitoring and/or further investigations of subsidence

Performance Measures	Potential Impacts	*Performance Triggers*	Management Strategies	Offsets	Other Actions
	exceeded.	to reference swamps).	g) update future predictions		impacts on bedrock base and rockbars.
		Exceeding Prediction: Mining results in a **>10%** (or otherwise statistically significant) decline in species richness or diversity during a period of stability or increase in species richness/diversity in reference swamps for **five** consecutive years.			
Maintenance or restoration of the structural integrity of the bedrock base of any significant permanent pool or controlling rockbar within the swamps	Subsidence impacts (ie. cracking) on bedrock base or controlling rockbar	*Level 1:* Fracturing observed in the bedrock base of any significant permanent pool which results in observable loss of surface water of **10%** compared to baseline for the pool (in addition to any decrease in reference pools). *Level 2:* Fracturing observed in the bedrock base of any significant permanent pool which results in observable loss of surface water of **20%** compared to baseline for the pool (in addition to any decrease in reference pools). *Level 3:* Fracturing observed in the bedrock base of any significant permanent pool which results in observable loss of surface water of **20%** compared to baseline for the pool for **>20%** of the time over a period of **1** year (in addition to any decrease in reference pools). *Exceeding Prediction* Structural integrity of the bedrock base of any significant permanent pool or controlling rockbar cannot be restored, ie pool water level within the swamp after CMAs continues to be **>20%** lower than baseline for **>20%** of the time over a period of **1** year.	a) upfront mine planning b) subsidence monitoring c) surface water monitoring d) groundwater monitoring e) grouting of controlling of controlling rockbars and bedrock base and/or use of other remediation techniques f) CMAs g) reporting h) investigation and review i) update future j) predictions	Offset required **immediately**, if no remediation considered practicable. Offset required **2 years** following remediation, if it is ineffective. This period can be extended to **5 years**, with the agreement of the Secretary.	

Performance Measures	Potential Impacts	*Performance Triggers*	Management Strategies	Offsets	Other Actions
Minor changes in the ecosystem functionality of the swamps	Falls in surface or near-surface groundwater levels in swamps *NB. Not linked specifically to a PM and would not be considered a breach if predictions were exceeded.*	*Level 1:* Groundwater level lower than baseline level at any monitoring site within a swamp (in comparison to reference swamps); and/or Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at any monitoring site (measured as average mm/day during the recession curve). *Level 2:* Groundwater level lower than baseline level at **50%** of monitoring sites (within 400 m of mining) within a swamp (in comparison to reference swamps); and/or Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at a **50%** of monitoring sites (within 400m of mining) within the swamp.	a) upfront mine planning b) groundwater monitoring c) implementation of swamp research program d) weeding e) fire management f) reporting g) update future predictions		Triggers for groundwater decline result in increased intensity and frequency of vegetation monitoring and/or further investigations of subsidence impacts on bedrock base and rockbars

		Level 3: Groundwater level lower than baseline level at **>80%** of monitoring sites (within 400m of mining) within a swamp (in comparison to reference swamps); and/or Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at **>80%** of monitoring sites (within 400 m of mining) within the swamp.			
Minor changes in the ecosystem functionality of the swamps	Falls in soil moisture levels in swamps *NB. Not linked specifically to a PM and would not be considered a breach if predictions were exceeded.*	*Level 1:* Soil moisture level lower than baseline level at **any** monitoring sites (within 400 m of mining) within a swamp (in comparison to reference swamps). *Level 2:* Soil moisture level lower than baseline level at **50%** of monitoring sites (within 400m of mining) within a swamp (in comparison to reference swamps). *Level 3:* Soil moisture level lower than baseline level at **>80%** of monitoring sites (within 400m of mining) within a swamp (in comparison to reference swamps).	a) upfront mine planning b) soil moisture monitoring c) water spreading d) weeding e) fire management f) reporting g) update future predictions		Triggers of soil moisture decline result in increased intensity and frequency of vegetation monitoring and/or further investigations of subsidence impacts on bedrock base and rockbars

Table 18: Dendrobium Area 3B Watercourse TARP.

Monitoring	Trigger	Action
OBSERVATIONAL, PHOTO POINT AND WATER MONITORING		
Wongawilli Creek, Donalds Castle Creek and WC-WF54 **Relevant Performance Measure(s):** • Wongawilli Creek - minor environmental consequences • Donalds Castle Creek - minor environmentalconsequences • Waterfall WC-WF54 – negligible environmentalconsequences General observation of streams in active mining areaswhen longwall is within 400m	***Level 1*** * • Crack or fracture up to 100mm width at its widest point with no observable loss of surface water or erosion • Crack or fracture up to 10m length with no observable loss of surface water or erosion • Erosion in a localised area (not associated with cracking or fracturing) which would be expected to naturally stabilise without CMA and within the period of monitoring • Observable release of strata gas at the surface • Observable increase in iron staining within the mining area • Observation that a pool on a subject creek has ceased to flow	• Continue monitoring program • Submit an Impact Report to BCD, DPIE, MEG, Water NSW • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Observation that a single pool on a subject creek is dry in consecutive monitoring events • Observation that two or more pools on a subject creek are dry in a single monitoring event • Observation that the subject creek has ceased to flow in consecutive monitoring event	• *Actions as stated for Level 1* • Carry out Water Flow Assessment Method D • Review monitoring frequency • Submit letter report to DPIE, MEG and WaterNSW and seek advice on any CMA required. • Implement agreed CMAs as approved (subject to agency feedback)
	• Crack or fracture between 100 and 300mm width at its widest point or any fracture which results in observable loss of surface water or erosion • Crack or fracture between 10 and 50m length • Soil surface crack that causes erosion that is likely to stabilise within the monitoring period without intervention • Observable increase in iron staining within the mining area continues to outside the mining area i.e. 400m from the longwall	• *Actions as stated for Level 1* • Review monitoring frequency • Submit letter report to DPIE, MEG and WaterNSW and seek advice on any CMA required. • Implement agreed CMAs as approved (subject to agency feedback)

Monitoring	Trigger	Action
	Level 3 * • Crack or fracture over 300mm width at its widest point • Crack or fracture over 50m length • Fracturing observed in the bedrock base of any significant permanent pool which results in observable loss of surface water • Soil surface crack that causes erosion that is unlikely to stabilise within the monitoring period without intervention • Gas release results in vegetation dieback, mortality or loss of aquatic habitat • Observable increase in iron staining within the mining area continues more than 600m from the longwall	• *Actions as stated for Level 2* • Offer site visit with BCD, DPIE, MEG, WaterNSW • Implement additional monitoring or increase frequency if required • Develop site CMA (subject to stakeholder feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it isappropriate to do so in consultation with BCD, DPIE, MEG, WaterNSW • Completion of works following approvals and at a time agreed between S32, DPIE, MEG and WaterNSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success • Review relevant TARP and Management Plan in consultation with keyagencies
	Exceeding Prediction • Structural integrity of the bedrock base of any significant pool or controlling rockbar cannot be restored i.e. pool water level within the pool after CMAs continues to be lower than baseline period • Gas release results in vegetation dieback that does not revegetate • Gas release results in mortality of threatened species or ongoing loss of aquatic habitat • Iron staining and associated increases in dissolved iron resulting from the mining is observed in water at Wongawilli Creek downstream monitoring site Wongawilli Creek (FR6) • Iron staining and associated increases in dissolved iron resulting from the mining is observed in water at the Donalds Castle Creek downstream monitoring site Donalds Castle Ck (FR6) • Rock fall at WC-WF54 or its overhang Impacts on the structural integrity of WC-WF54, its overhang orits pool	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent

Monitoring	Trigger	Action
Native Dog Creek, ND1, ND2, WC15, WC12, WC7, LA1 and LA2 General observation of streams in active mining areas when longwall is within 400m	***Level 1*** * • Crack or fracture up to 100mm width at its widest point with no observable loss of surface water or erosion • Crack or fracture up to 10m length with no observable loss of surface water or erosion • Erosion in a localised area (not associated with cracking or fracturing) which would be expected to naturally stabilise without CMA and within the period of monitoring • Observable release of strata gas at the surface Observable increase in iron staining within the mining area	• Continue monitoring program • Submit an Impact Report to BCD, DPIE, MEG, Water NSW • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Crack or fracture between 100 and 300mm width at its widest point or any fracture which results in observable loss of surface water or erosion • Crack or fracture between 10 and 50m length • Soil surface crack that causes erosion that is likely to stabilise within the monitoring period without intervention • Observable increase in iron staining within the mining area continues to outside the mining area i.e. 400m from the longwall	• *Actions as stated for Level 1* • Review monitoring frequency • Submit letter report to DPIE, MEG and WaterNSW and seek advice on any CMA required. • Implement agreed CMAs as approved (subject to agency feedback)
	Level 3 * • Crack or fracture over 300mm width at its widest point • Crack or fracture over 50m length • Fracturing observed in the bedrock base of any significant permanent pool which results in observable loss of surface water • Soil surface crack that causes erosion that is unlikely to stabilise within the monitoring period without intervention • Gas release results in vegetation dieback, mortality or loss of aquatic habitat • Observable increase in iron staining within the mining area continues more than 600m from the longwall	• *Actions as stated for Level 2* • Offer site visit with BCD, DPIE, MEG, WaterNSW • Implement additional monitoring or increase frequency if required • Develop site CMA (subject to stakeholder feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it isappropriate to do so in consultation with BCD, DPIE, MEG, WaterNSW • Completion of works following approvals and at a time agreed between S32, DPIE, MEG and WaterNSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success

Monitoring	Trigger	Action
		• Review relevant TARP and Management Plan in consultation with key agencies
Water Quality		
Wongawilli Creek Wongawilli Ck (FR6)Baseline means: • pH 5.98 • EC 98.8 uS/cm • DO 89.5% **Relevant Performance Measure(s):** Wongawilli Creek - minor environmental consequences	***Level 1*** * • One exceedance of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 4.45 – EC 154.1 uS/cm – DO 50.5%	• Continue monitoring program • Submit an Impact Report to BCD, DPIE, MEG, WaterNSW • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Two non-consecutive exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean within six months: – pH 4.45 – EC 154.1 uS/cm – DO 50.5%	• *Actions as stated for Level 1* • Review monitoring frequency • Submit letter report to BCD, DPIE, MEG and WaterNSW and seek advice on any CMA required. • Implement agreed CMAs as approved (subject to agency feedback)
	Level 3 * • Three exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean within six months: – pH 4.45 – EC 154.1 uS/cm – DO 50.5%	• *Actions as stated for Level 2* • Offer site visit with BCD, DPIE, MEG, WaterNSW • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key agencies • Develop site CMA (subject to agency feedback). This may include: – Limestone emplacement to raise pH where it is appropriate to do so • Completion of works following approvals and at a time agreed between S32, DPIE, MEG and WaterNSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success

Monitoring	Trigger	Action
	Exceeding Prediction • Mining results in two consecutive exceedances or three exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean within six months: – pH 4.45 – EC 154.1 uS/cm – DO 50.5%	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
Donalds Castle Creek Donalds Castle Ck (FR6)Baseline means: pH 5.41 EC 116.0 uS/cm DO 85.6% **Relevant Performance Measure(s):** Donalds Castle Creek - minor environmental consequences	***Level 1*** * • One exceedance of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean within six months: – pH 3.60 – EC 185.8 uS/cm – DO 40.1%	• Continue monitoring program • Submit an Impact Report to BCD, DPIE, MEG, WaterNSW • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	• Two non-consecutive exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean within six months: – pH 3.60 – EC 185.8 uS/cm – DO 40.1%	• *Actions as stated for Level 1* • Review monitoring frequency • Submit letter report to DPIE, MEG and WaterNSW and seek advice on any CMA required. • Implement agreed CMAs as approved (subject to agency feedback)
	Level 3 * • Three exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean within six months: – pH 3.60 – EC 185.8 uS/cm – DO 40.1%	• *Actions as stated for Level 2* • Offer site visit with BCD, DPIE, MEG, WaterNSW • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with keyagencies • Collect laboratory samples and analyse for: – pH, EC, major cations, major anions, Total FE, MN & Al – Filterable suite of metals • Develop site CMA (subject to agency feedback). This may include: – Limestone emplacement to raise pH where it is appropriate to do so

Monitoring	Trigger	Action
		• Completion of works following approvals and at a time agreed between S32, DPIE, MEG and WaterNSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success
	Exceeding Prediction • Mining results in two consecutive exceedances or three exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean within six months: – pH 3.60 – EC 185.8 uS/cm – DO 40.1%	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
Lake Avon Lake Avon tributary (LA4_S1) baseline means: pH 5.38 EC 90.8 uS/cm DO 89.9% **Relevant Performance Measure(s):** Avon Dam - negligible reduction in the quality ofsurface water inflows to Avon Dam	***Level 1*** * • One exceedance of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean within six months: – pH 4.90 – EC 129.8 uS/cm – DO 69.5%	• Continue monitoring program • Submit an Impact Report to BCD, DPIE, MEG, WaterNSW • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Two non-consecutive exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean within six months: – pH 4.90 – EC 129.8 uS/cm – DO 69.5%	• *Actions as stated for Level 1* • Review monitoring frequency • Submit letter report to DPIE, MEG and WaterNSW and seek advice on any CMA required. • Implement agreed CMAs as approved (subject to agency feedback)

Monitoring	Trigger	Action
	Level 3 * • Three exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean within six months: – pH 4.90 – EC 129.8 uS/cm – DO 69.5%	• *Actions as stated for Level 2* • Offer site visit with BCD, DPIE, MEG, WaterNSW • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with keyagencies • Collect laboratory samples and analyse for: – pH, EC, major cations, major anions, Total FE, MN & Al – Filterable suite of metals • Develop site CMA (subject to agency feedback). This may include: – Limestone emplacement to raise pH where it is appropriate to do so – Grouting of fractures in rockbar and bedrock base of any significant pool where flow diversion results in pool water level lower than baseline period • Completion of works following approvals and at a time agreed between S32, DPIE, MEG and WaterNSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success
	Exceeding Prediction • Mining results in two consecutive exceedances or three exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean within six months: – pH 4.90 – EC 129.8 uS/cm – DO 69.5%	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation Provide residual environmental offset for any mining impact where CMAsare unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
POOL WATER LEVEL		
Wongawilli Creek and Donalds Castle Creek **Relevant Performance Measure(s):** Wongawilli Creek - minor environmental consequences	***Level 1*** * Single pool on a subject creek is observed as dry	• Continue monitoring program • Carry out Water Flow Assessment Method D. • Submit letter report to DPIE, MEG, Water NSW • Report in the End of Panel Report • Summarise actions and monitoring in AEMR

Monitoring	Trigger	Action
Donalds Castle Creek - minor environmental consequences	***Level 2*** * • Single pool on a subject creek is observed as dry in consecutive monitoring events Two or more pools on a subject creek as observed as dry in a single monitoring period	• *Actions as stated for Level 1* • Review monitoring frequency • Submit letter report to DPIE, MEG and WaterNSW and seek advice on any CMA required. • Implement agreed CMAs as approved (subject to agency feedback)
	Level 3 * Fracturing resulting in diversion of flow such that <10% of thepools have water levels lower than baseline period	• *Actions as stated for Level 2* • Offer site visit with BCD, DPIE, MEG, WaterNSW • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with keyagencies • Develop site CMA (subject to agency feedback). This may include: Grouting of rockbar and bedrock base of any significant pool where it is appropriate to do so in consultation with BCD, DPIE, MEG, WaterNSW • Completion of works following approvals and at a time agreed between S32, DPIE, MEG and WaterNSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success
	Exceeding Prediction Fracturing resulting in diversion of flow such that >10% of thepools have water levels lower than baseline period	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAsare unsuccessful as required by Condition 14 Schedule 3 of the Development Consent

Monitoring	Trigger	Action
• **Waterfall WC-WF54** **Relevant Performance Measure(s):** Waterfall WC-WF54 – negligible environmentalconsequences	***Exceeding Prediction*** • Fracturing in Wongawilli Creek within 30m of the waterfall which results in observable flow diversion Fracturing in Wongawilli Creek which results in observable flow diversion from the lip of the waterfall	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAsare unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
SURFACE WATER FLOW		
Wongawilli Creek and Donalds Castle CreekAvon Dam and Cordeaux River **Relevant Performance Measure(s):** • Wongawilli Creek - minor environmental consequences • Donalds Castle Creek - minor environmentalconsequences • Avon Dam - negligible reduction in the quantity ofsurface water inflows to Avon Dam[1] • Cordeaux River - negligible reduction in the quantityof surface water inflow to the Cordeaux River at its confluence with Wongawilli Creek[2] **Surface water flow Reference sites**:	***Level 1*** • A) Lower flow than expected (additional 10-15% of days where Q% lower than Reference Q%) • B) 5-10% increase in cease-to-flow frequency beyond natural) • C) Reduction in Q50 (10-15% beyond natural)	• Continue monitoring program. • Submit an Impact Report to BCD, DPIE, MEG, WaterNSW. • Report in the End of Panel Report. • Summarise actions and monitoring in AEMR.
	Level 2 • A) Lower flow than expected (additional 15-20% of days where Q% lower than Reference Q%). • B) 10-20% increase in cease-to-flow frequency (beyond natural) • C) 15-20% reduction in Q50 (beyond natural) • D) Observation that the subject Creek has ceased to flow at spatially consecutive monitoring sites.	• *Actions as stated for Level 1* • Review monitoring frequency. • D) ➔ carry out Water Flow Assessment Method D. • Submit letter report to DPIE, MEG and WaterNSW and seek advice on anyCMA required. • Implement agreed CMAs as approved (subject to agency feedback).

Monitoring	Trigger	Action
• Wongawilli Creek - WWU (Wongawilli Creekupstream); • O'Hares Creek at Wedderburn (213200); • (other such sites, if necessary, include Woronora River2132101 and Bomaderry Creek 215016) NB. This section of the TARP contains four Water Flow Assessment Methods, labelled A, B, C and D, which arespecified in detail in Watershed HydroGeo (2019). Hydrological changes are assessed by comparing pre- and post-mining observed flows from impact or assessment sites to flow data from the reference sites. *Natural variability ('NV') will be defined as the 'average' change at the selected reference sites. Triggers may occur when the apparent impact at a site (NV + x% change) could be less than maximum observed variabilityat one of the reference sites.*	***Level 3*** • A) Lower flow than expected (additional >20% of days where Q% lower than Reference Q%) • B) >20% increase in cease-to-flow frequency (beyond natural) • C) >20% reduction in Q50 (beyond natural)	• *Actions as stated for Level 2* • Offer site visit with BCD, DPIE, MEG, WaterNSW. • Implement additional monitoring or increase frequency if required. • Develop site CMA (subject to agency feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it is appropriate to do so in consultation with BCD, DPIE, MEG, WaterNSW. • Completion of works following approvals and at a time agreed betweenS32, DPIE, MEG and WaterNSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success. • Review relevant TARP and Management Plan in consultation with key agencies.
	Exceeding Prediction Measured surface water flow reduction, based on Assessment Methods C, D, to be compared against predictions made in contemporary groundwater modelling conducted to the satisfaction of the Secretary to assess whether effects that cannotbe explained by natural variability "exceed prediction".	• *Actions as stated for Level 3* • Investigate reasons for the exceedance. • Update future predictions based on the outcomes of the investigation. • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent.
Tributaries of Wongawilli Creek and Donalds Castle Creek and other affected watercourses notsubject to performance measures **Surface water flow Reference sites:** • Wongawilli Creek - WWU (Wongawilli Creekupstream); • O'Hares Creek and Wedderburn (213200);	***Level 1*** • A) Lower flow than expected (additional 10-20% of days where Q% lower than Reference Q%) • B) 5-10% increase in cease-to-flow frequency (beyond natural) • C) 10-20% reduction in Q50 (beyond natural)	• Continue monitoring program. • Submit an Impact Report to BCD, DPIE, MEG, WaterNSW. • Report in the End of Panel Report. • Summarise actions and monitoring in AEMR.

Monitoring	Trigger	Action
• (other such sites, if necessary, include Woronora River2132101 and Bomaderry Creek 215016) NB. This section of the TARP contains four Water Flow Assessment Methods, labelled A, B, C and D, which arespecified in detail in Watershed HydroGeo (2019). Hydrological changes are assessed by comparing pre- and post-mining observed flows from impact or assessment sites to flow data from the reference sites. *Natural variability ('NV') will be defined as the 'average' change at the selected reference sites. Triggers may occur when the apparent impact at a site (NV + x% change) could be less than maximum observed variabilityat one of the reference sites.*	***Level 2*** • A) Lower flow than expected (additional 20-30% of days where Q% lower than Reference Q%) • B) 10-20% increase in cease-to-flow frequency (beyond natural) • C) 20-30% reduction in Q50 (beyond natural)	• *Actions as stated for Level 1* • Review monitoring frequency. • Submit letter report to DPIE, MEG and WaterNSW and seek advice on anyCMA required. • Implement agreed CMAs as approved (subject to agency feedback).
	Level 3 • A) Lower flow than expected (additional >30% of days where Q% lower than Reference Q%) • B) >20% increase in cease-to-flow frequency (beyond natural) • C) >30% reduction in Q50 (beyond natural)	• *Actions as stated for Level 2* • Offer site visit with BCD, DPIE, MEG, WaterNSW. • Implement additional monitoring or increase frequency if required • Develop site CMA (subject to agency feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it isappropriate to do so in consultation with BCD, DPIE, MEG, WaterNSW. • Completion of works following approvals and at a time agreed betweenS32, DPIE, MEG and WaterNSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success. • Review relevant TARP and Management Plan in consultation with key agencies.
AQUATIC ECOLOGY		
Pool water level, interconnectivity between pools andloss of connectivity, noticeable alteration of habitat • Wongawilli Creek catchment – 8 sites Donalds Castle Creek catchment – 1 site	***Level 1 **** Reduction in aquatic habitat for 1 year	• Continue monitoring program. • Submit an Impact Report to BCD, DPIE, MEG, WaterNSW. • Report in the End of Panel Report. • Summarise actions and monitoring in AEMR.
	Level 2 * Reduction in aquatic habitat for 2 years following the active subsidence period	• *Actions as stated for Level 1* • Review monitoring frequency • Submit letter report to DPIE, MEG and WaterNSW and seek advice on anyCMA required. • Implement agreed CMAs as approved (subject to agency feedback)

Monitoring	Trigger	Action
	Level 3 * Reduction in aquatic habitat for >2 years following the active subsidence period	• *Actions as stated for Level 2* • Offer site visit with BCD, DPIE, MEG, WaterNSW. • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key agencies • Develop site CMA (subject to agency feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it isappropriate to do so in consultation with BCD, DPIE, MEG, WaterNSW. • Completion of works following approvals and at a time agreed betweenS32, DPIE, MEG and WaterNSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success.
TERRESTRIAL FAUNA – THREATENED FROG SPECIES		
Pool water level, interconnectivity between pools andloss of connectivity, noticeable alteration of habitat • Wongawilli Creek catchment – 2 sites • Donalds Castle Creek catchment – 2 sites • Avon Dam tributary – 1 site • Native Dog tributary – 1 site	***Level 1 **** Reduction in habitat for 1 year	• Continue monitoring program. • Submit an Impact Report to BCD, DPIE, MEG, WaterNSW. • Report in the End of Panel Report. • Summarise actions and monitoring in AEMR.
	Level 2 * Reduction in habitat for 2 years following the active subsidence period	• *Actions as stated for Level 1* • Review monitoring frequency • Submit letter report to DPIE, MEG and WaterNSW and seek advice on anyCMA required. • Implement agreed CMAs as approved (subject to agency feedback)
	Level 3 * Reduction in habitat for > 2 years following the active subsidence period	• *Actions as stated for Level 2* • Offer site visit with BCD, DPIE, MEG, WaterNSW. • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key agencies • Develop site CMA (subject to agency feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it isappropriate to do so in consultation with BCD, DPIE, MEG, WaterNSW. • Completion of works following approvals and at a time agreed betweenS32, DPIE, MEG and WaterNSW (i.e. may be after mining

Monitoring	Trigger	Action
		induced movements and impacts are complete), including monitoring and reporting on success.

[1] *Surface water inflows calculation = [Impacts at gauged catchments (LA1 + LA2 + LA3 + LA4 + LA6+ NDT1 + ND2) + estimated impacts at ungauged but undermined catchments (e.g. LA5)] / [total inflow to LA].*

[2] *Flow reduction as determined from measured at flow gauging station WWL_A.*

Table 19: Dendrobium Landscape Impacts, Triggers and Response Plan.

Monitoring	Trigger	Action
LANDSCAPE FEATURES		
AREA 2 **Cliffs** • A2-CL1 (above LW4) **Steep Slopes** • A2-SL1 and A2-SL2 (above LWs 4 & 5) **Watercourses** • A2-WC10 and A2-WC11 (above LW3) • A2-WC13 & A2-WC16 (above LWs 4 & 5) **Swamp** • A2-SW1 (above LWs 4 & 5) **4WD Track** • A2-FT1 (above LWs 4 & 5) **Crinanite Surface Extent** • A2-CN1 & A2-CN2 (above LWs 3 & 4)	***Level 1*** * • Rock fall from a cliff which is left mostly intact (<10% length), resulting in insignificant ground disturbance • Surface movement or rock displacement with negligible soilsurface exposed • Crack at the surface, which should not result in any significant erosion or further ground movement • Crack in a fire trail which should not result in erosion orimpede access • Crack or fracture up to 100mm width • Crack or fracture up to 10m length • Erosion in a localised area which would be expected to naturally stabilise without CMA and within the period ofmonitoring	• Continue monitoring program • Report impacts to key stakeholders • Summarise impacts and Report in the End of Panel Report and AEMR
AREA 3A **Cliffs** All mapped cliff sites in subsidence area (Refer toDendrobium Area 3A SMP Figures 19.3 for location of sites) **Steep Slopes** All mapped steep slopes in subsidence area *Referto Dendrobium Area 3A SMP Figures 19.3 for location of sites* **Watercourses/ Swamps** All mapped watercourse and swamps insubsidence area *Refer to Dendrobium Area 3A SMP Figure 19.3* **Fire Trails** All mapped fire trails in subsidence area *Refer to Dendrobium Area 3A SMP Figure 19.3*	***Level 2 **** • Rock fall or overhang collapse at a cliff site, where characteristics of the cliff have changed, and there has beensignificant ground disturbance • Surface movement or rock displacement that has exposedsignificant areas of soil • A crack at the surface, which could result in significanterosion or movement at the surface • A crack at the surface with potential risk to safety and/orfauna entrapment • A crack in the fire trail, which could result in significanterosion or impede vehicle access • Crack or fracture between 100 and 300mm width • Crack or fracture between 10 and 50m length • Significant erosion at any location, which is not likely to naturally stabilise within the period of monitoring, or is located in a sensitive area e.g. swamps, creek, lake shore, and may result in increased sediment transport to Cordeaux Dam,	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Provide safety signage and barricades as appropriate • Implement approved repairs to ensure safety and serviceability on fire trails • Implement agreed CMAs as approved *Note: CMAs are to be proposed based on appropriate management of environmentaland other consequences of impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts*

Monitoring	Trigger	Action
AREA 3B **Cliffs** All mapped cliff sites in subsidence area *Refer to Dendrobium Area 3B SMP Figures 18.1for location of sites*	or has been previously identified as Level 1, but is not likely to naturally stabilise within the monitoring period	
	Level 3 * • Major cliff collapse where the characteristics of the cliff change significantly and there is significant ground disturbance that is unlikely to naturally stabilise within the monitoring period • Crack or fracture over 300mm width • Crack or fracture over 50m length • Mass movement of a slope causing large areas of exposedsoil with potential for further movement	• *Actions as stated for Level 2* • Immediately notify DPIE, DPIM, WaterNSW, resource managers and relevant technical specialists and seek advice on any CMA required • Site visits with stakeholders if required • Review monitoring program and modify if necessary within 1 month • Implement increased monitoring if required within 2 weeks • Develop site CMA in consultation with key stakeholders within 1 month, (pendingstakeholder availability) and seek approvals • Completion of works following approvals • Issue CMA report within 1 month of works completion • Conduct initial follow up monitoring & reporting within 2 months of CMAcompletion • Review the relevant TARP and Management Plan in consultation with keystakeholders *Note: CMAs are to be proposed based on appropriate management of environmentaland other consequences of impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts*
Sandy Creek Waterfall	***Exceeding Prediction*** • Rock fall at Sandy Creek Waterfall or from its overhang • Structural integrity of the waterfall, its overhang and itspool are impacted • More than negligible cracking within 30 m of the waterfall • More than negligible diversion of water from the lip of thewaterfall	• Actions as stated for Level 3 • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation
TERRESTRIAL FLORA AND FAUNA		
A number of sites located across and around Areas 2, and 3A. Refer Dendrobium Area 3A SMP Figure 21.1, 21.2 and 21.3	***Level 1 **** • Vegetation impacted by mining (by rockfalls, soil slippage, gas emissions) that is likely to naturally	• Continue monitoring program • Report impacts to key stakeholders • Summarise impacts and Report in the End of Panel Report and AEMR

Monitoring	Trigger	Action
General observation of active mining areas	regenerate within the monitoring period	
	Level 2 * • Vegetation impacted by mining (by rockfalls, soil slippage, gas emissions) that is unlikely to naturally regenerate within the monitoring period • Statistically significant difference between Before After Control Impact sites as a result of mining	• Actions as stated for Level 1 • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved
	Level 3 * • Vegetation impacted by mining that is not responding to CMAs	• Actions as stated for Level 2 • Immediately notify BCD, DPE, MEG, WaterNSW, other resource managers and relevant technical specialists and seek advice on any CMA required • Site visits with stakeholders if required • Review monitoring program and modify if necessary within 1 month • Implement increased monitoring if required within 2 weeks • Develop site CMA in consultation with key stakeholders within 1 month, (pending stakeholder availability) and seek approvals • Completion of works following approvals • Issue CMA report within 1 month of works completion • Conduct initial follow up monitoring & reporting within 2 months of CMA completion • Review the relevant TARP and Management Plan in consultation with key stakeholders

** These may be revised in consultation with DPIE and MEG and other key stakeholders following analysis of natural variability within the pre-mining baseline data.*
These TARPs relate to Dendrobium Area 3B and impacts resulting from mining in Areas 1, 2 and 3A were managed under previous SMPs