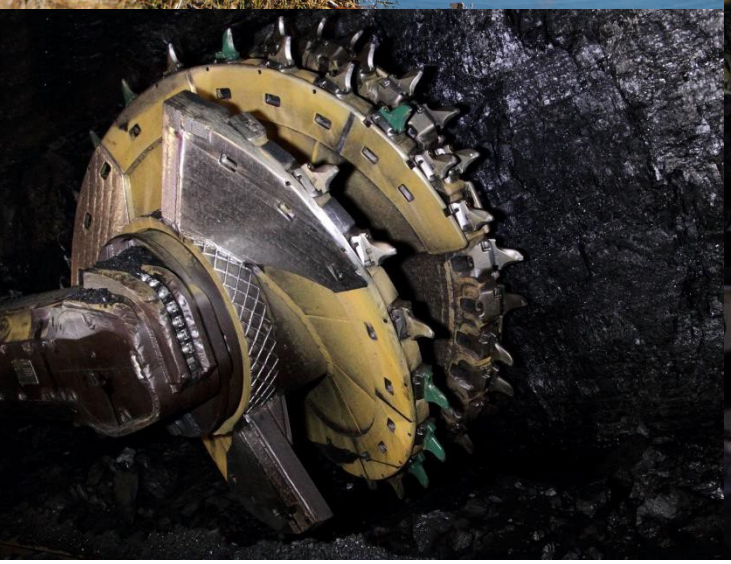
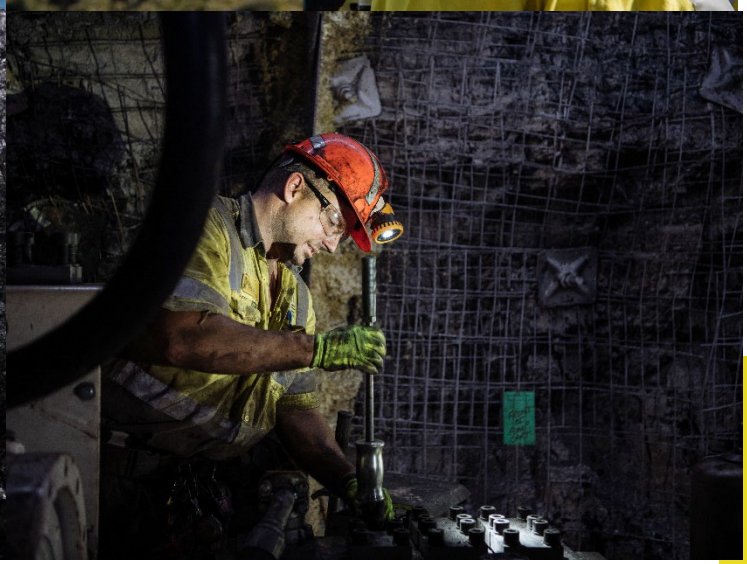
Illawarra Metallurgical Coal
End of Panel Report



DENDROBIUM AREA 3A
LONGWALL 19
END OF PANEL REPORT

July 2023

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 3A (DA3A) Longwall 19 and presents monitoring results and analyses compared to relevant impact assessment criteria and predictions in the DA3A Subsidence Management Plan (SMP).

Dendrobium Longwall 19 is located within Consolidated Coal Lease 768 and is the fourth panel to be extracted in DA3A. Extraction of Longwall 19 commenced on 20 June 2022 and was completed on 29 March 2023. The extracted longwall has a length of 1651 metres (m), a void width of 305 m (including first workings) and a maximum cutting height up to 3.9m.

The extraction of underground coal reserves from DA3A 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 $56 million in government royalties during the months July 2022 to February 2023.

Subsidence movements resulting from the extraction of Longwall 19 were monitored along lines and points within the SMP Area. The measured ground movements after the extraction of Longwall 19 are generally similar to or less than the predicted values.

During the extraction of Longwall 19, 63 new surface impacts were identified. These impacts are labelled as "*DA3A_LW19_001*" to "*DA3A_LW19_063*". 57 of these impacts were observed on natural features and the remaining six impacts were observed on built features such as fire roads and other access tracks. An update is provided for one existing Longwall 8 impact; this impact is labelled as *DA3A_LW8_003 (Update).*

No new water quality TARPs were triggered in the review period; however, water quality TARPs remain triggered at Lake Avon tributary site LA4_S1 for EC, pH and DO as a result of impacts related to Area 3B. In the last three years, new or recurrent iron staining has been noted on Wongawilli Creek, WC21, LA5, WC14, WC15 and SC10C, extending down to Sandy Creek. The increase in iron staining is partly related to increasing groundwater levels due to high rainfall. It is expected that the occurrence of iron seeps will decline as drier conditions return.

Analysis of flow-corrected trends in water quality indicate increasing electrical conductivity (EC), sulphate and manganese at WC_FR6, despite generally declining EC in non-flow-corrected data. Flow-corrected trends in EC, pH, Mn, Zn and Al are evident at DCC_FR6. At Sandy Creek Rockbar 5, flow-corrected EC, sulphate, Fe, Mn and Zn remain above baseline levels due to upstream contributions from SC10C which was mined beneath by Longwalls 7 and 8.

TARP triggers for surface water hydrology were identified at Donalds Castle Creek (*DCS2; DCU*); DC13 (*DC13S1*); WC21 (*WC21S1*); WC15 (*WC15S1*), LA4 (*LA4S1*), LA3 (*LA3S1*); LA2 (*LA2S1*); SC10 (*SC10S1*) and Sandy Creek (*SCL2/GS2122205*). Water flow performance measures were met for Longwall 19. Analysis of available surface water flow observation records for Wongawilli Creek did not trigger a TARP for any months assessed during the Longwall 19 period.

Pools along Wongawilli Creek and Sandy Creek were observed to be full and flowing during the review period.

No pools along these watercourses or SC10 have become dry as a result of Longwall 19. The upper reaches of WC14, at and upstream from Pool 16 were directly mined beneath by Longwall 19. Pool 16 ceased to flow and became dry following the passage of Longwall 19 beneath the site, as is common for watercourses directly mined beneath. Water levels and outflow status of the downstream Pool 3 remains unaffected.

The mean total mine inflow during Longwall 19 extraction was 12.0 ML/day which represents a 32% increase compared with the previous longwall. The increase is primarily due to the very high rainfall during the longwall extraction period and the previous two years. The net mine water balance is dominated by pumping from Area 3B (72 % of total), with Area 3A representing only 6.5 % of inflows.

Longwall 19 passed beneath, or within 400 m of Swamps 12, 15a, 15b, 34 and 148. A review of shallow groundwater hydrographs at swamp sites within the area of influence of Longwall 19 indicates mining subsidence effects at site 148_01 and a likely effect at site 15a_19, triggering additional swamp TARP Level 1 for Swamp 15a (one of seven piezometers) and Level 3 for Swamp 148 (single piezometer). Mining related effects related to previous Area 3A longwalls are evident at Swamps 12, 15b and 146 (>400m from Longwall 19), for which TARP Levels 3 remain.

A reassessment of swamp sites within the area of influence of Longwall 18 indicates that shallow groundwater levels at site 35b_01 are likely to have been affected by mining related fracturing and/or drawdown within the sandstone substrate. The impact results in a TARP Level 3 for Swamp 35b (single piezometer).

Only minor physical impacts in tributaries and no water quality impacts to watercourses in DA3A have been attributed to extraction of Longwall 19. The iron staining and gas release also represent relatively minimal impacts to aquatic habitat and biota in Wongawilli Creek and its tributaries, nor were any impacts observed to aquatic biota during surveys in April and June of 2023.

Eight Aboriginal cultural heritage sites were visited, with two impacts related to the extraction of Longwall 19 observed.

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

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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 19 is located within Consolidated Coal Lease 768 and is the fourth panel to be extracted in DA3A. Extraction of Longwall 19 commenced on 20 June 2022 and was completed on 29 March 2023. The extracted longwall has a length of 1651m, 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 19 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 Longwall 19 SMP was approved by the Department of Planning and Environment (DPE) on 11 March 2021.

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

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 19 are described in the following reports:

- Dendrobium Area 3A Subsidence Management Plan (SMP);
- Dendrobium Area 3A Watercourse Impact, Monitoring, Management and Contingency Plan (WIMMCP) (February 2021);
- Dendrobium Area 3A Swamp Impact, Monitoring, Management and Contingency Plan (SIMMCP) (June 2021).

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 DA3A 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. South32's Illawarra Metallurgical Coal Operations:

- Provide jobs for approximately 1,800 people, with more than 90% of wages paid to workers residing in the Illawarra region.
- Result in expenditure of A$800 million a year in the Illawarra region, of which A$300 million is spent with more than 200 locally based suppliers.
- Contributes more than A$1 million a year to support local community groups and organizations.
- Contributed approximately A$208 million in royalties to the NSW government in FY22.

From the operations of Dendrobium Mine, IMC paid approximately $56 million in government during the general period of Longwall 19 extraction i.e. the months July 2022 to February 2023.

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 risk associated 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 in the 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 19 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 19 include (Figure 1):

- Wongawilli Creek closure lines;
- Sandy Creek Waterfall closure lines;
- Area 3A 3D monitoring points;
- 330 kV transmission line monitoring points;
- Tributary cross lines;
- Swamp cross lines; and
- Airborne laser scans of the area.

The predicted subsidence effects have been obtained using subsidence model presented in Report No. MSEC1082 which supported the SMP Application for Longwall 19.

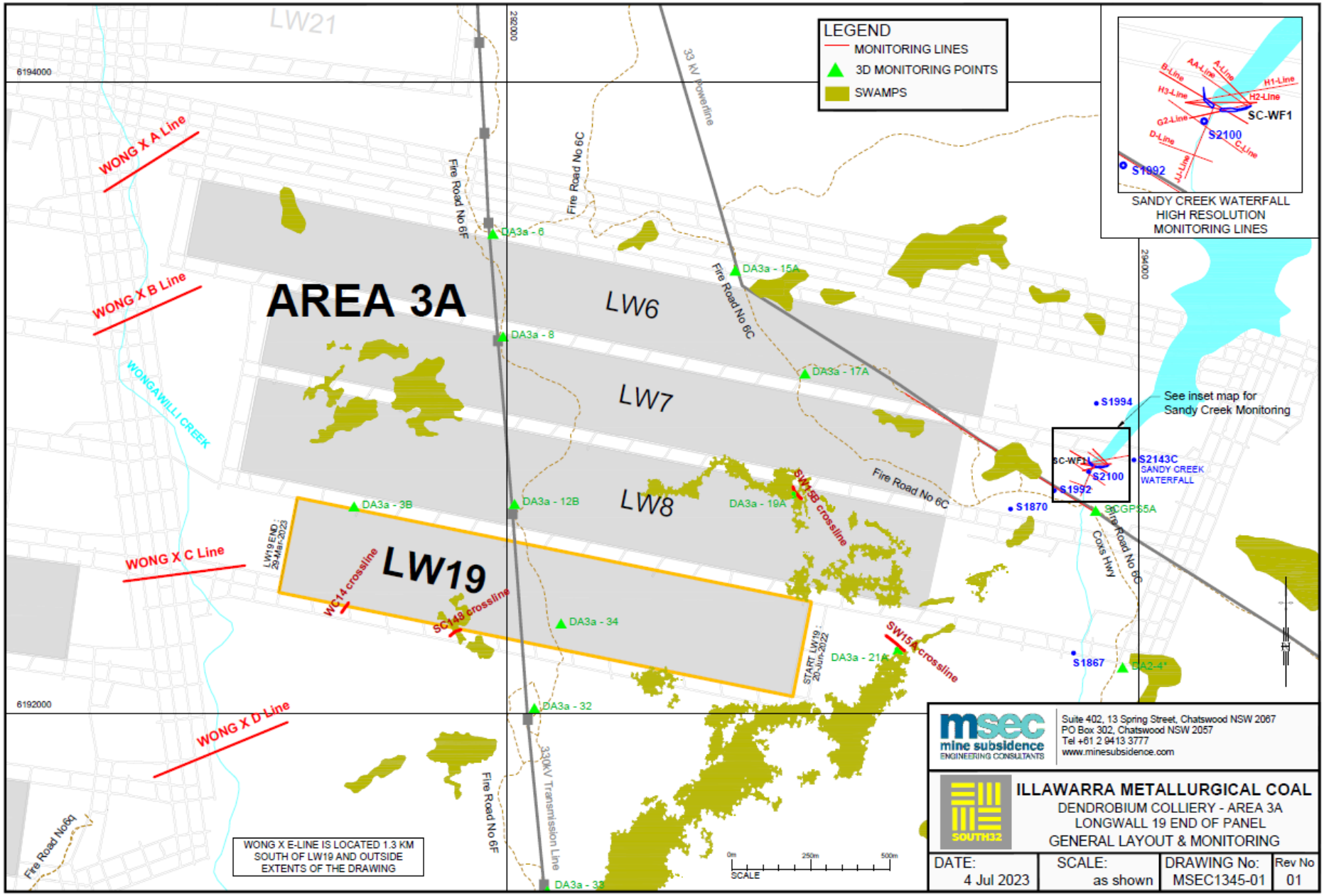

Figure 1: Overview of subsidence monitoring sites, comprised of monitoring lines and monitoring points (Source: Attachment B).

2.1. Wongawilli Creek Closure Lines

Closure movements across Wongawilli Creek have been measured by IMC using 2D survey techniques at the Wong X A-Line to Wong X E-Line (Figure 2). These monitoring lines have been measured after the mining of each of Longwall 6 to Longwall 8 in Area 3A, Longwall 9 to Longwall 18 in Area 3B and then Longwall 19 in Area 3A.

The measured total closures at the Wong X A-Line and B-Line were 124 mm and 101 mm, respectively, after the completion of LW18 and they reduced to 96 mm and 90 mm, respectively, after the completion of Longwall 19. The final measured closures are less than the predicted values at these two monitoring lines.

The measured total closure at the Wong X C-Line of 216 mm is greater than the predicted total closure of 180 mm in that location. The exceedance of 36 mm at this monitoring line represents +20 % of the measured value and, therefore, it is within the order of the accuracy of the prediction method of ±25 %.

The measured total closure at the Wong X C-Line is similar to but slightly greater than the maximum predicted closure slightly downstream of this location of 210 mm. The exceedance of 6 mm compared to the maximum predicted value represents less than 3 % of the measured value and it is in the order of survey tolerance.

It is therefore considered that the movements measured using the Wongawilli Creek closure lines are reasonably consistent with the predictions (i.e. in the order of accuracy of the prediction method of ±25 %) provided in Report No. MSEC1082 which supported the SMP Application for Longwall 19.

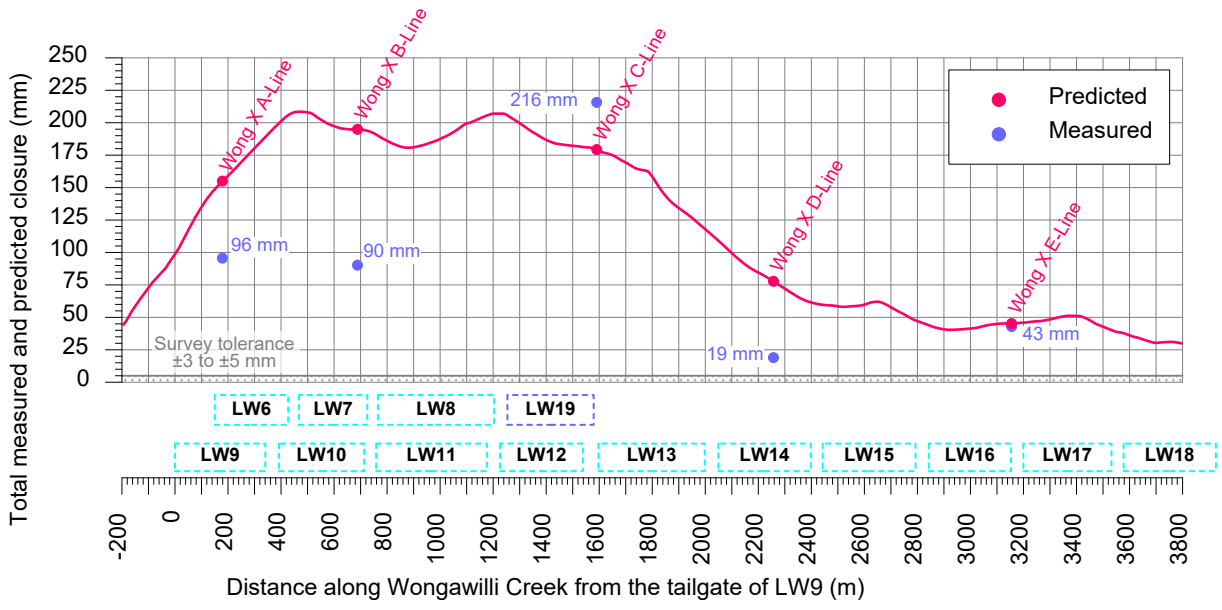

Figure 2: Measured and predicted total closure along Wongawilli Creek after Longwall 19

2.2. Sandy Creek Waterfall Closure Lines

Closure across Sandy Creek Waterfall (SCW) has been measured by IMC using the High-Resolution Survey (HRS) monitoring lines consisting of the H2-Line, H3-Line, G2-Line, A-Line and B-Line (Figure 3). The locations of these monitoring lines are shown in Figure 1. The HRS SCW monitoring lines each comprise two survey marks with one mark on each valley side.

In the latest survey, the measured incremental movements for the HRS SCW closure lines are less than ±2 mm

which is within the nominal accuracy when considering survey tolerance and environmental effects. That is, the mining-related movements are not measurable outside the nominal accuracy.

The HRS SCW closure lines measured up to approximately 3 mm closure during the mining of Longwall 19 before reducing below the nominal accuracy at the completion of mining. These movements are likely to include survey tolerance and environmental effects.

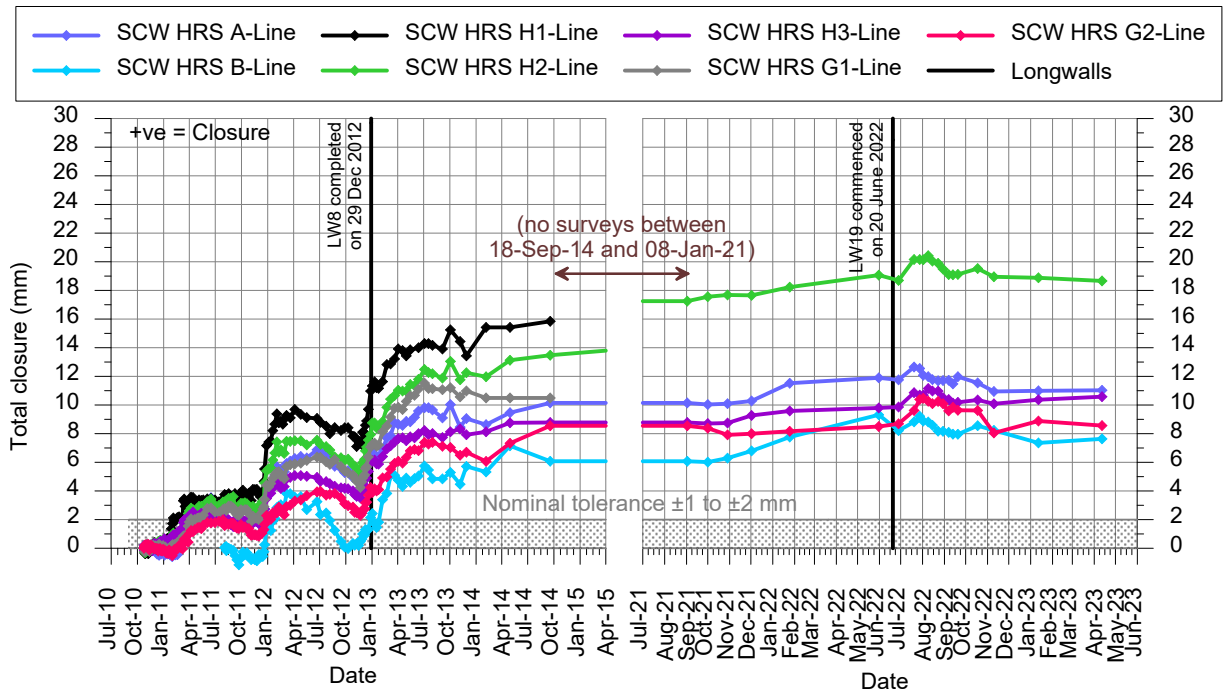

Figure 3: Measured total closures for the HRS SCW closure lines due to Longwall 6 to Longwall 8 and Longwall 19.

2.3. Wongawilli Creek Tributaries

The mine subsidence effects for a tributary to Wongawilli Creek have been measured by IMC using 2D survey techniques at the WC14 cross line. The location of this monitoring line is shown in Figure 1.

A summary of the maximum measured and predicted subsidence and closure at the WC14 cross line after the completion of Longwall 19 are provided in Table 3. The predicted subsidence value has been derived from the predicted subsidence contours illustrated in Report No. MSEC1082. The predicted closure is based on a combination of the conventional horizontal movements and valley-related movements, taking the equivalent height of the valley within half-depth of cover from the valley base.

Table 3: Maximum measured and predicted incremental vertical subsidence and closure at the WC14 cross line due to the mining of Longwall 19

Type	Maximum incremental vertical subsidence (mm)	Maximum incremental closure (mm)
Measured	105	55
Predicted	150	250

The accuracies of the measured absolute levels of the survey marks are in the order of ±30 mm. The accuracies of the measured closures are in the order of ±5 mm.

The maximum measured incremental vertical subsidence and closure at the WC14 cross line are less than the maximum predicted values.

It is therefore considered that the ground movements measured using the WC14 cross line are consistent with the predictions provided in Report No. MSEC1082 which supported the SMP Application for Longwall 19.

2.4. Swamp cross lines

The mine subsidence effects at the swamps and their associated drainage lines have been measured by IMC using 2D survey techniques at the Swamp 15A, Swamp 15B and Swamp 148 cross lines. Other swamp monitoring lines are located outside the zone of influence for Longwall 19.

The development of the measured accumulated closure at the Swamp 15A, Swamp 15B and Swamp 148 cross lines is illustrated in Figure 4. The cross lines were established after the completion of Longwall 8 and, therefore, the measured movements represent the additional movements due to Longwall 19 only. These three monitoring lines have short lengths and they are located near the valley base and, therefore, they may not measure the maximum closure within the valley.

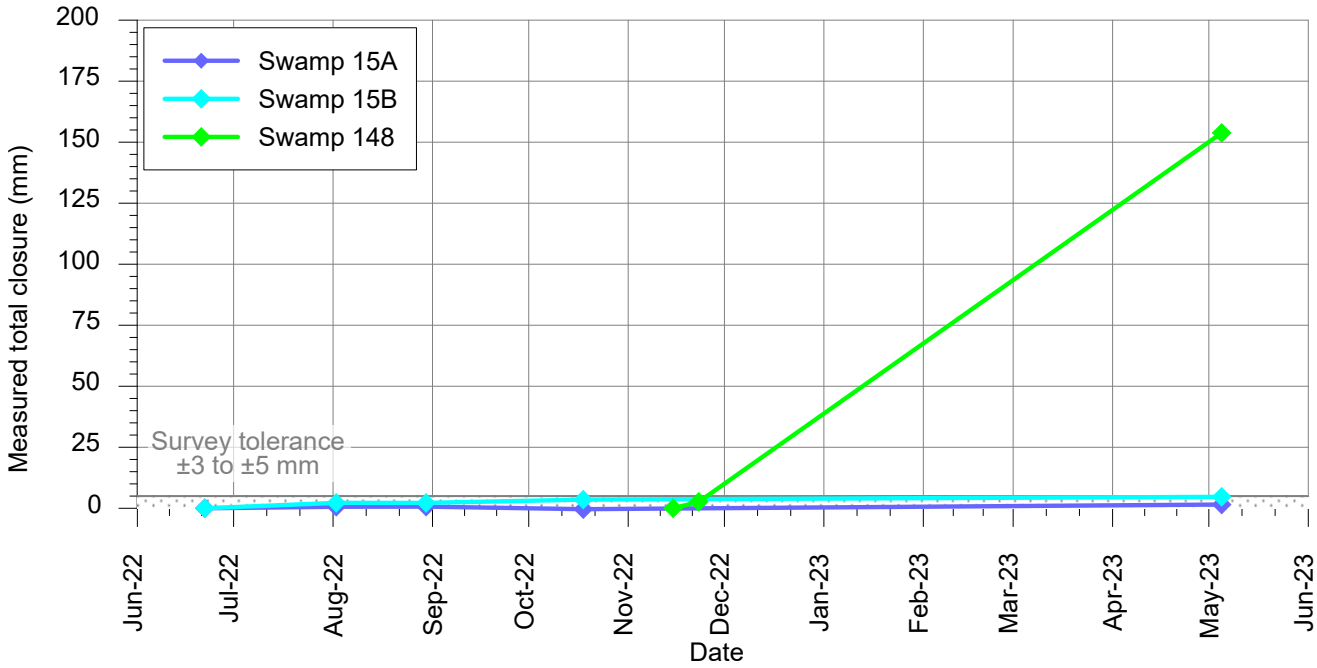

Figure 4: Measured accumulated closure for the swamp cross lines

The accuracies of the measured absolute levels of the survey marks are in the order of ±30 mm. The accuracies of the measured closures are in the order of ±5 mm.

The maximum measured incremental closure at the Swamp 148 cross line of 154 mm is similar to but slightly greater than the maximum predicted value of 150 mm. The exceedance of 4 mm represents less than 3 % of the measured value and it is in the order of survey tolerance. The maximum measured incremental vertical subsidence and closure at the Swamp 15A and Swamp 15B cross lines and the measured incremental vertical subsidence at the Swamp 148 cross line are less than the maximum predicted values. It is therefore considered that the ground movements measured using the swamp cross lines are consistent with the predictions provided in Report No. MSEC1082 which supported the SMP Application for Longwall 19.

2.5. Dendrobium Area 3A 3D and the Avon Dam 3D monitoring points

Far-field horizontal movements near Longwall 19 have been measured by IMC using the Dendrobium Area 3A 3D

monitoring points (DA3A 3D) monitoring points. The locations of these monitoring points are shown in Figure 1.

The accuracies of the measured absolute positions (i.e. eastings and northings) are in the order of ±20 mm. The greatest incremental horizontal movements occur directly above Longwall 19. The vectors located above the previously mined longwalls are orientated towards the south and towards the active Longwall 19. 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 DA3A 3D monitoring points with those previously measured in Dendrobium Area 1 (DA1 3D) and Dendrobium Area 2 (DA2 3D) and Dendrobium Area 3B (DA3B 3D) is provided in Figure 5. The mean and the 95 % confidence level for the 3D monitoring data at Dendrobium Mine are also shown in this figure.

The measured incremental horizontal movements due to the mining of Longwall 19 are within the range of those measured at similar distances from previously mined longwalls at Dendrobium Mine.

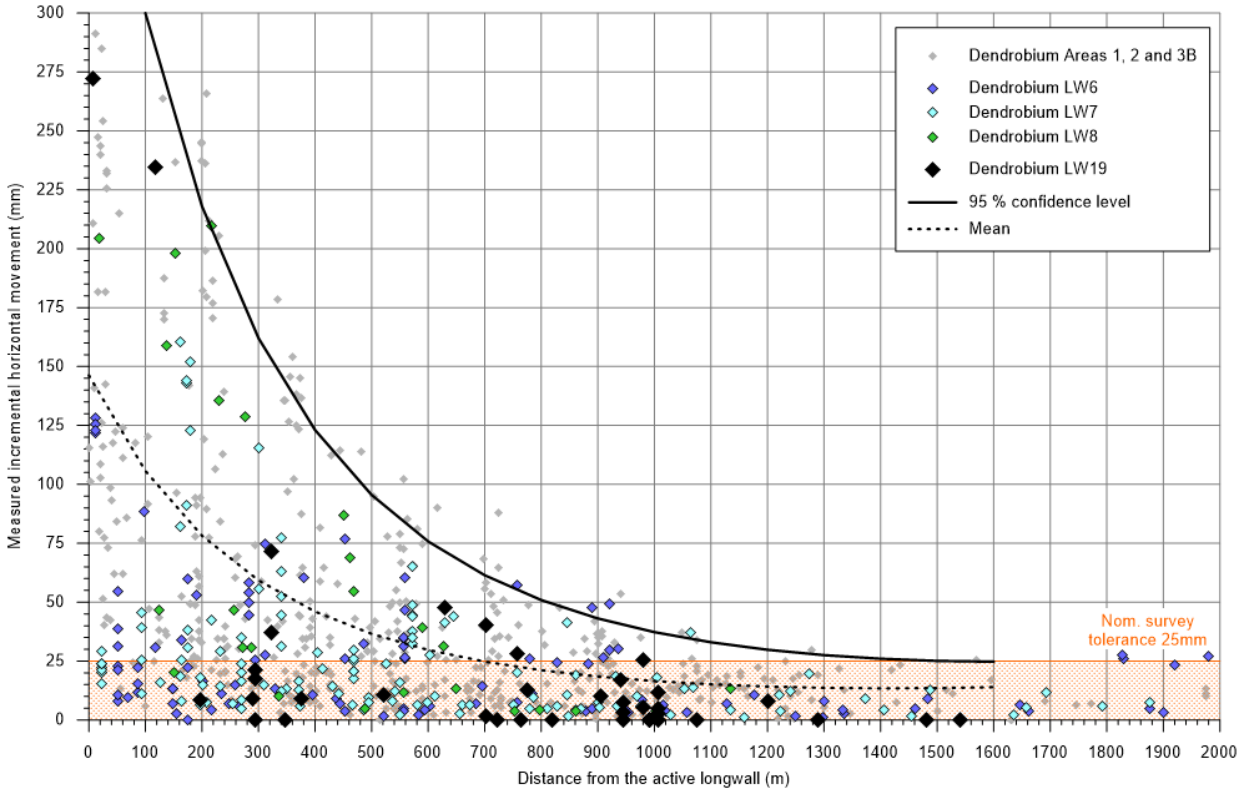

Figure 5: Measured incremental horizontal movements in Area 3A at Dendrobium Mine (source: Attachment B)

2.6. 330 kV transmission line monitoring

The mine subsidence effects for the 330 kV transmission line have been measured by IMC using 2D monitoring points located on and around Towers TWR17-14 to TWR17-19. The locations of the transmission towers are shown in Figure 1.

The monitoring results were included in the subsidence review reports (MSEC1300, Rev. R01 to R26) which were issued during and after the mining of Longwall 19. The monitoring data was reviewed by IMC, MSEC and TransGrid and no additional management measures were required during mining. The measured incremental vertical subsidence movements for Towers TWR17-14, TWR17-15, TWR17-16 and TWR17-17 are illustrated in Figure 6. This figure presents the additional movements due to the mining of Longwall 19 only since the base survey.

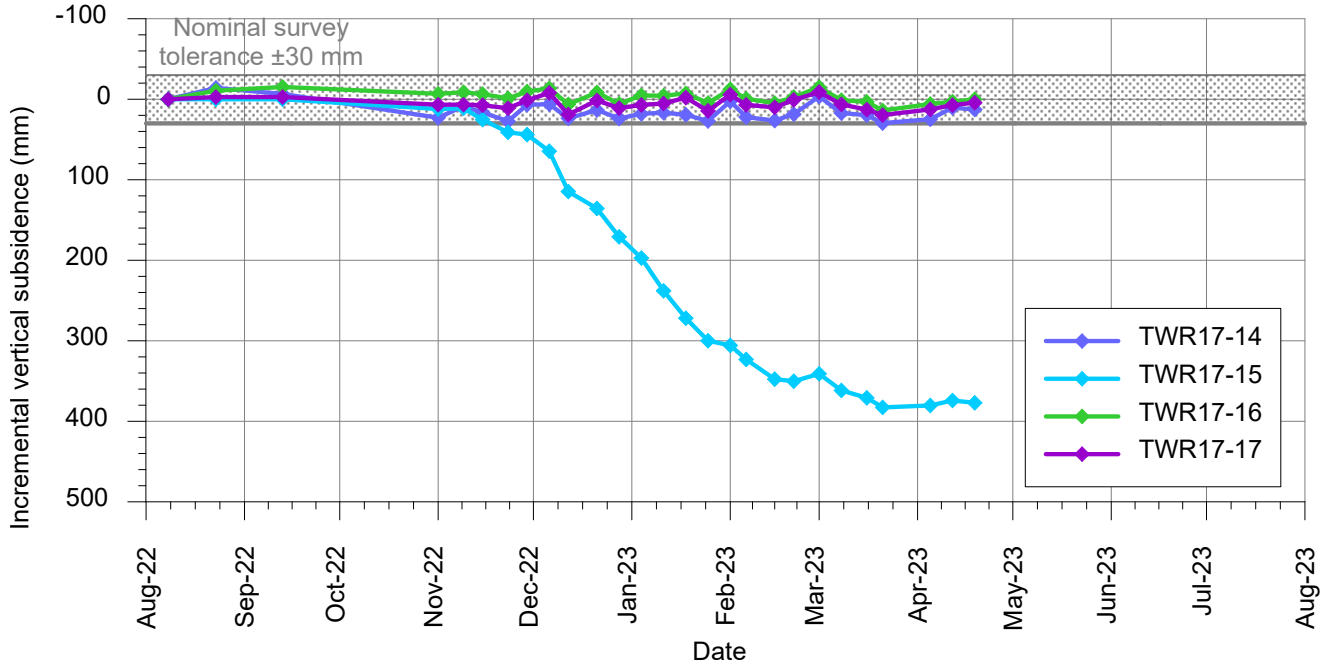

Figure 6: Measured incremental vertical subsidence for TWR17-14, TWR17-15, TWR17-16 and TWR17-17 due to the mining of Longwall 19 only.

The vertical subsidence developed progressively at Tower TWR17-15 as Longwall 19 mined adjacent to and beyond it. Only low-level vertical subsidence was measured at the remaining towers which were in the order of survey tolerance for absolute height of ±30 mm. The accuracies of the measured relative levels and changes in distances are in the order of ±5 mm. The maximum measured incremental vertical subsidence of 377 mm at Tower TWR17-15 is less than one third the maximum predicted value.

The reason is that the subsidence model was calibrated to conservatively provide additional subsidence above the tailgate chain pillar and adjacent longwalls, therefore, providing increased predictions in these locations. The measured incremental changes in relative level, tilt, changes in distance between tower legs and changes in distance between the bases of adjacent towers were similar to or less than the predicted values and were less than the Level 1 Triggers. It is therefore considered that the ground movements measured using the 330 kV transmission line monitoring points are consistent with the predictions provided in Report No. MSEC1082 which supported the SMP Application for Longwall 19.

2.7. ALS / LiDAR surveys

Changes in surface level due to the mining in Area 3A have been measured using Airborne Laser Scan (ALS) / Light Detection and Ranging (LiDAR) surveys. The initial surface level contours have been determined from the survey carried out in January 2010 before the commencement of Longwall 6. The post-mining surface level contours have been determined from the subsequent surveys carried out in April 2011 after the completion of Longwall 6, March 2012 after the completion of Longwall 7, January 2013 after the completion Longwall 8 and April 2023 after the completion of Longwall 19.

The measured incremental changes in surface level due to the mining of Longwall 19 only are shown in Figure 7. These contours have been determined by taking the differences between the surface levels measured before and after the mining of this longwall. The changes in surface level were determined by calculating the differences between pre-mining surface levels and post-mining surface levels, incrementally (Figure 7), and cumulatively (Figure 8).

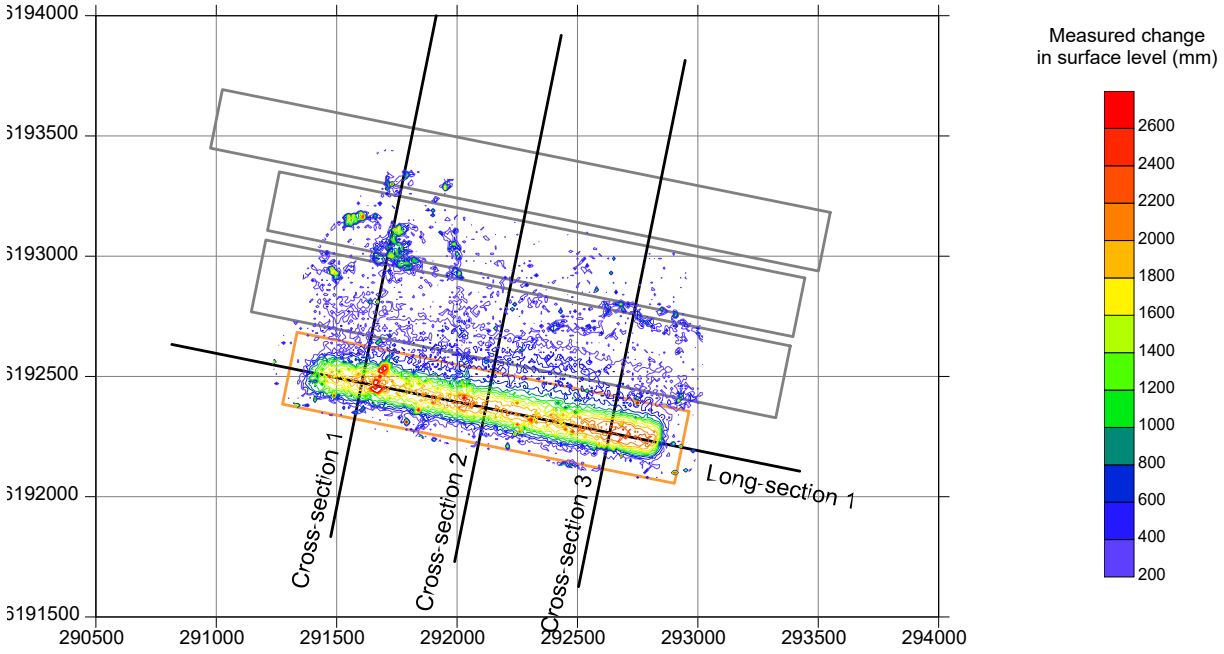

Figure 7: Measured incremental changes in surface level due to the mining Longwall 19

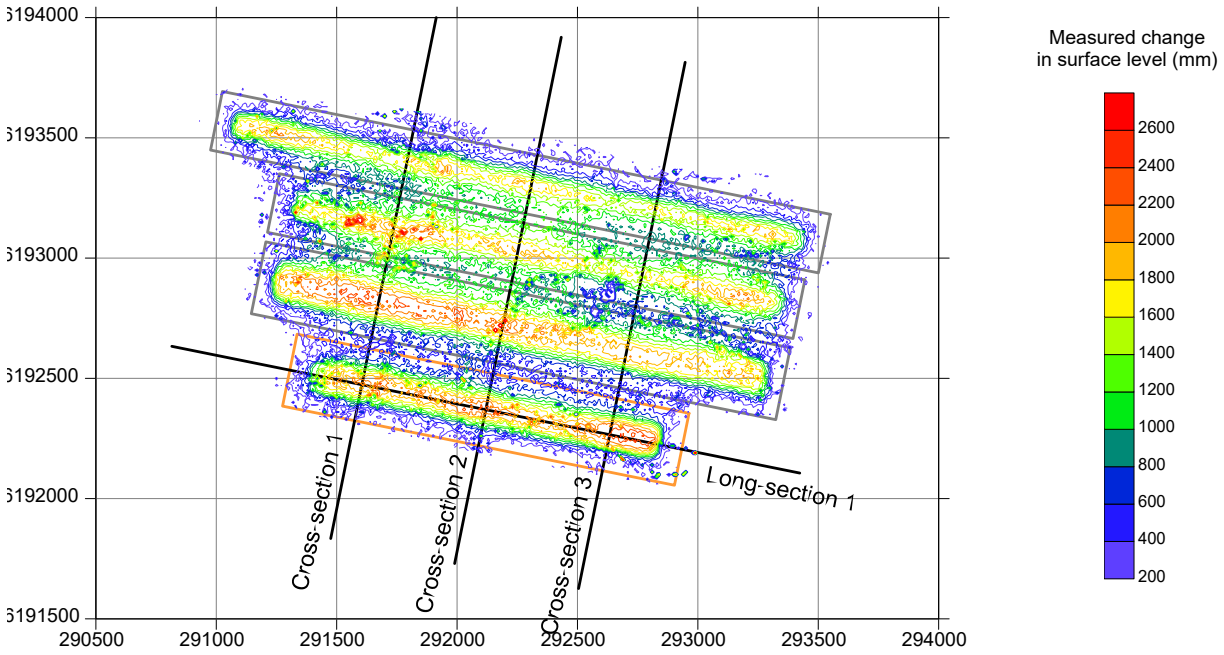

Figure 8: Measured total changes in surface level due to the mining of Longwall 6 to Longwall 8 and Longwall 19

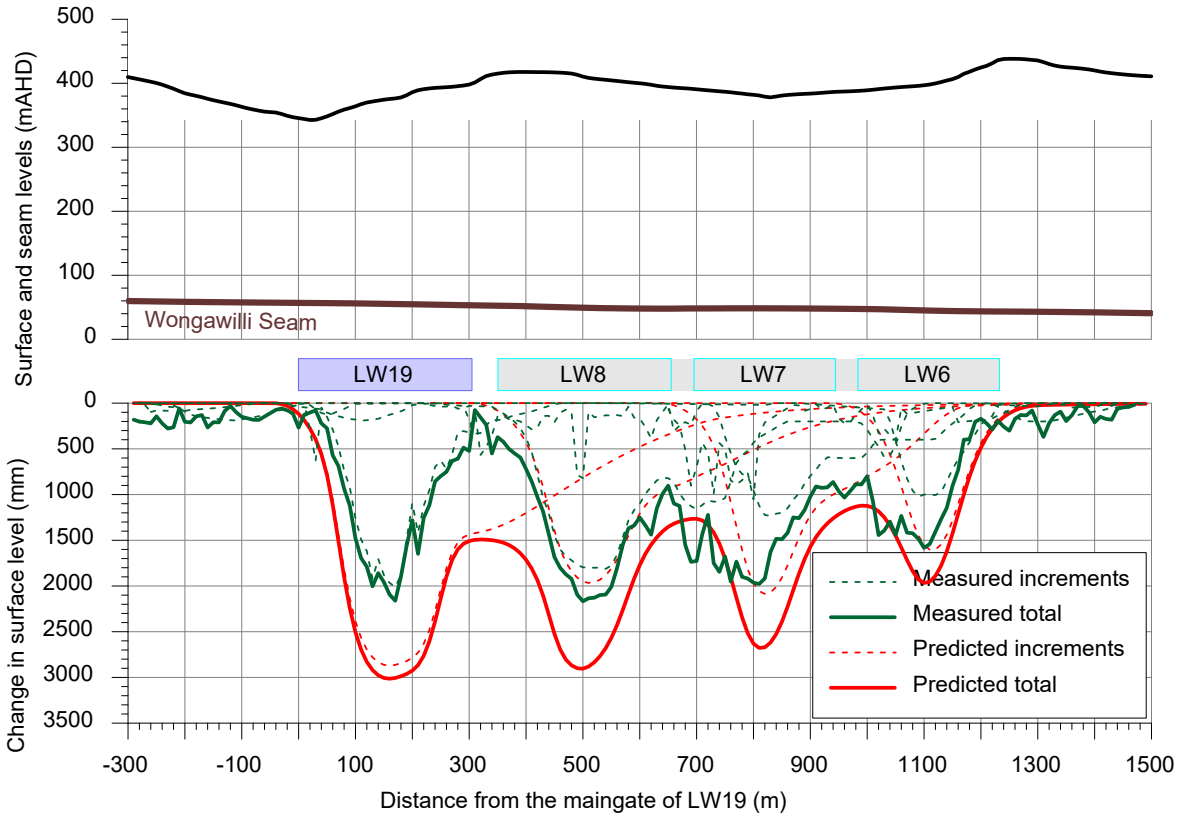

Figure 9: Measured changes in surface level and predicted vertical subsidence along Cross section 1

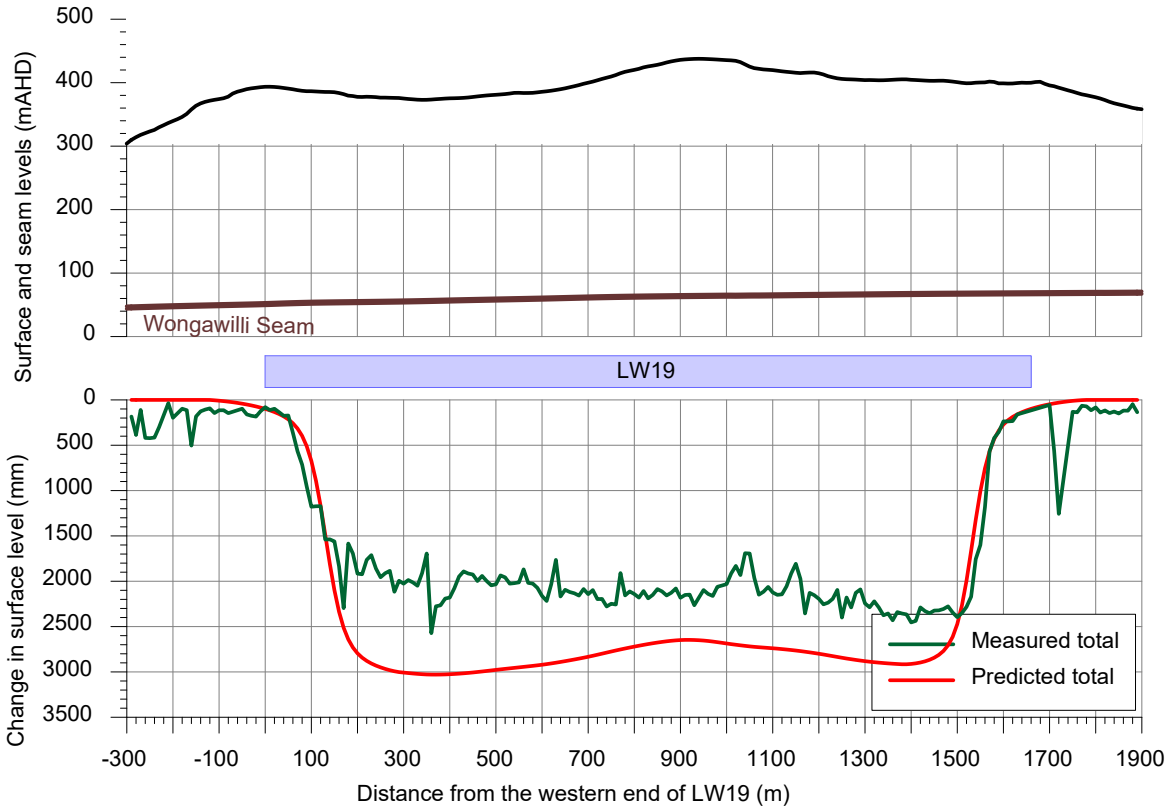

Figure 10: Measured changes in surface level and predicted vertical subsidence along Long section 1

The profiles of the measured changes in surface level reasonably match the predicted profiles of vertical subsidence along the cross-sections and long-section (Figure 9 and Figure 10). 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.

The measured changes in surface level are greater than the predicted vertical subsidence outside the mining area for each of the cross-sections and long-section. However, this is due to the measurement tolerance and the effects of the horizontal movements and sloping terrain on the LiDAR surveys. The differences between the measured and predicted movements above solid coal are generally in the order of accuracy of the LiDAR surveys of ±200 mm. There are localised areas where these differences exceed the measurement tolerance; however, these are artefacts of the LiDAR surveys and are not real movements. It can be inferred from the slopes of the profiles, that the measured changes in grade are similar to the predicted tilts along the cross-sections and long-section. It is not possible to derive the curvature nor the horizontal movements from the LiDAR surveys.

It is considered that the ground movements measured using the LiDAR surveys are consistent with the predictions provided in Report No. MSEC1082 which supported the SMP Application for Longwall 19.

3. IMPACTS TO NATURAL FEATURES

During the extraction of Longwall 19, 57 new surface impacts on natural features were identified. An update is provided for one existing Longwall 8 impact; this impact is labelled as *DA3A_LW8_003 (Update).* Other triggers are addressed in their respective sections, with further detail in the attached specialists' assessments.

The monitoring program for Longwall 19 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 19 are provided in **Attachment C2**. The results of monitoring undertaken by specialist consultants are provided in **Attachments D** to **H**. Figure 14 and Figure 15 illustrates the locations of surface impacts identified during the Longwall 19 monitoring period.

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 DA3A are discussed in the DA3A SMP, WIMMCP and SIMMCP.

An overview of impacts observed during the extraction of Longwall 19 is provided in the following sections. For specific details on the impacts, refer to the relevant impact reports (**Attachment C2**).

3.1. Impacts to Wongawilli Creek

During the Longwall 19 monitoring period there was one impact identified on Wongawilli Creek which consisted of a gas release on WC_Pool 50 (Photo 1).

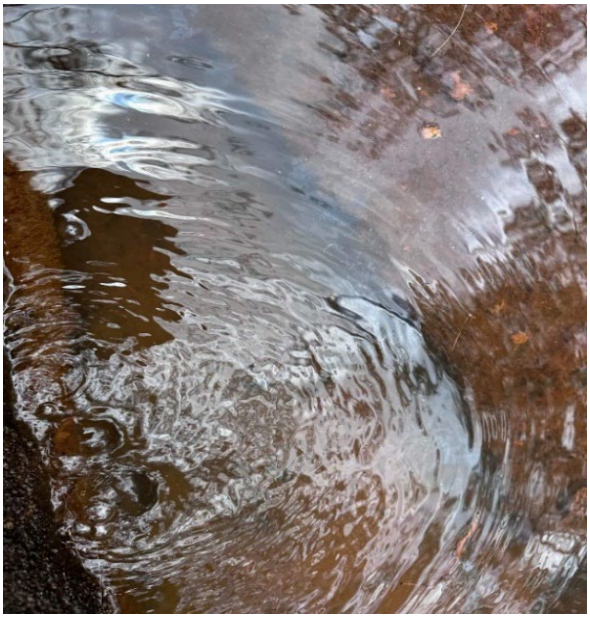

Photo 1: DA3A_LW19_029, showing a gas release on Wongawilli Creek. Taken on 18/01/2023.

3.1.1. Iron Staining on Wongawilli Creek

In August 2021, an increase in iron staining was observed along reaches of Wongawilli Creek adjacent to Areas 3A

and 3B. The most noticeable iron-staining effects extended from WC_Pool 50 to Pool 2. The source of the iron staining was identified as a pre-existing but reactivated spring located on the valley slope of Wongawilli Creek, approximately 35m to the east and upslope from WC_Pool 50. The observations corresponded to a Level 3 trigger according to the Dendrobium Area 3B Watercourse Impact Monitoring, Management and Contingency Plan (WIMMCP) and were reported by IMC on 9 August 2021.

A review of monitoring data concluded that the appearance of iron staining along Wongawilli Creek in August 2021 was caused by increasing groundwater levels and reactivation of slope springs in response to high rainfall and groundwater recharge events in March and May 2021 (and generally high rainfall since 2020) (HGEO, 2021b). Spring discharge is likely facilitated by fracturing associated with mine subsidence; however discharge via natural fractures is also possible (and was observed during baseline monitoring). It should also be noted that increased iron staining has been observed in natural catchments on the Woronora Plateau that are located outside mining influence. Discharge from the slope spring resulted in elevated concentrations of dissolved iron above the baseline P95 level in Wongawilli Creek Pools 49 and 38 (Figure 11).

As of April 2023, dissolved iron concentrations remained elevated relative to baseline at Pools 49 and 38, decreasing downstream to baseline levels by Pool 20 (Figure 11). It is expected that dissolved iron concentrations will continue to decline as the fracture systems, through which groundwater is discharging, age and weather. A return to drier weather conditions will also likely result in reduced discharge from the slope spring to Wongawilli Creek.

3.2. Impacts to Sandy Creek

Iron staining was observed to extend from tributary SC10C downstream to Sandy Creek (Rockbar 5 and Sandy Creek waterfall) in May 2022, prior to Longwall 19. Iron staining was first reported in SC10C (Pool 3) on 11 March 2013 following Longwall 8 (impact LW8_158) and after a period of high rainfall. Iron staining was again reported at Pool 3 and extending downstream to SCK_Rockbar5 on 3 September 2020, following high rainfall. The occurrence and reactivation of iron staining in 2020 triggered a Level 2 TARP within the Area 3A WIMMCP. The iron staining is a Longwall 8 impact reactivated prior to Longwall 19 and is therefore not included as a Longwall 19 impact. The TARP level related to the iron staining from SC10C to Sandy Creek remains at Level 2. As of the most recent inspection at SCk_Rockbar 5 there were no signs of water cloudiness, with the water clarity being generally clear.

3.3. Impacts to First and Second Order Streams

Seven first and second streams were monitored as part of the Longwall 19 monitoring program; WC17, WC15, WC14, WC13, SC10, SC10C and SC10B. Impacts recorded to first and second order streams are presented below in Table 4, with Photo 2 to Photo 6 showing the impacts recorded.

Table 4: Summary of impacts identified on first and second order streams during the Longwall 19 monitoring period

Site ID	Eastings	Northings	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3A_LW19_003	291372	6192315	Iron Staining	WC14	16/08/2022	2	Increase in Iron staining at tributary WC14	17/08/2022
DA3A_LW8_003 (Update)	291534	6192335	Rock Fracturing, Rockfall and Fragmentation	WC14	12/04/2023	1	Rock fracturing with associated rockfall and fragmentation on WC14.	29/01/2020 and 17/04/2023 (Update)
DA3A_LW19_043	291507	6192349	Rock Fracturing and Uplift	WC14	17/04/2023	2	Rock fracturing and Uplift on WC14_Rockbar 7 which affects flow diversion.	27/04/2023
DA3A_LW19_045	290884	6192410	Iron Staining	WC15	26/04/2023	1	Iron staining beneath a step that flows in to WC15_Pool 2.	01/05/2023
DA3A_LW19_051	291835	6192265	Rock Fracturing	WC14	04/05/2023	1	Rock fracturing on small rockbar (WC14 Channel 17) within Swamp 148.	09/05/2023

Photo 2: DA3A_LW19_003, showing iron staining on WC14. Taken on 16/08/2022.

Photo 3: DA3A_LW8_003, showing rock fracturing and rockfall on WC14. Taken on 12/04/2023.

Photo 4: DA3A_LW19_043, showing rock fracturing and uplift on WC14. Taken on 17/04/2023.

Photo 5: DA3A_LW19_045, showing iron staining on WC15. Taken on 26/04/2023.

Photo 6: DA3A_LW19_051, showing rock fracturing on WC14. Taken on 04/05/2023.

3.4. Impacts to Other Landscape Features

Impacts recorded on steep slopes, steps and general landscape features are presented below in Table 5, with Photo 7 to Photo 56 showing the impacts recorded.

Table 5: Summary of Impacts to other landscape features during the Longwall 19 monitoring period

Site ID	Eastings	Northings	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3A_LW19_001	292826	6192225	Rock Fracturing	Steep Slope/ Step	3/08/2022	1	Rock fracturing to a steep slope/ step, east of Fire Road 6F.	5/08/2022
DA3A_LW19_002	292849	6192228	Rock Fracturing	Steep Slope/ Step	3/08/2022	2	Rock fracturing to a steep slope/ step, east of Fire Road 6F.	5/08/2022
DA3A_LW19_004	292690	6192352	Rock Fracturing and Fragmentation	Steep Slope/ Step	19/08/2022	1	Rock fracturing to a steep slope/ step, west of Swamp 15b.	23/08/2022
DA3A_LW19_005	292674	6192330	Rock Fracturing	Steep Slope/ Step	19/08/2022	1	Rock fracturing to a steep slope/ step, west of Swamp 15b.	23/08/2022
DA3A_LW19_006	292955	6192582	Soil Cracking	Bushland	31/08/2022	2	Soil cracking to bushland south of tributary SC10C.	5/09/2022
DA3A_LW19_007	292579	6192537	Soil Cracking	Bushland	18/10/2022	1	Soil cracking in bushland between Longwall 19 and Swamp 15b.	20/10/2022
DA3A_LW19_008	292201	6192364	Rock Fracturing	Rock Outcrop	7/11/2022	1	Rock fracturing to rock outcrop east of Fire Road 6F.	9/11/2022
DA3A_LW19_009	292218	6192350	Rock Fracturing	Rock Outcrop	7/11/2022	1	Rock fracturing to rock outcrop east of Fire Road 6F.	9/11/2022
DA3A_LW19_010	292242	6192320	Rock Fracturing	Rock Outcrop	7/11/2022	1	Rock fracturing to rock outcrop east of Fire Road 6F.	9/11/2022
DA3A_LW19_011	292252	6192308	Rock Fracturing	Rock Outcrop	7/11/2022	1	Rock fracturing to rock outcrop east of Fire Road 6F.	9/11/2022
DA3A_LW19_012	292290	6192348	Rock Fracturing	Rock Outcrop	7/11/2022	1	Rock fracturing to rock outcrop east of Fire Road 6F.	9/11/2022
DA3A_LW19_013	292461	6192421	Rock Fracturing and Rock Movement	Steep Slope/ Step	7/11/2022	2	Rock fracturing and rock movement at a steep slope/ step, east of Fire Road 6F. *Coordinates shown here are correct, updated from error in initial report.*	9/11/2022
DA3A_LW19_014	292448	6192427	Rock Movement	Boulder	7/11/2022	1	Dislodgement of a boulder east of Fire Road 6F.	9/11/2022
DA3A_LW19_015	292738	619127	Rock Fracturing	Steep Slope/ Step	7/11/2022	2	Rock fracturing to a steep slope/ step, north of Swamp 15a.	9/11/2022 and 22/12/2022 (Update)

Site ID	Eastings	Northings	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3A_LW19_016	292449	6192346	Rock Fracturing and Rockfall	Steep Slope/ Step	7/11/2022	2	Rock fracturing and small rock fall at a steep slope/ step, east of Fire Road 6F.	9/11/2022 and 22/12/2022 (Update)
DA3A_LW19_017	292245	6192382	Rock Fracturing	Rock Outcrop	13/12/2022	1	Rock fracturing to a rock outcrop, east of Fire Road 6F.	15/12/2022
DA3A_LW19_018	292388	6192402	Rock Displacement	Steep slope	13/12/2022	1	Rock displacement to a steep slope, east of Fire Road 6F.	15/12/2022
DA3A_LW19_019	292408	6192390	Rock Displacement	Steep slope	13/12/2022	1	Rock displacement to a steep slope, east of Fire Road 6F.	15/12/2022
DA3A_LW19_020	292448	6192368	Soil Cracking	Bushland	13/12/2022	2	Soil cracking at the base of a rock outcrop, east of Fire Road 6F.	15/12/2022
DA3A_LW19_021	292491	6192387	Soil Cracking and Rock Displacement	Boulders	13/12/2022	2	Soil cracking and rock displacement to boulders, east of Fire Road 6F.	15/12/2022
DA3A_LW19_022	292503	6192363	Soil Cracking, Rock Fracturing and Rock Displacement	Bushland/ Rock Outcrop	13/12/2022	2	Soil cracking, rock fracturing and rock displacement in bushland, east of Fire Road 6F.	15/12/2022
DA3A_LW19_023	292508	6192390	Rock Fracturing	Rock Outcrop	13/12/2022	1	Rock fracturing to a rock outcrop, east of Fire Road 6F.	15/12/2022
DA3A_LW19_024	292660	6192191	Rock Fracturing and Soil Cracking	Step/ Bushland	20/12/2022	2	Rock fracturing to a step and soil cracking to bushland, east of Fire Road 6F.	22/12/2022
DA3A_LW19_025	292763	6192156	Rock Displacement	Boulder	20/12/2022	1	Rock displacement away from soil, east of Fire Road 6F.	22/12/2022 and 09/02/2023 (Update)
DA3A_LW19_015 (Update)	292545	6192234	Rock Fracturing	Steep Slope/ Step	7/11/2022	2	Rock fracturing to a steep slope/ step, east of Fire Road 6F.	9/11/2022 & 22/12/2022 (Update)
DA3A_LW19_016 (Update)	292523	6192252	Rock Fracturing, Fragmentation and Rockfall	Steep Slope/ Step	7/11/2022	2	Rock fracturing, fragmentation and rock fall at a steep slope/ step, east of Fire Road 6F.	9/11/2022 & 22/12/2022 (Update)
DA3A_LW19_027	292069	6192332	Rock Fracturing and Rockfall	Step	10/01/2023	1	Rock fracturing and two small rockfalls at a step, west of Fire Road 6F.	11/01/2023

Site ID	Eastings	Northings	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3A_LW19_028	292172	6192301	Rock Fracturing	Rock Outcrop	6/02/2023	1	Rock fracturing to rock outcrop east of Fire Road 6F	09/02/2023
DA3A_LW19_025 (Update)	292763	6192156	Rock Displacement, Rock Fracturing and Soil Cracking	Rock Step/Outcrop	20/12/2022, 17/01/2022 (update)	1	Rock displacement away from soil, rock fracturing and soil cracking east of Fire Road 6F. *Coordinates shown here are correct, updated from error in initial report.*	22/12/2022 and 09/02/2023 (Update)
DA3A_LW19_030	292181	6192366	Rock Fracturing	Rock Outcrop	15/02/2023	2	Rock fracturing to rock outcrop east of Fire Road 6F	17/02/2023
DA3A_LW19_031	292281	6192359	Rock Fracturing	Rock Outcrop	15/02/2023	1	Rock fracturing to rock outcrop east of Fire Road 6F	17/02/2023
DA3A_LW19_032	292267	6192304	Rock Fracturing	Rock Outcrop	15/02/2023	1	Rock fracturing to rock outcrop east of Fire Road 6F	17/02/2023
DA3A_LW19_033	292257	6192257	Rockfall	Rock Step/Outcrop	15/02/2023	1	Rockfall on rock outcrop east of Fire Road 6F	17/02/2023
DA3A_LW19_034	292233	6192251	Rock Fracturing	Rock Outcrop	15/02/2023	1	Rock fracturing to rock outcrop east of Fire Road 6F	17/02/2023
DA3A_LW19_039	291495	6192380	Rockfall	Steep Slope/ Step	12/04/2023	1	Rockfall at base of steep slope/step to the north of WC14.	17/04/2023
DA3A_LW19_040	291523	6192422	Rockfall and Fragmentation	Step	12/04/2023	1	Rockfall with some associated fragmentation to the north of WC14.	17/04/2023
DA3A_LW19_041	291460	6192410	Rockfall	*LW19_SS5*	12/04/2023	2	Large rockfalls with boulders that dislodged and rolled downhill at landscape monitoring site LS19_SS5.	17/04/2023
DA3A_LW19_042	291389	6192392	Rockfall and Fragmentation	LW19_SS4	12/04/2023	1	Small rockfall with some associated fragmentation at landscape monitoring site LW19_SS4.	17/04/2023
DA3A_LW19_044	291000	6192679	Iron Staining	Bushland	19/04/2023	1	Iron staining in bush within proximity but not flowing into Wongawilli Creek.	27/04/2023
DA3A_LW19_046	291636	6192624	Rockfall	Steep Slope/ Step	27/04/2023	1	Rockfall on top of steep slope/ step where several boulders have dislodged from the slope face west of Fire Road 6F.	01/05/2023
DA3A_LW19_047	291302	6192673	Rockfall	Steep Slope/ Step	27/04/2023	1	Small rockfall on edge of steep slope/ step to the north of WC14.	01/05/2023
DA3A_LW19_052	291521	6192382	Rock Fracturing and Rockfall	Steep Slope	04/05/2023	1	Rock fracturing and associated rockfall on steep slope to the north of WC14.	09/05/2023
DA3A_LW19_053	291508	6192499	Rock Fracturing and Rockfall	Rock Step	04/05/2023	1	Rock fracturing and associated rockfall at base of a rock step to the north of WC14.	09/05/2023
DA3A_LW19_054	291671	6192546	Rock Fracturing and Fragmentation	Steep Slope	04/05/2023	1	Rock fracturing and fragmentation at base of a steep slope to the west of Fire Road 6F.	09/05/2023

Site ID	Eastings	Northings	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3A_LW19_055	291494	6192483	Rock Fracturing and Rockfall	Steep Slope	04/05/2023	1	Rock fracturing and an associated rockfall beneath an overhang to the north of WC14.	09/05/2023
DA3A_LW19_056	291611	6192519	Rock Fracturing and Rockfall	Step/ Overhang	05/05/2023	2	Rock fracturing and rockfall on a steep slope to the north of WC14.	09/05/2023
DA3A_LW19_057	291553	6192524	Rockfall	Step	05/05/2023	1	Rockfall at a step to the north of WC14.	09/05/2023
DA3A_LW19_058	291541	6192528	Rock Fracturing and Fragmentation	Rock Outcrop	05/05/2023	1	Rock fracturing and fragmentation on edge of a rock outcrop to the north of WC14.	09/05/2023
DA3A_LW19_059	291458	6192561	Rock Fracturing and Fragmentation	Overhang	05/05/2023	1	Rock fracturing and associated fragmentation beneath an overhang to the north of WC14.	09/05/2023
DA3A_LW19_060	291426	6192566	Rock Fracturing, Displacement and Rockfall	Step/ Outcrop	05/05/2023	1	Rock fracturing, displacement and rockfall on a steep slope/ outcrop to the north of WC14.	09/05/2023
DA3A_LW19_061	291404	6192596	Rock Fracturing and Soil Cracking	Step/ Outcrop	05/05/2023	2	Rock fracturing and soil cracking on a steep slope/ outcrop to the north of WC14.	09/05/2023
DA3A_LW19_062	291527	6192539	Rock Fracturing	Rock Outcrop	05/05/2023	1	Rock fracturing on the face of an outcrop to the north of WC14.	09/05/2023
DA3A_LW19_063	292280	6192283	Rock Movement	Steep Slope	10/05/2023	1	Boulder shifted downslope, east of Fire Road 6F.	15/05/2023

Photo 7: DA3A_LW19_001 showing rock fracturing. Tape set at 2m. Taken on 19/04/2023.

Photo 8: DA3A_LW19_002 showing width of rock fracturing. Taken on 03/08/2022.

Photo 9: DA3A_LW19_004, showing rock fracturing and fragmentation. Taken on 19/08/2022.

Photo 10: DA3A_LW19_005, showing rockfall. Tape set at 2.7m. Taken on 19/04/2023.

Photo 11 DA3A_LW19_006, showing soil cracking. Taken on 31/08/2022.

Photo 12: DA3A_LW19_007, showing soil cracking. Taken on 19/04/2023.

Photo 13: DA3A_LW19_008, showing rock fracturing. Taken on 7/11/2022.

Photo 14: DA3A_LW19_009, showing rock fracturing. Taken on 7/11/2022.

Photo 15: DA3A_LW19_010, showing rock fracturing. Taken on 7/11/2022.

Photo 16: DA3A_LW19_011, showing rock fracturing. Taken on 7/11/2022.

Photo 17: DA3A_LW19_012, showing rock fracturing. Taken on 7/11/2022.

Photo 18: DA3A_LW19_013, showing rock fracturing. Taken on 7/11/2022.

Photo 19: DA3A_LW19_014, showing rock movement. Taken on 7/11/2022.

Photo 20: DA3A_LW19_015, showing rock fracturing. Taken on 7/11/2022.

Photo 21: DA3A_LW19_016, showing rock fracturing and rockfall. Taken on 7/11/2022.

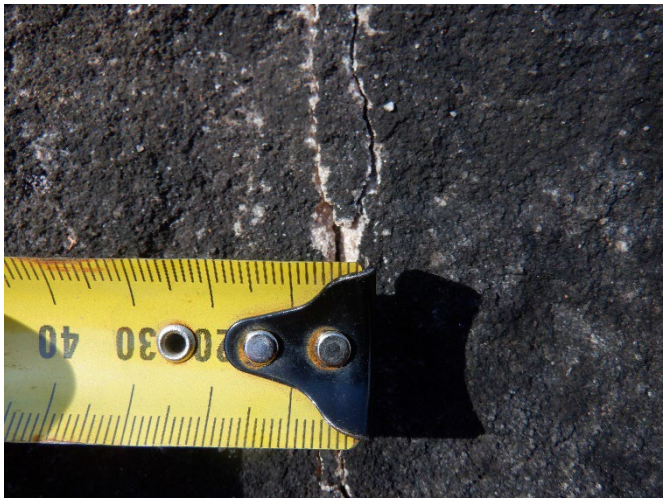

Photo 22: DA3A_LW19_017, showing rock fracturing. Taken on 13/12/2022.

Photo 23: DA3A_LW19_018, showing rock displacement. Taken on 13/12/2022.

Photo 24: DA3A_LW19_019, showing rock displacement. Taken on 13/12/2022.

Photo 25: DA3A_LW19_020, showing soil cracking. Taken on 13/12/2022.

Photo 26: DA3A_LW19_021, showing soil cracking and displacement. Taken on 13/12/2022.

Photo 27: DA3A_LW19_022, showing rock fracturing. Taken on 09/05/2023.

Photo 28: DA3A_LW19_023, showing rock fracturing. Taken on 09/05/2023.

Photo 29: DA3A_LW19_024, showing rock fracturing. Taken on 20/12/2022.

Photo 30: DA3A_LW19_025, showing rock fracturing. Taken on 20/12/2022

Photo 31: DA3A_LW19_027, showing rock fracturing and rockfall. Taken on 10/01/2023.

Photo 32: DA3A_LW19_028, showing rock fracturing. Taken on 06/02/2023.

Photo 33: DA3A_LW19_030, showing rock fracturing. Taken on 15/02/2023.

Photo 34: DA3A_LW19_031, showing rock fracturing. Taken on 15/02/2023.

Photo 35: DA3A_LW19_032, showing rock Fracturing. Taken on 15/02/2023.

Photo 36: DA3A_LW19_033, showing rock fracturing. Taken on 15/02/2023.

Photo 37: DA3A_LW19_034, showing rock fracturing. Taken on 15/02/2023.

Photo 38: DA3A_LW19_039, showing rockfall. Taken on 12/04/2023.

Photo 39: DA3A_LW19_040, showing rock fall and fragmentation. Taken on 12/04/2023.

Photo 40: DA3A_LW19_041, showing rockfall at landscape monitoring site LW19_SS5. Taken on 12/04/2023.

Photo 41: DA3A_LW19_042, showing rockfall and fragmentation at landscape monitoring site LW19_SS4. Taken on 12/04/2023.

Photo 42: DA3A_LW19_044, showing iron staining. Taken on 19/04/2023.

Photo 43: DA3A_LW19_046, showing rockfall. Taken on 27/04/2023.

Photo 44: DA3A_LW19_047, showing rockfall. Taken on 27/04/2023.

Photo 45: DA3A_LW19_052, showing rock fracturing and rockfall. Taken on 04/05/2023.

Photo 46: DA3A_LW19_053, showing rock fracturing and rockfall. Taken on 04/05/2023.

Photo 47: DA3A_LW19_054, showing rock fracturing and fragmentation. Taken on 04/05/2023.

Photo 48: DA3A_LW19_055, showing area of rockfall. Taken on 04/05/2023.

Photo 49: DA3A_LW19_056, showing rockfall. Taken on 05/05/2023.

Photo 50: DA3A_LW19_057, showing rockfall. Taken on 05/05/2023.

Photo 51: DA3A_LW19_058, showing rockfall. Tape measure set at 0.5m. Taken on 05/05/2023.

Photo 52: DA3A_LW19_059, showing rock fracturing and rockfall. Taken on 05/05/2023.

Photo 53: DA3A_LW19_060, showing rock fracturing and rockfall. Taken on 05/05/2023.

Photo 54: DA3A_LW19_061, showing rock fracturing. Taken on 05/05/2023.

Photo 55: DA3A_LW19_062, showing rock fracturing. Taken on 05/05/2023.

Photo 56: DA3A_LW19_063, showing rock movement. Taken on 10/05/2023.

3.5. Impact Dimensions

Data for impact dimensions across DA3A was analysed in an attempt to account for the apparent differences in impact dimensions over DA3A panels. Figure 11 displays the spread of maximum impact widths and lengths over DA3A. The below comments and limitations are noted:

Impact Lengths

There have been changes to the way surface impacts are recorded since earlier DA3A panels i.e. over 10+ years. Since the update of TARPs beginning in DA3B panels and continuing for Longwall 19, impact length for assessment of TARP level has focussed on continuous length of the impact void. In earlier DA3A panels, total discontinuous length was recorded. This has resulted in surface impacts over earlier DA3A panels having an apparent larger length when compared to contemporary reporting.

Impact Widths

Impact LW19_006 has a recorded width of 140mm however and width of 700mm was also noted in the impact report, to account for erosion of the edges of the crack. Including the 700mm width in analysis of dimensions skews the average width for Longwall 19 surface impacts. It is recommended that the 140mm width instead be used for consistency with other recordings. Using the 140mm measurement results in an average width of Longwall 19 impacts of 67mm, compared to other DA3A impacts (25-42mm average max. width).

The differing nature of topography over each DA3A panel should also be considered. The nature of subsidence movements and valley closure means that impacts identified on the crest of slopes and ridges are generally wider as the crest opens compared to base of valleys, resulting in down slope movements. Similarly, impacts located on relatively flat ground tend to be narrower in width. The location of impacts over Longwall 19 have generally been more prevalent on the crest/slope of ridgelines when compared to previous DA3A impacts where impacts were observed over areas with lower slope. This has contributed to a wider average impact width over Longwall 19.

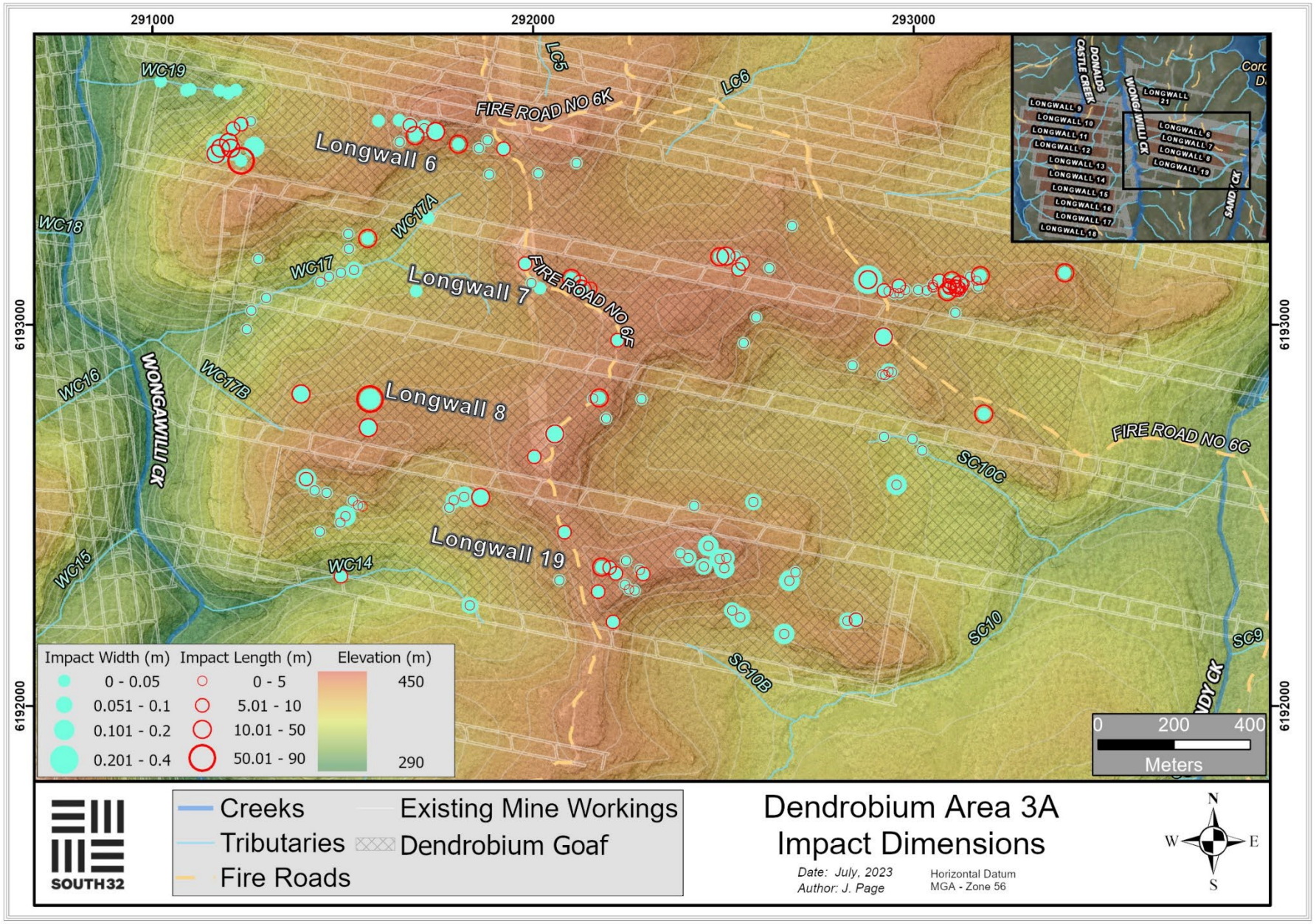

Figure 11: Impact dimensions overview of fracturing and cracking over Dendrobium Area 3A. Inset map shows Dendrobium mining operations.

3.6. 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, dissolved oxygen (DO), oxygen reduction potential (ORP) and a suite of laboratory-tested analytes.

In general, stream salinity (measured by EC) has decreased since 2020 and during the last four longwalls due to higher-than-average rainfall and significant increase in runoff compared with the preceding drought period (2017-2019). Similarly, DO has been generally elevated due to higher flows. No new water quality TARPs were triggered in the review period; however, water quality TARPs remain triggered at Lake Avon tributary site LA4_S1 for EC, pH and DO as a result of impacts related to Area 3B. Anomalous water quality effects are noted in streams that have been directly mined under by previous longwalls (e.g. WC21, SC10C, LA4, Donalds Castle Creek). 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.

Analysis of flow-corrected trends in water quality indicate increasing EC, sulphate and manganese at WC_FR6, despite generally declining EC in non-flow-corrected data. Flow-corrected trends in EC, pH, Mn, Zn and Al are evident at DCC_FR6. At Sandy Creek Rockbar 5, flow-corrected EC, sulphate, Fe, Mn and Zn remain above baseline levels due to upstream contributions from SC10C which was mined beneath by Longwall 7 and 8.

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 three years, new or recurrent iron staining has been noted on Wongawilli Creek, WC21, LA5, WC14, WC15 and SC10C, extending down to Sandy Creek. These increases in iron staining is partly related to increasing groundwater levels due to high rainfall. It is expected that the occurrence of iron seeps will decline as drier conditions return. During latest inspection of Sandy Creek water was observed to be generally clear.

A gas release was observed in Wongawilli Creek at WC_Pool 50 on 18 January 2023. The release is intermittent to continuous and emanates from the base of a sandstone step on the western side of the pool with smaller gas bubbles from the centre of the pool. A gas sample was collected on 1 February 2023 for laboratory analysis, which indicated mostly carbon dioxide and very low levels of methane. Methane content was lower than that expected from strata or in-seam gas.

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

3.7. 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. The findings for DC13S1, DCS2 (both at Level 3 for all three flow assessments) are similar to those for the EoP report for Longwall 15 to Longwall 18

Lake Avon tributaries LA4, LA3 and LA2, have been affected by mining. The effects at LA2 are intensifying (one Level 1 and two Level 3 triggers at LA2 compared to Level 3 for all assessments at the other two sites), and are recent, occurring as a result a Longwall 18 and strengthening slightly during the Longwall 19 period (although based on distance, not affected by Longwall 19 extraction).

Similarly, the flow characteristics at WC21S1 and WC15S1 within the Wongawilli Creek catchment have altered as a result of mining with these sites at Level 3 for two out of three assessments. As with the sub-catchments above, the effects at WC21 and WC15 are similar to those for the previous End of Panel reports. Regarding WC12, despite Longwall 16 terminating within 50 m of and the end of Longwall 17 mining under WC12 respectively, and based on comparison against Reference Sites there are no mining-related effects discernible beyond natural variability/method accuracy (although rainfall-runoff modelling suggests a Level 1 impact), and this has persisted for the Longwall 18 and 19 assessment periods.

Native Dog Creek tributary ND1 (site ND1S1) shows no clear sign of effects beyond natural variability when comparing against Reference Sites, although comparison against a rainfall-runoff model suggests a Level 2 impact (which is considered to have lower reliability given the difficulty in calibrating the model for this sub-catchment). The site on the main watercourse (Native Dog Creek (site NDCS1) is slightly upstream of the ND1 tributary confluence with Native Dog Creek. There is only a short pre-mining baseline record available at NDCS1 which limits reliability, however there is no indication of a mining effect beyond natural variability from nearby Dendrobium Longwall 18 at NDCS1.

Sandy Creek and tributaries are assessed formally for the first time due to mining moving back to Area 3A (Longwall 19). Tributary SC10C was clearly affected by mining of Longwalls 7 and8 in 2012, including obvious iron staining effects. The current assessment indicates that SC10C still triggers Level 2 (cease-to-flow) and Level 3 (median flow), although restricting the assessments to a more recent period (since 2017) indicates that in terms of water quantity (flow) effects, flows in this tributary would not trigger the TARP assessments. Tributary SC10 has not triggered any of the three assessments, while SCL2/GS2122205 shows signs of a mild increase in cease-to-flow frequency.

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 Assessment B, which examines cease-to-flow duration and frequency, indicates that the watercourse at DCU has been experiencing a mild increase (Level 1) in the number of cease-to-flow days compared to the Reference sites. This finding has been consistent for Longwalls 14-19 periods.

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 (0.1 ML/d) and DCS2 (0.09 ML/d) are >70%% of median

flow (Q50) at DCU. 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 DCU beyond natural variability (i.e. variability at two Reference sites).

Similar behaviour is now observed at Sandy Creek sites. Reductions in Q50 at site SC10CS1 trigger Level 3, but SC10CS1 did not trigger at downstream site SC10S1, although it was close to doing so, and no reductions in Q50 were evident at the downstream site GS2122205.

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 19 period.

Water flow performance measures were met for Longwall 19 (Table 7). Further details are presented in **Attachment D**.

Table 6: Summary of Surface Water flow triggers for Longwall 19.

Site	Watercourse	Catchment Mined under?	Position of sub-catchment in relation to mining	A) Low flow Q%ile outsideReference 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 LW14-18.
DCS2	Donalds Castle Creek	Yes	Above LWs	Level 3	Level 3	Level 3	Similar to LW14-18.
DCU	Donalds Castle Creek	Yes	Downstream	Not triggered	Level 1	Not triggered	Similar to LW14-18. Rainfall-runoff modelling supports this finding.
WC21S1	WC21	Yes	Above LWs	Level 3	Level 1	Level 3	Similar to LW14-18.
WC15S1	WC15	Yes	Above LWs	Level 3	Level 2	Level 3	Similar to LW15-18. * 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	Similar to LW16-18. No discernible effect. Rainfall-runoff modelling suggests **Level 1** impact.
WWL	Wongawilli Creek	Yes	Downstream	Not triggered	Not triggered	Not triggered	Similar to LW14-18. 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 LW16-18.
LA2S1	LA2	Yes	Above LWs	Level 2	Not triggered	Level 3	Similar to LW18.
NDS1	ND1	Yes	Headwater	Not triggered	Not triggered	Not triggered	LW18 mined under part of ND1 tributaries. No discernible effects. However, rainfall-runoff modelling suggests **Level 2** impact.
NDCS1	Native Dog Greek	Yes	Offset	Not triggered	Not triggered	Not triggered	No discernible effect.
SC10CS1	SC10C	Yes	Above LWs	Not triggered	Level 2	Level 3	Although still Level 2&3 for two indicators, this site shows signs of recovery.
SC10S1	SC10	Yes	Above LWs	Not triggered	Not triggered	Not triggered	No discernible effect, as for previous LWs. Rainfall-runoff modelling supports this
SCL2/ GS2122205	Sandy Ck	Yes	Downstream	Not triggered	Level 1	Not triggered	Minor effect on low flows, no other discernible effect. Rainfall-runoff modelling supports this

Site Watercourse		Comment
Wongawilli Creek	Not triggered	Refer to Performance Measures

Table 7: Summary of surface water Performance Measures for Longwall 19.

Wongawilli Creek – minor environmental consequences	This Performance Measure is met.
Donalds Castle Creek – minor environmental consequences	This Performance Measure is met.
Lake Avon – negligible reduction in the quantity of surface water inflows to Lake Avon	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.
Sandy Creek – minor environmental consequences	This Performance Measure is met.
Lake Cordeaux – negligible reduction in the quantity of surface water inflows to Lake Cordeaux	This Performance Measure is met.

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

3.8. 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 3A Subsidence Management Plan (South32, 2020b). 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.**

3.8.1. 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 mean total mine inflow during Longwall 19 extraction was 12.0 ML/day which represents a 32% increase compared with the previous longwall. The increase is primarily due to the very high rainfall during the longwall extraction period and the previous two years, with Figure 7 showing that total mine inflow has recently declined as a result of drier conditions in 2023. The net mine water balance is dominated by pumping from Area 3B (72 % of total), with Area 3A representing only 6.5 % of inflows. It is likely that some of the water reporting to Area 3B and 3C is derived from up-gradient areas such as Area 3A during high inflow periods

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 is an isotope of hydrogen (3H), generated in the atmosphere through interactions with cosmic rays and through past atmospheric nuclear weapons testing (Clark, 2015). Tritium is incorporated into water molecules in rainfall and enters groundwater systems through recharge (rainfall and stream-bed infiltration). 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 the Area 3B goaf outflow is typically within or close to baseline concentrations in deep groundwater, as defined by the 95th percentile (P95) level for samples collected from the Scarborough

Sandstone. This implies a very low modern contribution to mine inflow in Area 3B. The median tritium content in Area 3B has increased slightly since 2020 but remains below 0.2 TU. Samples from Areas 2 and 3A are typically slightly higher than in Area 3B, ranging up to approximately 0.5 and implying a higher proportion of modern water.

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. Samples collected from the Area 3B goaf outflow tank (DWS203) have low percentage modern carbon (pMC) (median 1.8%) 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. Samples from Area 3A and Area 2 have median pMC values of 4.8% and 3.9%, slightly higher than Area 3B and consistent with tritium results

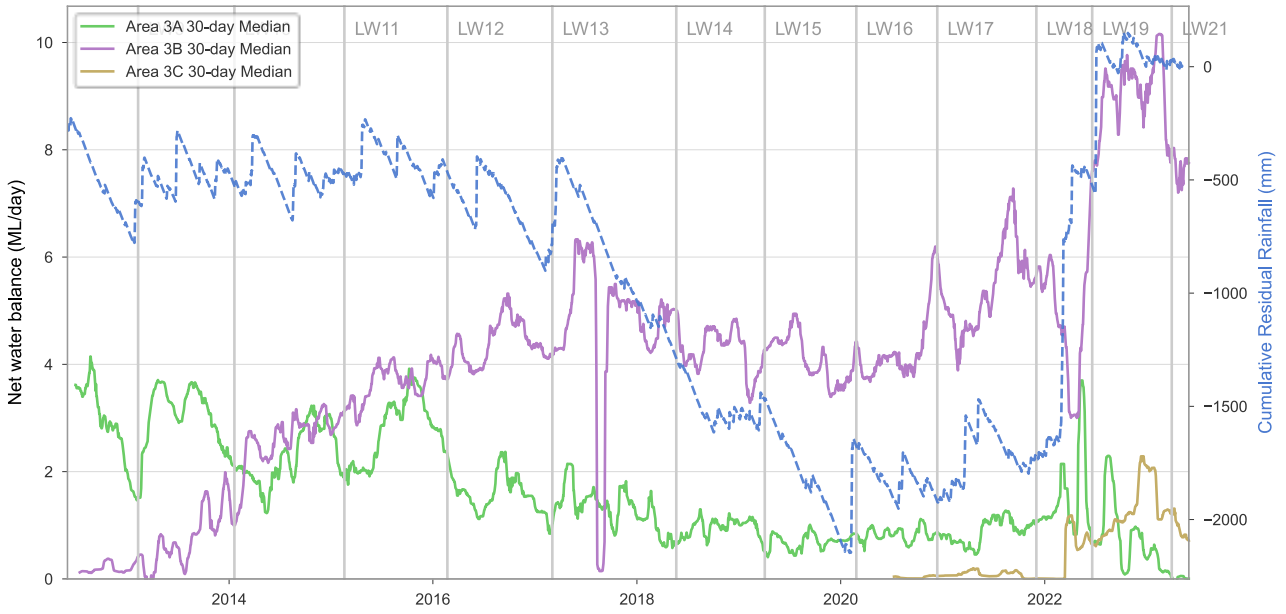

Figure 12: Groundwater inflow to the mine for Areas 3A, 3B and 3C (ML/d).

3.8.2. Deep Groundwater Levels

Mining of Longwall 19 resulted in continued depressurisation of the target coal seam and overlying strata in line with numerical model predictions. Importantly, for piezometers installed in the barrier zone between Lake Avon and Area 3B, observed head is similar to, or higher than, the numerical model prediction. Therefore, the model predictions are generally accurate as of Longwall 19 or tend to over-estimate groundwater drawdown.

IMC has carried out investigation drilling above extracted Longwalls in Areas 3A and 3B (HGEO, 2020a, 2020b, 2021a). The most recent drilling and re-installation was above Longwall 18 (S2521). Piezometers installed after longwall extraction indicate significant depressurisation throughout all strata and throughout the Hawkesbury Sandstone (HBSS) in most holes. Holes drilled above extracted longwalls provide evidence for groundwater perching and recovery in the years following mining. Drawdown in the HBSS reduces with distance and is typically negligible at distances greater than 1.2 km from the goaf footprint.

Piezometers located to the north and west, and within 1 km of Area 3 (S1910, S1892, S1998 / S2401, S2006, S2007, S1969) 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 (S1910, S1892). At S2006 (1 km west of Longwall 9)

piezometric head deceased to their lowest level in most strata towards the end of Longwall 14 and have shown recovery in within the HBSS and upper BGSS since Longwall 14 which continued during Longwall 19.

The Elouera Fault is located to the south of Area 3B, between Longwall 18 and Elouera Mine Longwall 8. 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 during Longwall 19 confirms this to be the case.

3.8.3. 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 was measured using electrical conductivity (EC) and pH for all samples collected from monitoring bores in DA3A and DA3B. Adverse trends are identified where recent samples define a consistent freshening trend (decreasing EC). Such trends in bores located adjacent to water storage reservoirs may indicate migration of fresh surface waters towards the mine. Despite efforts to avoid the use of drilling additives during the installation of sampling pumps, it is still common for samples collected in the first few months or years following installation to be tainted by bentonite, cement grout or other compounds. Influence from grout or bentonite typically manifests as high EC and anomalously high pH (>8.5 to 11), making it difficult to discern background groundwater trends.

3.9. Impacts to Upland Swamps

3.9.1. Shallow Groundwater and Soil Moisture

Trigger values for subsidence-induced decreases in groundwater levels, at surface and near-surface monitoring sites at Area 3A swamps, have been established within the Swamp Impact Monitoring Management and Contingency Plan (SIMMCP) for Longwall 19 (South32, 2021b). Shallow groundwater level has been identified as an indicator of potential changes in ecosystem functionality of the 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.

It was predicted that subsidence related to Longwall 19 would likely result in shallow groundwater levels impacts in approximately 7% of the area of Swamp 15a and most of Swamp 148. Other swamps within 400 m of Longwall 19 (Swamps 12 and 15b) were previously impacted by subsidence at Area 3A but may experience further effects due to Longwall 19.

A review of shallow groundwater hydrographs at swamp sites within the area of influence of Longwall 19 indicates

mining subsidence effects at site 148_01 and a likely effect at site 15a_19, triggering additional swamp TARP Level 3 for Swamp 148 (single piezometer) and Level 1 for Swamp 15a (one of five piezometers). Mining related effects related to previous Area 3A longwalls are evident at Swamps 12, 15b and 146 (>400m from Longwall 19), for which TARP Levels 3 remain.

A reassessment of swamp sites within the area of influence of Longwall 18 indicates that shallow groundwater levels at site 35b_01 are likely to have been affected by mining related fracturing and/or drawdown within the sandstone substrate. The impact results in a TARP Level 3 for Swamp 35b.

Shallow groundwater levels and soil moisture levels in reference swamps have been generally high since 2020. Within the zone of influence for Longwall 19, average soil moisture levels declined to below baseline levels at piezometers at Swamp sites S148_01 and S15a_19, consistent with impacts to shallow groundwater. In addition, average soil moisture dropped below the pre-Longwall 19 baseline at sites S15a_07 and S15a_15 within 400m of Longwall 19, corresponding to TARP Level 2 for Swamp 15a and Level 3 for Swamp 148.

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 19 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 19 impact sites.

Swamp	Sensors and TARP triggers			HGEO Comment	IMCEFT ASSESSED LEVEL	HGEO ASSESSED LEVEL
	Not Triggered	Triggered	Not within mine influence			
12		S12_01 S12_04		Both sites record average soil moisture below Longwall 19 baseline; noting that the sites were previously mined under and impacted by Longwall 7	No Trigger	3
15a	S15a_12 S15a_18	S15a_07 S15a_15 S15a_19	S15a_03 S15a_04	Soil moisture in 3 out of 5 sensors within 400m dropped below baseline during review period.	2	2
15b		S15b_39	S15b_H1 S15b_H2 S15b_H3	Logging sensors installed after Longwall 8 passed beneath or near sites. Likely impacted.	2	1
148		S148_01		Recoded average soil moisture below baseline from 11/2022 after the passage of Longwall 19	3	3
34	S34_01			No TARP trigger following Longwall 19	No Trigger	No Trigger

Table 9: Summary of shallow groundwater level TARP status at Longwall 19 impact sites.

SWAMP	PIEZOMETERS WITH AN OBSERVED RESPONSE			HGEO COMMENT	IMCEFT ASSESSED LEVEL	HGEO ASSESSED LEVEL
	YES	UNCLEAR	NO			
12	12_01 12_03 12_04			All three piezometers show low levels of saturation compared with reference swamps after being directly mined under by Longwall 7.	No Trigger	3
15a	15a_19	15a_03 15a_04	15a_07 15a_12 15a_15 15a_18	Evidence for impact at 15a_19 following extraction of longwall 19.	1	1
15b	15b_H1 15b_H2 15b_H3 15b_39			All four sites show evidence for impact; low saturation levels and high recession rates compared with reference sites. Impacts associated with Longwall 7.	No Trigger	3

148	148_01			WL dropped below piezo base on 20/11/2022 with no significant saturation since despite moderate rainfall in March 2023. Longwall 19 passed within 38 m of 148_01	No Trigger	3
34	34_01			Shallow groundwater saturation behaviour and recessions similar to previous.	No Trigger	No Trigger

3.9.2. 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. Following geoprocessing of ALS data potential areas of interest were highlighted for targeted infield verification, all these sites were inspected however, no erosion was identified in any swamps.

3.10. Other Observations

An area of erosion was identified on tributary DC13. The erosion was identified immediately upstream from BCD-installed flow monitoring weir (Photo 58). The baseline condition of the site can be seen in Photo 57. Following recent observations erosion of the soil was identified extending upstream from the sandstone rockbar. A sandstone-base channel was present during the baseline mapping of the watercourse, however during recent inspections there is evidence of erosion to the soil banks and loss of vegetation (Photo 59). The erosion does not extend upstream into Swamp 1b. This site will continue to be monitored on a periodic basis to determine whether there is continued erosion.

Photo 57: Baseline mapping of DC13. Taken on 05/08/2011.

Photo 58: DC13 following weir installation. Taken on 13/08/2013.

Photo 59: Erosion upstream of weir on DC13. Taken on 28/02/2023.

3.11. Terrestrial Ecology

Niche Environmental and Heritage (Niche) was commissioned by South32 to undertake terrestrial ecology monitoring for 2022. This report will include assessment of features within the Longwall 19 mining area. The Terrestrial Ecology Monitoring Program Annual Report 2022 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).

The 2022 iteration of the monitoring program largely identified a continuation of the trends identified in recent monitoring years (Niche 2021, Niche 2022a). Trends across swamps indicate declining TSR post-mining for the majority of Impact swamps and Control swamps. Compositional changes show trends of the loss of flora species, generally (but not entirely) those with a preference for ‘wet environments’. While it is reasonable to expect natural species turnover to occur at a swamp, the overall patterns of change are suggestive of either declining swamp condition (die back or die off of swamp dependent species), or vegetation community transition. Many trending

declines in TSR and species detection appear to have commenced either pre- or at some years post-mining. In addition to this, the declining TSR levels and Swamp extents recorded at the Control swamps are indicative of other factors that may be contributing to declining swamp conditions, at least in terms of the metrics applied in the monitoring program. The assessment of performance measures suggest that impacts are being detected at the Impact monitoring swamps utilised in the Program, although there is variation across the varying TARPs and TARP levels that have been triggered to date. All of the ten Impact monitoring swamps are considered at risk of potential impacts based upon their proximity to mining activity. In 2022, eight of the ten Impact monitoring swamps recorded at least one TARP trigger.

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. Analysis to date has identified that where pre-mining frog detection data is available, detection was statistically significantly lower at impact transects than the controls, indicating this disparity in control and impact transect pre-dates mining effects. Significantly above average rainfall conditions in 2022 served to ameliorate some of the observed impacts previously recorded (e.g. flocculant and reduced pool levels). Despite this, the findings of the 2022 iteration of the monitoring program are largely consistent with previous years, with several Impact monitoring transects showing reduced habitat conditions, or reduced frog detection in the post-mining period. In 2022, TARP levels were triggered at seven of the fourteen Impact transects monitored as part of the Program.

Assessment of terrestrial ecology is included in the Terrestrial Ecology Monitoring Program Annual Report 2022 (**Attachment H**).

3.12. Aquatic Ecology

Cardno was commissioned by South32 to undertake a review of aquatic flora and fauna in relation to the extraction of Longwall 19 Cardno has been undertaking ongoing monitoring of watercourses within the DA3B mining area including WC15, WC13, WC14 and WC17, and Sandy Creek tributaries SC10, SC10A, SC10B and SC10C.

The overall objective of the monitoring is to determine whether the extent and nature of observed impacts, primarily subsidence-induced fracturing of bedrock, flow diversion and loss of aquatic habitat, if any, are consistent with the predictions made in the Aquatic Flora and Fauna Assessment (AFFA) (Cardno 2020a), Subsidence Management Plan (SMP) (IMC 2021a) and Watercourse Impact Monitoring, Management and Contingency Plan (IMC 2021b) for Longwall 19.

The monitoring requirements recommended in the AFFA and SMP for Longwall 19 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.

Only relatively minor impacts were observed in watercourses following commencement of extraction of Longwall 19. These were iron staining in WC14, WC15, and in bushland adjacent to Wongawilli Creek, a gas release in WC Pool 50, and an extension of a previously identified rock fracture in WC14. No changes in water quality in watercourses were identified (HGEO 2023). Localised iron staining in WC14 and WC15 would not be associated with significant impacts to aquatic habitat and biota given these ephemeral / intermittent tributaries provide aquatic habitat of limited value and represent a very small component of the total aquatic habitat in the Dendrobium Mine area.

Although flow diversions may occur due to the fracture in WC14, any reduction in availability and connectivity of aquatic habitat and associated impacts to aquatic biota in the naturally ephemeral / intermittent WC14 would also be minor. In the absence of changes in water quality in Wongawilli Creek associated with the gas release in Pool 50, and any change in aquatic habitat noted during the recent aquatic ecology surveys in Wongawilli Creek in April and June 2023, any associated impacts to aquatic ecology are expected to be negligible.

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 19.

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 19.
Fracturing of bedrock and diversion of surface flows	The overall likelihood of significant fracturing resulting in surface water flow diversions at the rockbars along Wongawilli Creek is 7% (based on the rate of rockbar fractures experienced in DA3B due to extraction of Longwalls 9 to 12). Minor fracturing could occur along the creek at distances up to approximately 400 m from the proposed longwall (0.9 km of watercourse length). Fracturing and flow diversions are not predicted to occur in Sandy Creek.	A total of 32 pools with length up to 160 m (total of 1,164 m of pool habitat) have been identified in this section of creek. Based on the predicted fracture rate, it would be unlikely the major rockbar would experience fracturing associated with flow diversions. In the unlikely event this did occur, the length of aquatic habitat that would be affected due to flow diversions is expected to be limited. Some reduction in the population size of aquatic biota associated with pool habitat (fish and many macroinvertebrates) would be expected. Though given the limited amount of pool habitat that would be affected, impacts to aquatic habitat and biota as a direct result of pool drainage would be relatively minor.	No reductions in pool water levels and flow or changes in water quality observed by IMC during extraction of Longwall 19, and thus no suggestion of impacts occurring to aquatic habitat and biota.

Water Quality and Availability	Groundwater modelling suggests the number of no-flow days would increase from 10 % to 28% of the time due to extraction of all DA3A, DA3B and DA3C longwalls. However, these are conservative predictions and considered highly unlikely (SLR 2020, HGEO 2020). Extraction of Longwall 19 would contribute less than 10 % of this increase. Impacts to water quality due to mining are expected to be minor in stream reaches within subsidence affected areas (HGEO 2020). Effects are likely to include slight and temporary changes in water salinity, pH and iron content with local discolouration of streambeds and rock faces by iron hydroxide.	An overall reduction in base flow and increase in the number of zero flow days would impact aquatic habitat and biota in Wongawilli Creek and Sandy Creek. Although substantial reductions in baseflow that may result in relatively severe impacts to aquatic ecology are not expected. Impacts to aquatic habitat and biota due to changes in water quality appear unlikely as only minor changes in water quality are expected.	Iron staining and the single gas release are not associated with any water quality triggers. No evidence of impacts to aquatic biota during observations in April and June 2023.

Attribute	Predicted Physical Impacts	Predicted Impacts on AquaticEcology	Observed Impacts to Aquatic Ecology
Tributaries of Wongawilli Creek and Sandy Creek			
Ponding, flooding and scouring of stream banks due to tilt	Although predicted changes in grade (3%) are larger as a proportion of the natural grade (10% to 20%), compared with that for creeks, it is unlikely that there would be large-scale adverse changes in the levels of ponding or scouring of the banks along these drainage lines due to subsidence induced tilt. It is possible that localised increased ponding could develop in some isolated locations, where the natural grades are small and where the drainage lines exit the mining area	Localised changes in habitat availability and connectivity may occur along the drainage lines due to tilt but these effects will be difficult to detect due the large variability in grade and natural flows within these ephemeral systems. The impacts resulting from the changes in surface water flows are expected to be small in comparison with those which occur during natural flooding conditions. Consequently, impacts to aquatic habitat and biota due to tilt, if any, are expected to be minor and localised.	No impacts observed due to tilt.

Fracturing of bedrock and diversion of surface flows	Fracturing is expected to occur along the sections of the drainage lines that are located directly above the proposed Longwall 19. Fracturing can also occur outside the extents the proposed longwalls, with minor and isolated fracturing occurring at distances up to approximately 400 m. Surface water flow diversions are also likely to occur along the sections of drainage lines that are located directly above the proposed longwalls. In times of heavy rainfall, the majority of the runoff would flow over the fractured bedrock and soil beds and would not be diverted into the dilated strata below. In times of low flow, however, surface water flows can be diverted into the dilated strata below the beds.	Fracturing induced flow diversions in the highly ephemeral drainage lines directly above the longwalls would result in a reduction in the amount of aquatic habitat. However, smaller drainage lines such as these are limited in habitat value for aquatic biota. Flow diversions would reduce the volume and duration of flow in these ephemeral drainage lines. Approximately 0.5 km of first and second order drainage lines occur directly above Longwall 19 and a further approximate 3.0 km within the Study Area. These lengths represent a very small proportion of that present in the wider Cordeaux River Catchment. The majority of these watercourses have previously been impacted by extraction of longwalls from DA3A and DA3B.	Extension of a rock fracture previously identified in WC14 following extraction of Longwall 8 was observed. Although flow diversions may occur, the natural ephemeral nature of WC14 indicates that any reduction in availability and connectivity of aquatic habitat and associated impacts to aquatic biota in WC14 would be minor.

Water quality	Impacts to water quality due to mining are expected to be minor in stream reaches within subsidence affected areas (HGEO 2020). Effects are likely to include temporary changes in water salinity, pH and iron content with local discolouration of streambeds and rock faces by iron hydroxide.	Minor impacts to water quality are unlikely to represent substantial risks to aquatic habitat and biota in drainage lines.	Iron staining in WC14 and WC15 was not associated with any water quality triggers. No impacts to water quality in drainage lines observed. Thus, no impacts to aquatic habitat and biota are expected. Iron staining previously identified in SC10C and SC10 during extraction of Longwall 8 continued during extraction of Longwall 19. However, no evidence that Longwall 19 has contributed to this iron staining and the previously reported limited impacts to aquatic ecology (Cardno 2020c).

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

TARP	Wongawilli Creek
Level 1 – Reduction in aquatic habitat for 1 year	Not triggered
Level 2 – Reduction in aquatic habitat for 2 years following the active subsidence period (i.e. when a longwall within 400m of a feature, such as a creek, is completed)	Not triggered
Level 3 – Reduction in aquatic habitat for >2 years or complete loss of habitat following the active subsidence period	Not triggered

3.13. Cultural Heritage

Following the extraction of Longwall 19, an inspection of Aboriginal cultural heritage sites within the Longwall 19 study area (as defined in Niche 2022; **Attachment G**) was conducted from 26 to 28 April 2023 (Figure 13).

Two out of the eight Aboriginal cultural heritage sites had observable impacts from subsidence related movements due to the extraction of Longwall 19 (Table 12;Photo 60 and Photo 61).

Sandy Creek Road 21 (AHIMS ID#52-5-0273) has horizontal cracking along the inner lower lip and lower back wall of the shelter measuring 10 m in length, stretching from the southern end of the shelter, and terminating 30 cm below Art Panel 2. No direct impacts to the art itself were observed. A new area of spalling was observed associated with the northern end of the horizontal cracking described above. The shelter interior remains dry despite the new cracking, and at the time of recording (26 April 2023) the structural integrity of the shelter overhang remains intact despite the observed cracking.

DM15 (AHIMS ID#52-2-3639) has newly recorded vertical cracking which partially runs through Art Panel 1 Motif 1. An area of fresh spalling and exfoliation was identified approximately 1 m above Art Panel 1 Motif 1, along with minor new block fall from the eastern lip of the shelter overhang (associated with the upper termination of the vertical cracking). This minor block fall has not impacted the art or the structural integrity of the shelter. There was also previously unrecorded water seepage and water wash (including partially across the art panel) observed at this site.

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 19.

AHIMS Number	Site Name	Observed Subsidence Related Changes
48-2-0056	DM13	No impacts related to the extraction of Longwall 19 were observed.
52-2-1645	Browns Road Site 31	No impacts related to the extraction of Longwall 19 were observed.
52-2-1646	Browns Road Site 32	No impacts related to the extraction of Longwall 19 were observed.
52-2-3639	DM15	Newly recorded vertical cracking which partially runs through Art Panel 1 Motif 1. An area of fresh spalling and exfoliation was identified approximately 1 m above Art Panel 1 Motif 1, along with minor new block fall from the eastern lip of the shelter overhang
52-2-3640	DM16	No impacts related to the extraction of Longwall 19 were observed.
52-2-3641	DM17	No impacts related to the extraction of Longwall 19 were observed.
52-2-3644	DM20	No impacts related to the extraction of Longwall 19 were observed.
52-5-0273	Sandy Creek Road 21	Horizontal cracking along the inner lower lip and lower back wall of the shelter measuring 10 m in length, stretching from the southern end of the shelter and terminating 0.3m below Art Panel 2. No direct impacts to the art itself were observed.

Photos redacted

Photo 60: DA3A_LW19_037, rock fracturing through cave at Sandy Creek 21. Taken on 28/03/2023.

Photo 61: Cave art at DM15- image taken in latest inspection showing current fracturing. Recent fracture is circled. Taken on 28/03/2023.

Figure redacted

Figure 13: Aboriginal Cultural Heritage sites within the Longwall 19 study area.

4. IMPACTS TO BUILT FEATURES

The built features in proximity to Longwall 19 are shown in **Attachment B** and include: fire trails and other access tracks, Sandy Creek Waterfall, Cordeaux Dam and survey control marks.

Six impacts were observed on built features during the extraction of Longwall 19. Comparisons between the MSEC assessments and the reported impacts for the built features due to the mining of Longwall 19 are provided in Table 13. The reported impacts are based on those recorded by IMC Environmental Field Team, that are described in the accompanying Landscape Report.

It is considered that the observed impacts on the built features due to the mining of Longwall 19 are similar to or less than the MSEC assessments provided in Report No. MSEC1082 which supported the SMP Application for that longwall.

Table 13: Summary of predicted impacts in comparison to observed impacts relevant to Longwall 19.

Built feature	MSEC assessed impacts	Reported impacts
Fire trails and four-wheel drive tracks	Cracking of unsealed road surfaces	One instance of soil cracking observed on Fire Road 6F (LW19_026) due to mining of Longwall 19. Cracking also observed in bushland near the trails and tracks, with widths typically ranging between 10mm and 180mm. Refer to the IMC Landscape Report for further details
Sandy Creek Waterfall	Adverse impacts not anticipated	No reported impacts to the waterfall due to the mining of Longwall 19.
Cordeaux Dam	Adverse impacts not anticipated.	No reported impacts on the dam walls. Refer to associated groundwater report for further 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. The marks to be re-established after completion of mining, as required.

Table 14: Impacts to built features during Longwall 19 monitoring period.

Site ID	Eastings	Northings	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3A_LW19_026	292083	6192457	Soil Cracking	Fire Road 6F	21/12/2022	1	Soil cracking to Fire Road 6F.	22/12/2022
DA3A_LW19_035	291863	6192548	Soil Cracking	Closed Access Track and Bushland	16/03/2023	2	Soil cracking and rock displacement on a closed vehicle access track and adjacent bushland, west of Fire Road 6F.	17/03/2023
DA3A_LW19_036	291530	6193145	Soil Cracking	Closed Access Track	21/03/2023	1	Soil cracking on a closed access track over Longwall 7.	24/03/2023
DA3A_LW19_048	291780	6192521	Rock Fracturing and Rock Movement	Closed Access Track	27/04/2023	1	Rock fracturing and rock movement along a closed access track west of Fire Road 6F.	01/05/2023
DA3A_LW19_049	291793	6192541	Soil Cracking	Closed Access Track	27/04/2023	1	Soil Cracking running along a closed access track west of Fire Road 6F.	01/05/2023
DA3A_LW19_050	291820	6192550	Soil Cracking	Closed Access Track	27/04/2023	2	Soil Cracking running along a closed access track west of Fire Road 6F.	01/05/2023

4.1. Level 1 Surface Cracking

Four Level 1 impacts were observed during the Longwall 19 monitoring period.

Photo 62: DA3A_LW19_026, showing soil cracking on Fire Road 6F.
Taken on 16/06/2022

Photo 63: DA3A_LW19_036, showing soil cracking on a closed vehicle access track. Taken on 21/03/2023.

Photo 64: DA3A_LW19_048, showing rock fracturing on a closed vehicle access track. Taken on 27/04/2023.

Photo 65: DA3A_LW19_049, showing soil cracking on a closed vehicle access track. Taken on 27/04/2023.

4.2. Level 2 Surface Cracking

Two Level 2 impacts were observed during the Longwall 19 monitoring period.

Photo 66: DA3A_LW19_035, showing soil cracking on a closed vehicle access track. Taken on 16/03/2023.

Photo 67: DA3A_LW19_050, showing soil cracking on a closed vehicle access track. Taken on 27/04/2023.

5. SUMMARY OF TARP TRIGGERS

A summary of TARP triggers during the extraction of Longwall 19 is presented below in Table 15; additionally, an overview of Longwall 19 surface impacts and triggers is presented in Figure 14 and Figure 15..

Table 15: Summary of TARP Triggers during the extraction of Longwall 19.

**A recent change to the reporting process has meant impact reports being revised following initial report date to include a summary of stakeholder consultation. This has resulted in a Version 2 (V2) of respective of reports with an accompanying revised date.

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3A_LW19_001	Rock Fracturing	Steep Slope/ Step	3/08/2022	1	Rock fracturing to a steep slope/ step, east of Fire Road 6F.	5/08/2022
DA3A_LW19_002	Rock Fracturing	Steep Slope/ Step	3/08/2022	2	Rock fracturing to a steep slope/ step, east of Fire Road 6F.	5/08/2022
DA3A_LW19_003	Iron Staining	WC14	16/08/2022	2	Increase in Iron staining at tributary WC14	17/08/2022
DA3A_LW19_004	Rock Fracturing and Fragmentation	Steep Slope/ Step	19/08/2022	1	Rock fracturing to a steep slope/ step, west of Swamp 15b.	23/08/2022
DA3A_LW19_005	Rock Fracturing	Steep Slope/ Step	19/08/2022	1	Rock fracturing to a steep slope/ step, west of Swamp 15b.	23/08/2022
DA3A_LW19_006	Soil Cracking	Bushland	31/08/2022	2	Soil cracking to bushland south of tributary SC10C.	5/09/2022
DA3A_LW19_007	Soil Cracking	Bushland	18/10/2022	1	Soil cracking in bushland between Longwall 19 and Swamp 15b.	20/10/2022
DA3A_LW19_008	Rock Fracturing	Rock Outcrop	7/11/2022	1	Rock fracturing to rock outcrop east of Fire Road 6F.	9/11/2022
DA3A_LW19_009	Rock Fracturing	Rock Outcrop	7/11/2022	1	Rock fracturing to rock outcrop east of Fire Road 6F.	9/11/2022
DA3A_LW19_010	Rock Fracturing	Rock Outcrop	7/11/2022	1	Rock fracturing to rock outcrop east of Fire Road 6F.	9/11/2022
DA3A_LW19_011	Rock Fracturing	Rock Outcrop	7/11/2022	1	Rock fracturing to rock outcrop east of Fire Road 6F.	9/11/2022
DA3A_LW19_012	Rock Fracturing	Rock Outcrop	7/11/2022	1	Rock fracturing to rock outcrop east of Fire Road 6F.	9/11/2022

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3A_LW19_013	Rock Fracturing and Rock Movement	Steep Slope/ Step	7/11/2022	2	Rock fracturing and rock movement at a steep slope/ step, east of Fire Road 6F. *Coordinates shown here are correct, updated from error in initial report.*	9/11/2022
DA3A_LW19_014	Rock Movement	Boulder	7/11/2022	1	Dislodgement of a boulder east of Fire Road 6F.	9/11/2022
DA3A_LW19_015	Rock Fracturing	Steep Slope/ Step	7/11/2022	2	Rock fracturing to a steep slope/ step, north of Swamp 15a.	9/11/2022 and 22/12/2022 (Update)
DA3A_LW19_016	Rock Fracturing and Rockfall	Steep Slope/ Step	7/11/2022	2	Rock fracturing and small rock fall at a steep slope/ step, east of Fire Road 6F.	9/11/2022 and 22/12/2022 (Update)
DA3A_LW19_017	Rock Fracturing	Rock Outcrop	13/12/2022	1	Rock fracturing to a rock outcrop, east of Fire Road 6F.	15/12/2022
DA3A_LW19_018	Rock Displacement	Steep slope	13/12/2022	1	Rock displacement to a steep slope, east of Fire Road 6F.	15/12/2022
DA3A_LW19_019	Rock Displacement	Steep slope	13/12/2022	1	Rock displacement to a steep slope, east of Fire Road 6F.	15/12/2022
DA3A_LW19_020	Soil Cracking	Bushland	13/12/2022	2	Soil cracking at the base of a rock outcrop, east of Fire Road 6F.	15/12/2022
DA3A_LW19_021	Soil Cracking and Rock Displacement	Boulders	13/12/2022	2	Soil cracking and rock displacement to boulders, east of Fire Road 6F.	15/12/2022
DA3A_LW19_022	Soil Cracking, Rock Fracturing and Rock Displacement	Bushland/ Rock Outcrop	13/12/2022	2	Soil cracking, rock fracturing and rock displacement in bushland, east of Fire Road 6F.	15/12/2022
DA3A_LW19_023	Rock Fracturing	Rock Outcrop	13/12/2022	1	Rock fracturing to a rock outcrop, east of Fire Road 6F.	15/12/2022
DA3A_LW19_024	Rock Fracturing and Soil Cracking	Step/ Bushland	20/12/2022	2	Rock fracturing to a step and soil cracking to bushland, east of Fire Road 6F.	22/12/2022
DA3A_LW19_025	Rock Displacement	Boulder	20/12/2022	1	Rock displacement away from soil, east of Fire Road 6F.	22/12/2022 and 09/02/2023 (Update)
DA3A_LW19_026	Soil Cracking	Fire Road 6F	21/12/2022	1	Soil cracking to Fire Road 6F.	22/12/2022
DA3A_LW19_015 (Update)	Rock Fracturing	Steep Slope/ Step	7/11/2022	2	Rock fracturing to a steep slope/ step, east of Fire Road 6F.	9/11/2022 & 22/12/2022 (Update)

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3A_LW19_016 (Update)	Rock Fracturing, Fragmentation and Rockfall	Steep Slope/ Step	7/11/2022	2	Rock fracturing, fragmentation and rock fall at a steep slope/ step, east of Fire Road 6F.	9/11/2022 & 22/12/2022 (Update)
S148_01	Soil Moisture	*Swamp 148*	22/12/2022	3	Soil moisture lower than baseline trigger in *Swamp 148.*	22/12/2022
DA3A_LW19_027	Rock Fracturing and Rockfall	Step	10/01/2023	1	Rock fracturing and two small rockfalls at a step, west of Fire Road 6F.	11/01/2023
DA3A_LW19_028	Rock Fracturing	Rock Outcrop	6/02/2023	1	Rock fracturing to rock outcrop east of Fire Road 6F	09/02/2023
DA3A_LW19_029	Gas Release	Wongawilli Creek	18/01/2023	1	Gas release in WC_Pool 50, Wongawilli Creek	09/02/2023
DA3A_LW19_025 (Update)	Rock Displacement, Rock Fracturing and Soil Cracking	Rock Step/Outcrop	20/12/2022, 17/01/2022 (update)	1	Rock displacement away from soil, rock fracturing and soil cracking east of Fire Road 6F. *Coordinates shown here are correct, updated from error in initial report.*	22/12/2022 and 09/02/2023 (Update)
DA3A_LW19_030	Rock Fracturing	Rock Outcrop	15/02/2023	2	Rock fracturing to rock outcrop east of Fire Road 6F	17/02/2023
DA3A_LW19_031	Rock Fracturing	Rock Outcrop	15/02/2023	1	Rock fracturing to rock outcrop east of Fire Road 6F	17/02/2023
DA3A_LW19_032	Rock Fracturing	Rock Outcrop	15/02/2023	1	Rock fracturing to rock outcrop east of Fire Road 6F	17/02/2023
DA3A_LW19_033	Rockfall	Rock Step/Outcrop	15/02/2023	1	Rockfall on rock outcrop east of Fire Road 6F	17/02/2023
DA3A_LW19_034	Rock Fracturing	Rock Outcrop	15/02/2023	1	Rock fracturing to rock outcrop east of Fire Road 6F	17/02/2023
35b_01 (DA3B)	Groundwater	*Swamp 35b*	27/02/2023	3	Groundwater recession rate greater than baseline	14/03/2023
DA3A_LW19_035	Soil Cracking	Closed Access Track and Bushland	16/03/2023	2	Soil cracking and rock displacement on a closed vehicle access track and adjacent bushland, west of Fire Road 6F.	17/03/2023
DA3A_LW19_036	Soil Cracking	Closed Access Track	21/03/2023	1	Soil cracking on a closed access track over Longwall 7.	24/03/2023
DA3A_LW19_037	Rock Fracturing and Rockfall	*Sandy Creek 21 (Cultural Heritage Site)*	28/03/2023	2	Rock fracturing and rockfall within proximity to cultural heritage site Sandy Creek 21	29/03/2023

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3A_LW19_038	Rock Fracturing and Rockfall	DM15 (Cultural Heritage Site)	28/03/2023	2	Rock fracturing and rockfall at cultural heritage site *DM15*.	29/03/2023
DA3A_LW8_003 (Update)	Rock Fracturing, Rockfall and Fragmentation	WC14	12/04/2023	1	Rock fracturing with associated rockfall and fragmentation on WC14.	29/01/2020 and 17/04/2023 (Update)
DA3A_LW19_039	Rockfall	Steep Slope/ Step	12/04/2023	1	Rockfall at base of steep slope/step to the north of WC14.	17/04/2023
DA3A_LW19_040	Rockfall and Fragmentation	Step	12/04/2023	1	Rockfall with some associated fragmentation to the north of WC14.	17/04/2023
DA3A_LW19_041	Rockfall	*LW19_SS5*	12/04/2023	2	Large rockfalls with boulders that dislodged and rolled downhill at landscape monitoring site LS19_SS5.	17/04/2023
DA3A_LW19_042	Rockfall and Fragmentation	LW19_SS4	12/04/2023	1	Small rockfall with some associated fragmentation at landscape monitoring site LW19_SS4.	17/04/2023
DA3A_LW19_043	Rock Fracturing and Uplift	WC14	17/04/2023	2	Rock fracturing and Uplift on WC14_Rockbar 7 which affects flow diversion.	27/04/2023
DA3A_LW19_044	Iron Staining	Bushland	19/04/2023	1	Iron staining in bush within proximity but not flowing into Wongawilli Creek.	27/04/2023
DA3A_LW19_045	Iron Staining	WC15	26/04/2023	1	Iron staining beneath a step that flows in to WC15_Pool 2.	01/05/2023
DA3A_LW19_046	Rockfall	Steep Slope/ Step	27/04/2023	1	Rockfall on top of steep slope/ step where several boulders have dislodged from the slope face west of Fire Road 6F.	01/05/2023
DA3A_LW19_047	Rockfall	Steep Slope/ Step	27/04/2023	1	Small rockfall on edge of steep slope/ step to the north of WC14.	01/05/2023
DA3A_LW19_048	Rock Fracturing and Rock Movement	Closed Access Track	27/04/2023	1	Rock fracturing and rock movement along a closed access track west of Fire Road 6F.	01/05/2023
DA3A_LW19_049	Soil Cracking	Closed Access Track	27/04/2023	1	Soil Cracking running along a closed access track west of Fire Road 6F.	01/05/2023
DA3A_LW19_050	Soil Cracking	Closed Access Track	27/04/2023	2	Soil Cracking running along a closed access track west of Fire Road 6F.	01/05/2023
DA3A_LW19_051	Rock Fracturing	WC14	04/05/2023	1	Rock fracturing on small rockbar (WC14 Channel 17) within Swamp 148.	09/05/2023
DA3A_LW19_052	Rock Fracturing and Rockfall	Steep Slope	04/05/2023	1	Rock fracturing and associated rockfall on steep slope to the north of WC14.	09/05/2023

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3A_LW19_053	Rock Fracturing and Rockfall	Rock Step	04/05/2023	1	Rock fracturing and associated rockfall at base of a rock step to the north of WC14.	09/05/2023
DA3A_LW19_054	Rock Fracturing and Fragmentation	Steep Slope	04/05/2023	1	Rock fracturing and fragmentation at base of a steep slope to the west of Fire Road 6F.	09/05/2023
DA3A_LW19_055	Rock Fracturing and Rockfall	Steep Slope	04/05/2023	1	Rock fracturing and an associated rockfall beneath an overhang to the north of WC14.	09/05/2023
DA3A_LW19_056	Rock Fracturing and Rockfall	Step/ Overhang	05/05/2023	2	Rock fracturing and rockfall on a steep slope to the north of WC14.	09/05/2023
DA3A_LW19_057	Rockfall	Step	05/05/2023	1	Rockfall at a step to the north of WC14.	09/05/2023
DA3A_LW19_058	Rock Fracturing and Fragmentation	Rock Outcrop	05/05/2023	1	Rock fracturing and fragmentation on edge of a rock outcrop to the north of WC14.	09/05/2023
DA3A_LW19_059	Rock Fracturing and Fragmentation	Overhang	05/05/2023	1	Rock fracturing and associated fragmentation beneath an overhang to the north of WC14.	09/05/2023
DA3A_LW19_060	Rock Fracturing, Displacement and Rockfall	Step/ Outcrop	05/05/2023	1	Rock fracturing, displacement and rockfall on a steep slope/ outcrop to the north of WC14.	09/05/2023
DA3A_LW19_061	Rock Fracturing and Soil Cracking	Step/ Outcrop	05/05/2023	2	Rock fracturing and soil cracking on a steep slope/ outcrop to the north of WC14.	09/05/2023
DA3A_LW19_062	Rock Fracturing	Rock Outcrop	05/05/2023	1	Rock fracturing on the face of an outcrop to the north of WC14.	09/05/2023
DA3A_LW19_063	Rock Movement	Steep Slope	10/05/2023	1	Boulder shifted downslope, east of Fire Road 6F.	15/05/2023
Swamp 15b	Soil Moisture	*Swamp 15b*	29/05/2023	2	Soil moisture trigger at swamp sites *S15b_39*, *S15b_H2* and *S15b_H3.*	29/05/2023
Swamp 15a	Shallow Groundwater	*Swamp 15a*	12/07/2023	1	Groundwater trigger at one site in Swamp 15a (15a_19).	17/07/2023
	Soil Moisture			2	Soil moisture triggers at three sites within Swamp 15a. (S15a_07, S15a_15 and S15a_19).	
Swamp 1a (DA3B)	Ecosystem Function	*Swamp 1A*	N/A	2	A continuing decline in Tea-Tree Thicket greater than that experienced at the Control Group in 2019-2020, 2020-2021, 2021-2022 has been identified in 2022.	Niche (2022)
Swamp 5 (DA3B)	Ecosystem Function	*Swamp 5*	N/A	3	A decline in Tea-Tree Thicket greater than that of the Control Group was detected in 2018-19, 2019-20, 2020-21 and 2021-22.	Niche (2022)

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
Swamp 23 (DA3B)	Ecosystem Function	*Swamp 23*	N/A	1	A decline in Banksia Thicket greater than that of the Control Group detected in 2020-21 and 2021-22.	Niche (2022)
	Swamp Extent			2	Trending decline in the extent of an upland swamp (combined area of groundwater dependent communities) for three consecutives monitoring periods, greater than observed in the Control Group, and exceeding the SE of the Control Group.	
Swamp 15a	Terrestrial Ecology (Flora)	*Swamp 15a*	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)
					A statistically significant difference in species composition	
Swamp 13 (DA3B)	Terrestrial Ecology (Flora)	*Swamp 13*	N/A	2	A statistically significant difference in species composition	Niche (2022)
Swamp 14 (DA3B)	Terrestrial Ecology (Flora)	*Swamp 14*	N/A	1	A statistically significant difference in species composition	Niche (2022)
Swamp 1b (DA3B)	Terrestrial Ecology (Flora)	*Swamp 1B*	N/A	Exceeding Expectation	An exceeding expectation TARP has been triggered following seven consecutive years of species composition data being different to pre-mining data. Consistent with Niche (2022).	Niche (2022)
SC10C (Transect)	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) (Transect)	Terrestrial Ecology (Fauna)	*SC10(1)*	N/A	2	Triggered due to appearance at SC10(1) (Fractured bedrock (upstream in SC10C) and iron flocculant present at 13 of the 14 pools recorded) and habitat unlikely to naturally regenerate within the monitoring period.	Niche (2022)
WC17 (Transect)	Terrestrial Ecology (Fauna)	*WC17*	N/A	2	Triggered due to appearance at WC17 (Iron flocculant and fractured bedrock since 2017 at WC17) and habitat unlikely to naturally regenerate within the monitoring period.	Niche (2022)
DC13 (Transect -DA3B)	Terrestrial Ecology (Fauna)	*DC13*	N/A	3	Level 3 TARP remains triggered. The detection of the Adult lifecycle stage remains statistically lower than that of the pre-mining years and there has been a reduction in habitat for greater than two years following the active subsidence period.	Niche (2022)
LA2 (Transect -DA3B)	Terrestrial Ecology (Fauna)	*LA2*	N/A	2	Triggered due to a reduction in habitat (reduction in aquatic habitat, contrary to that observed at the controls) for 1 year following the active subsidence period.	Niche (2022)
WC15 (Transect -DA3B)	Terrestrial Ecology (Fauna)	*WC15*	N/A	3	Triggered due a reduction in habitat (dry pools for extended time and bedrock cracking) for three-years following the active subsidence period.	Niche (2022)
WC21 (Transect -DA3B)	Terrestrial Ecology (Fauna)	*WC21*	N/A	3	Triggered due a continued reduction in habitat (fractured bedrock) at WC21 for more than two-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
DC13S1	Surface Water Hydrology	*DC13*	N/A	3	General Hydrological Behaviour	HGEO (2023)
				2	Changes in cease-to-flow frequency (below natural)	
				3	Changes to median flow	
DCS2	Surface Water Hydrology	*DCS2*	N/A	3	General Hydrological Behaviour	HGEO (2023)
				3	Changes in cease-to-flow frequency (below natural)	
				3	Changes to median flow	
DCU	Surface Water Hydrology	*DCU*	N/A	1	Changes in cease-to-flow frequency (below natural)	HGEO (2023)
WC21S1	Surface Water Hydrology	*WC21*	N/A	3	General Hydrological Behaviour	HGEO (2023)
				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 (2023)
				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 (2023)
				3	Changes in cease-to-flow frequency (below natural)	
				3	Changes to median flow	
LA3S1	Surface Water Hydrology	*LA3*	N/A	3	General Hydrological Behaviour	HGEO (2023)
				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 (2023)
				3	Changes to median flow	
SC10CS1	Surface Water Hydrology	*SC10C*	N/A	2	Changes in cease-to-flow frequency (below natural)	HGEO (2023)
				3	Changes to median flow	
SCL2/GS2122205	Surface Water Hydrology	*Sandy Ck*	N/A	1	Changes in cease-to-flow frequency (below natural)	HGEO (2023)
Swamp 12 (HGEO)	Shallow Groundwater	*Swamp 12*	N/A	3	All three piezometers show low levels of saturation compared with reference swamps after being directly mined under by Longwall 7.	HGEO (2023)
	Soil Moisture			3	Both sites record average soil moisture below Longwall 19 baseline; noting that the sites were previously mined under and impacted by Longwall 7	

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
Swamp 15a (HGEO)	Shallow Groundwater	*Swamp 15a*	N/A	1	Evidence for impact at 15a_19 following extraction of longwall 19.	HGEO (2023)
	Soil Moisture			2	Soil moisture in 3 out of 5 sensors within 400m dropped below baseline during review period.	
Swamp 15b (HGEO)	Shallow Groundwater	*Swamp 15b*	N/A	3	All four sites show evidence for impact; low saturation levels and high recession rates compared with reference sites. Impacts associated with Longwall 7.	HGEO (2023)
	Soil Moisture			1	Logging sensors installed after Longwall 8 passed beneath or near sites. Likely impacted.	
Swamp 35b (DA3B) (HGEO)	Shallow Groundwater	*Swamp 35b*	N/A	3	Increase in recession rate following passage of Longwall 18; Shallow groundwater levels below expected in early 2023 compared with previous and reference sites	HGEO (2023)
Swamp 148 (HGEO)	Shallow Groundwater	*Swamp 148*	N/A	3	Water level dropped below piezometer base on 20/11/2022 with no significant saturation since despite moderate rainfall in March 2023.	HGEO (2023)
	Soil Moisture			3	Recoded average soil moisture below baseline from 11/2022 after the passage of Longwall 19	
Swamp 146 (HGEO)	Shallow Groundwater	*Swamp 146*	N/A	3	Site shows low levels of saturation and high recession rates compared with reference sites indicating impacts associated with Longwall 7, prior to installation of the piezometer.	HGEO (2023)

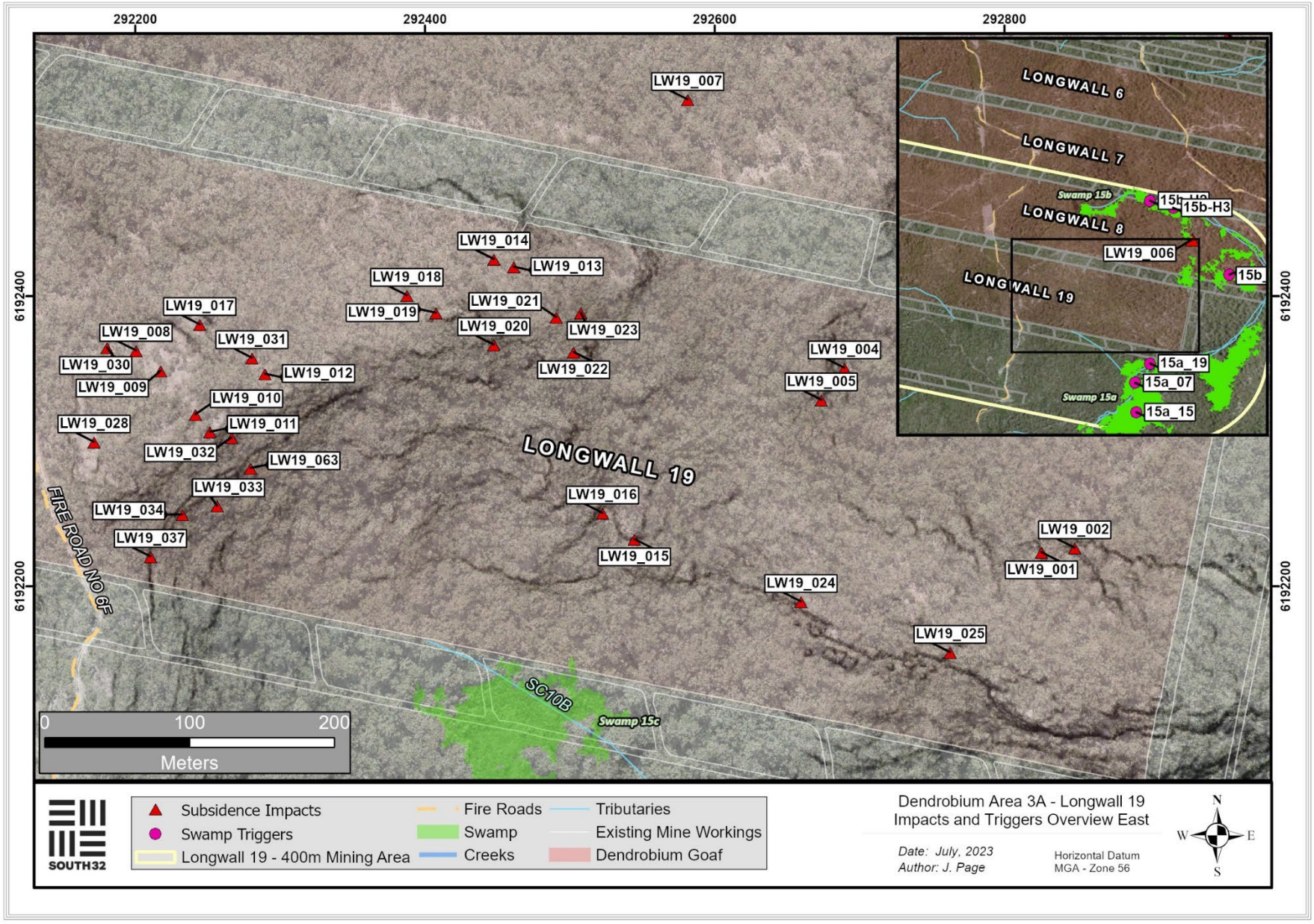

Figure 14: Overview of surface impacts observed during the Longwall 19 monitoring period on the eastern end.

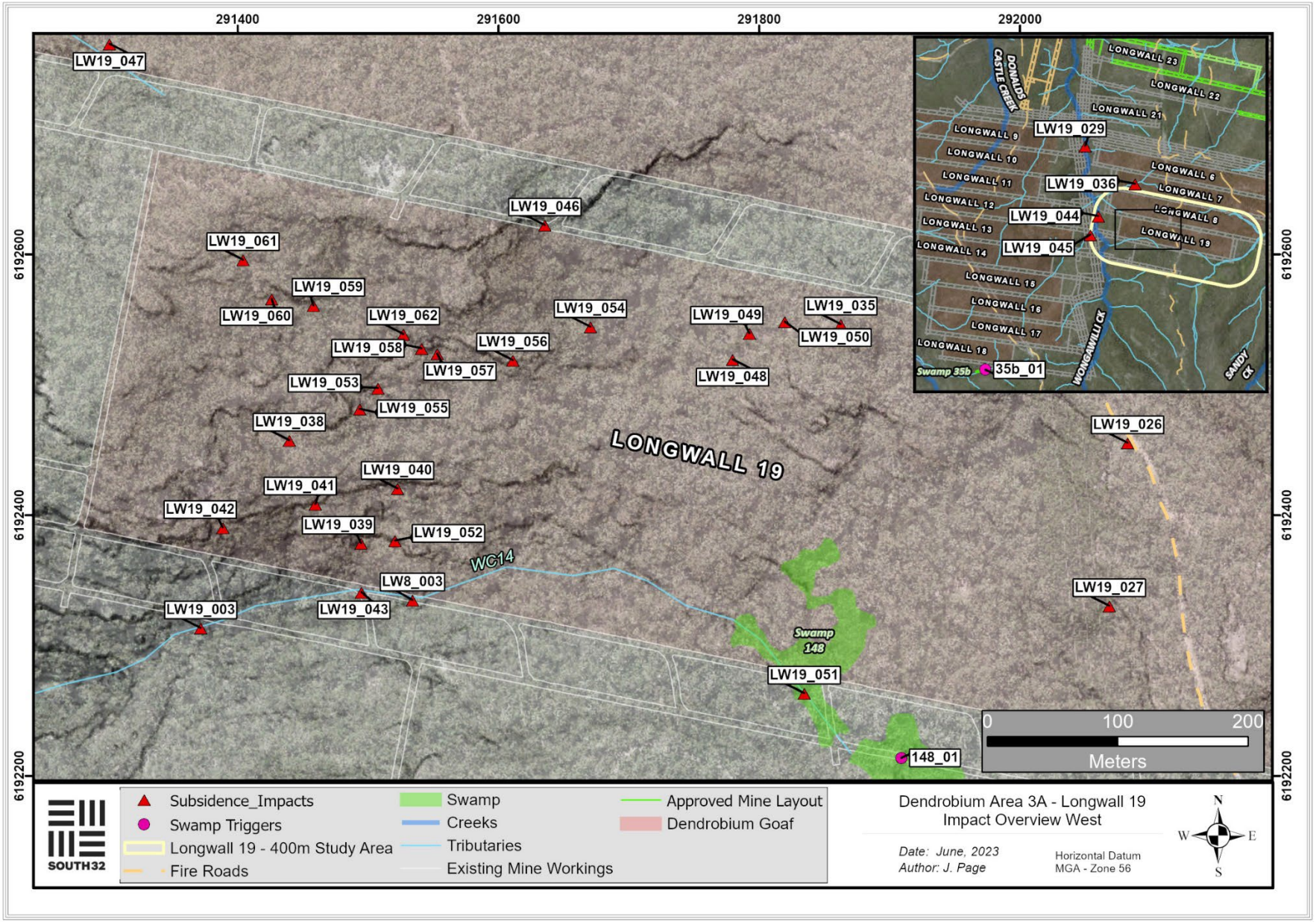

Figure 15: Overview of surface impacts observed during the Longwall 19 monitoring period on the western end.

6. LONGWALL 19 MONITORING PROGRAM

Table 16: Summary of monitoring sites associated with the extraction of Longwall 19. Recommended monitoring sites associated with the extraction of Longwall 21 are also included.

Aspect	Monitoring Sites Associated with Longwall 19	Monitoring Frequency	Longwall 21 Recommended Future Monitoring
Watercourses	**Observational, photo point and water monitoring**		
	Longwall 19 Monitoring • Wongawilli Creek • Sandy Creek • SC10 • SC10B • SC10C • WC13 • WC13A • WC14 • WC15 • WC17 • WC17B	Monthly 2 years pre and post mining, weekly when longwall is within 400m of monitoring site. Reference sites 6 monthly. Landscape Sites: pre and post mining, monthly whenlongwall is within 400m of monitoring site.	**Longwall 21 Monitoring** • Wongawilli Creek • WC20 • WC21 • WC24 • WC24A • LC5 **DA3A Monitoring (post-mining)** • Wongawilli Creek • Sandy Creek • SC10 • SC10B • SC10C • SC7 • WC13 • WC13A • WC14 • WC15 • WC17 • WC17B **Dendrobium Area 3B (post-mining for 2 years)** • LA2 • ND1 • ND1A • ND1B • ND1C • ND2 • WC12 • WC15 • WC7
	Water Quality		
	Wongawilli Creek and tributaries • Wongawilli Creek (WC_Channel 14, WC_Pool 53, WC_Pool 55, WC_Pool 69, WC_Pool 72b, WC_Pool 72A) • 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)	Monthly monitoring pre, during and post mining for two years.	**Longwall 21 Monitoring** • Wongawilli Creek (WC_Pool 49, WC_Pool 46, WC_Pool 45, WC_Pool 44, WC_Channel 10, WWU1, WWU4, Wongawilli Creek (FR6)) • WC20 (WC20_Pool 8, WC20_Rockbar 17) • WC24 (WC24_Pool 10, WC24_Pool 22) • WC24A (WC24A_Pool 1)

Aspect	Monitoring Sites Associated with Longwall 19	Monitoring Frequency	Longwall 21 Recommended Future Monitoring
	Sandy Creek and tributaries • 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, SC10C_Pool 5, SC10C_Pool 8, SC10C_Pool 11a) **Reference Site** • LC5_S1 • CR36_S1 • NDC1		• LC5 (LC5_Pool 26, LC5_S1) Lake Cordeaux (LC_1) **Dendrobium Area 3A (post-mining for 2 years)** **Wongawilli Creek and tributaries** • Wongawilli Creek (WC_Channel 14, WC_Pool 53, WC_Pool 55, WC_Pool 69, WC_Pool 72b, WC_Pool 72A) • 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) **Sandy Creek and tributaries** • 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, SC10C_Pool 5, SC10C_Pool 8, SC10C_Pool 11a) **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) • 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 34) • Wongawilli Creek • WC7 (WC7_Pool 1, WC7_Pool 9, WC7_Pool 14
Swamps	**Observational, Photo Point and Water Monitoring**		
	• Swamps 12, 15a, 15b, 34, 95, 146, 148	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 9, 144 and 145

Aspect	Monitoring Sites Associated with Longwall 19	Monitoring Frequency	Longwall 21 Recommended Future Monitoring
	Shallow Groundwater Level		
	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 **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	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 21 Monitoring • Swamps, 9,144 and 145 Dendrobium Area 3B (post-mining for 2 years) • Swamp 14: 14_01 • Swamp 35a: 35a_01 • Swamp 35b: 35b_01 • Swamp 150: 150_01 • Swamp 151: 151_01 **Reference Sites** • Swamp 2: 02_01 • Swamp 22: 22_01, 22_02 • Swamp 24: 24_01 • Swamp 25: 25_01 • Swamp 33: 33_01, 33_03 • Swamp 84: 84_02 • Swamp 85: 85_01, 85_02 • Swamp 86: 86_01, 86_02 • Swamp 87: 87_01, 87_02 • Swamp 88: 88_01, 88_02
	Soil Moisture		
	• 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 **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	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 21 Monitoring • Swamps 9, 144 and 145 Dendrobium Area 3B (post-mining 2 years) • Swamp 14: 14_01 • 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

Aspect	Monitoring Sites Associated with Longwall 19	Monitoring Frequency	Longwall 21 Recommended Future Monitoring
			• Swamp 86: S86_S01, S86_S02 • Swamp 87: S87_S01, S87_S02 • Swamp 88: S88_S01, S88_S02
Landscape	**Targeted Sites**		
	Cliffs • DA3-CF7 • DA3-CF8 • DA3-CF15 • DA3-CF16 • DA3-CF17 • DA3-CF18 **Fire Trails** • Fire Road 6F (across active mining area)	Monthly monitoring during any subsidence period. Monitoring to continue 6 monthly for 2 years following the completion of mining.	**Cliffs** • DA3-CF13 **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.

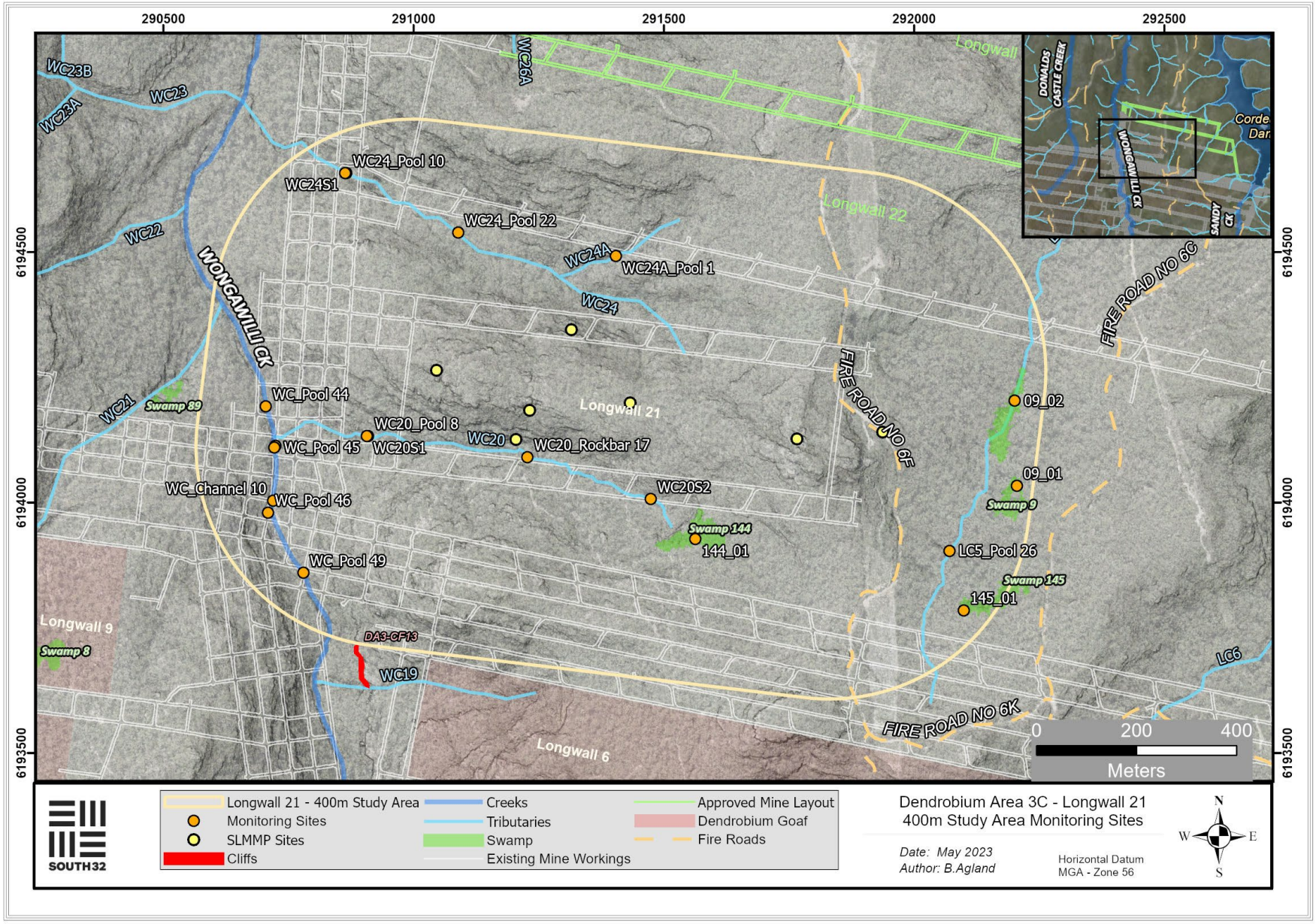

Figure 19: Overview of monitoring sites relevant to Longwall 21 active mining area.

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8. APPENDIX A – IMPACTS, TRIGGERS AND RESPONSE

Table 17: Dendrobium Landscape TARPs.

Landscape Features		
Longwall 19 and 19A Study Area **Cliffs** All mapped cliff sites in subsidence area *(Refer to Figures 3-1 for location of sites)* **Steep Slopes** All mapped steep slopes in subsidence area *(Refer to Figure 3-1 for location of sites)* **Fire Trails** All mapped fire trails in subsidence area *(Refer to Figure 3-1 for location of sites)*	***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 soil surface 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 or impede access Crack or fracture up to 100 mm width Crack or fracture up to 10 m length Erosion in a localised area which would be expected to naturally stabilise without CMA and within the period of monitoring	Continue monitoring program Submit an Impact Report to key stakeholders Summarise impacts and report in the EOP and AR

	Level 2 • Rock fall or overhang collapse at a cliff site, where characteristics of the cliff have changed, and there has been significant ground disturbance • Surface movement or rock displacement that has exposed significant areas of soil • A crack at the surface, which could result in significant erosion or movement at the surface • A crack at the surface with potential risk to safety and/or fauna entrapment • A crack in the fire trail, which could result in significant erosion or impede vehicle access • Crack or fracture between 100 and 300 mm width • Crack or fracture between 10 and 50 m 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	• *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 environmental and 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*
	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 300 mm width • Crack or fracture over 50 m length • Mass movement of a slope causing large areas of exposed • soil with potential for further movement	• *Actions as stated for Level 2* • Immediately notify stakeholders and technical specialists and seek advice on any CMA required • Offer site visit with stakeholders • Implement additional monitoring or increase frequency if required • Completion of works following approvals and at a time agreed between S32, DPE 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 *Note: CMAs are to be proposed based on appropriate management of environmental and 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*

Table 18: Dendrobium 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	*Level 1:* 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. *Level 2*: 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. *Level 3:* 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 (ie 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 **No significant change** to the composition or distribution of species within the swamps	Swamp vegetation changes: - Swamp size - Species richness, distribution, composition and diversity - Vegetation sub-communities	**Swamp Size** *Level 1:* 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. *Level 2:* A trending decline in the extent of an upland swamp (combined area of groundwater dependent communities) 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 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	a) upfront mine planning b) vegetation monitoring c) water spreading d) seeding/planting 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	Offset required **immediately**, if no remediation considered practicable. Offset required **5 years** following remediation, if it is ineffective. This period can be extended to **10 years**, with the agreement of the Secretary.	Monitoring period for swamp size is related to capture of Lidar data at the end of each longwall ~ 1 year Triggers for groundwater decline result in increased intensity and frequency of vegetation monitoring

		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** *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, 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 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 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*	*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	a) upfront mine planning b) groundwater monitoring c) implementation of swamp research program d) weeding		Triggers for groundwater decline result in increased intensity and frequency of vegetation monitoring and/or further

	considered a breach if predictions were exceeded.	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. *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.	e) fire management f) reporting g) update future predictions		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 *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

		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) withinthe swamp.			
Minor changes inthe 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 breachif predictions were exceeded.*	*Level 1:* Soil moisture level lower than baseline level at **any** monitoring sites (within400 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 impactson bedrock base and rockbars

Table 19: Dendrobium Area 3A Watercourse TARP.

OBSERVATIONAL MONITORING		
Sandy Creek and Wongawilli Creek **Relevant Performance Measure(s):** • Wongawilli Creek - minor environmental consequences • Sandy Creek - minor environmental consequences 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 • Observation that a pool on a subject Creek is dry • Observation that the subject Creek has ceased to flow	• Continue monitoring program • Submit an Impact Report to BCD, DPE, DRG, 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 DPE, DRG and Water NSW 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 DPE, DRG and Water NSW 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	• *Actions as stated for Level 2* • Offer site visit with BCD, DPE, DRG, Water NSW • Implement additional monitoring or increase frequency if required

	• 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	• 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, DPE, DRG, Water NSW • Completion of works following approvals and at a time agreed between S32, DPE, DRG and Water NSW (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 • Structural integrity of the bedrock base of any significant permanent pool or controlling rockbar cannot be restored i.e. pool water level within the pool after CMAs 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 Sandy Creek downstream monitoring site Sandy Creek SCk_Rockbar 5. • Cracking in Sandy Creek within 30 m of the waterfall is of greater than negligible environmental and hydrological consequence • Greater than negligible diversion of water occurs 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 CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
WC13, WC14, WC15, WC16, WC17, WC17A, WC17B, SC7, SC10 and SC10C 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	• Continue monitoring program • Submit an Impact Report to BCD, DPE, DRG, Water NSW • Report in the End of Panel Report • Summarise actions and monitoring in AEMR

	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	
	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 DPE, DRG and Water NSW 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, DPE, DRG, Water NSW • 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, DPE, DRG, Water NSW • Completion of works following approvals and at a time agreed between S32, DPE, DRG and Water NSW (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
WATER QUALITY		
Wongawilli Creek **Relevant Performance Measure(s):** • Wongawilli Creek - minor environmental consequences Wongawilli Creek (FR6)	***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 4.39 – EC 163.9 uS/cm – DO 49.1%	• Continue monitoring program • Submit an Impact Report to BCD, DPE, DRG, Water NSW • Report in the End of Panel Report • Summarise actions and monitoring in AEMR

Baseline means: • pH 6.01 • EC 100.4 uS/cm • DO 89.5%	***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 4.39 – EC 163.9 uS/cm – DO 49.1%	• *Actions as stated for Level 1* • Review monitoring frequency • Submit letter report to DPE, DRG and Water NSW 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 4.39 – EC 163.9 uS/cm – DO 49.1%	• *Actions as stated for Level 2* • Offer site visit with BCD, DPE, DRG, Water NSW • 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, DPE, DRG and Water NSW (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 4.39 – EC 163.9 uS/cm – DO 49.1%	• *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
Sandy Creek **Relevant Performance Measure(s):** • Sandy Creek - minor environmental consequences SCk_Rockbar 5 Site Baseline means:	***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 5.10 – EC 129.9 uS/cm – DO 17.9%	• Continue monitoring program • Submit an Impact Report to BCD, DPE, DRG Water NSW • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2	• *Actions as stated for Level 1*

• pH 5.54 • EC 101.1 uS/cm • DO 74.8%	• 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 5.10 – EC 129.9 uS/cm – DO 17.9%	• Review monitoring frequency • Submit letter report to DPE, DRG and Water NSW 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 5.10 – EC 129.9 uS/cm – DO 17.9%	• *Actions as stated for Level 2* • Offer site visit with BCD, DPE, DRG, Water NSW • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key agencies • 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 • Completion of works following approvals and at a time agreed between S32, DPE, DRG and Water NSW (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 5.10 – EC 129.9 uS/cm – DO 17.9%	• *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 Cordeaux **Relevant Performance Measure(s):** • Lake Cordeaux - negligible reduction in the quality of surface water inflows to Lake Cordeaux	***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 3.96 – EC 137 uS/cm – DO 49.4%	• Continue monitoring program • Submit an Impact Report to BCD, DPE, DRG, Water NSW • Report in the End of Panel Report • Summarise actions and monitoring in AEMR

Sandy Creek Arm Site Baseline means: • pH 6.11 • EC 93 uS/cm • DO 87.6%	***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 3.96 – EC 137 uS/cm – DO 49.4%	• *Actions as stated for Level 1* • Review monitoring frequency • Submit letter report to DPE, DRG and Water NSW 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 3.96 – EC 137 uS/cm – DO 49.4%	• *Actions as stated for Level 2* • Offer site visit with BCD, DPE, DRG, Water NSW • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key agencies • 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, DPE, DRG and Water NSW (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 3.96 – EC 137 uS/cm – DO 49.4%	• *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

Table 20: Dendrobium Landscape Impacts, Triggers and Response Plan.

Monitoring	Trigger	Action
LANDSCAPE FEATURES		
AREA 2	***Level 1*** *	• Continue monitoring program

Monitoring	Trigger	Action
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)	• 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 anysignificant 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 of monitoring	• 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* **AREA 3B** **Cliffs** All mapped cliff sites in subsidence area *Refer to Dendrobium Area 3B SMP Figures 18.1for location of sites*	***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, or has been previously identified as Level 1, but is not likely to naturally stabilise within the monitoring period	• *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 environmental and 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*
	Level 3 * • Major cliff collapse where the characteristics of the cliff change significantly and there is significant	• *Actions as stated for Level 2* • Immediately notify DPIE, DPIM, WaterNSW, resource managers and relevant technicalspecialists and seek advice on any CMA required

Monitoring	Trigger	Action
	ground disturbance that is unlikely to naturally stabilise within themonitoring 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	• 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 environmental and 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

Monitoring	Trigger	Action
		• 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

9. APPENDIX B – CORRECTIVE MANAGEMENT ACTIONS

Site/ Impact ID	Trigger Level	Identification Date	Impact type	Exceeding predictions?	Corrective management actions completed	Corrective management actions yet to be implemented	Outcomes (For Level 2 and above)
DA3A_LW19_001	1	3/08/2022	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_002	2	3/08/2022	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • 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		No specific CMAs (Prior to V2 Reports being prepared)
DA3A_LW19_003	2	16/08/2022	Iron Staining	No	• Continue monitoring program • Submit an Impact Report to BCD, DPE, DRG, Water NSW • Report in the EOP Report • Summarise actions and monitoring in AEMR • Review monitoring frequency • Submit letter report to DPE, DRG and WaterNSW and seek advice on any CMA required • Implement agreed CMAs as approved (subject to agency feedback)		No specific CMAs (Prior to V2 Reports being prepared)

DA3A_LW19_004	1	19/08/2022	Rock Fracturing and Fragmentation	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_005	1	19/08/2022	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_006	2	31/08/2022	Soil Cracking	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • 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		No specific CMAs (Prior to V2 Reports being prepared)
DA3A_LW19_007	1	18/10/2022	Soil Cracking	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_008	1	7/11/2022	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_009	1	7/11/2022	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		

DA3A_LW19_010	1	7/11/2022	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_011	1	7/11/2022	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_012	1	7/11/2022	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_013	2	7/11/2022	Rock Fracturing and Rock Movement	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • 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		No specific CMAs (Prior to V2 Reports being prepared)
DA3A_LW19_014	1	7/11/2022	Rock Movement	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_015	2	7/11/2022	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		No specific CMAs (Prior to V2 Reports being prepared)

					• 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		
DA3A_LW19_016	2	7/11/2022	Rock Fracturing and Rockfall	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • 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		No specific CMAs (Prior to V2 Reports being prepared)
DA3A_LW19_017	1	13/12/2022	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_018	1	13/12/2022	Rock Displacement	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_019	1	13/12/2022	Rock Displacement	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		

DA3A_LW19_020	2	13/12/2022	Soil Cracking	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • 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		No specific CMAs (Prior to V2 Reports being prepared)
DA3A_LW19_021	2	13/12/2022	Soil Cracking and Rock Displacement	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • 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		No specific CMAs (Prior to V2 Reports being prepared)
DA3A_LW19_022	2	13/12/2022	Soil Cracking, Rock Fracturing and Rock Displacement	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Provide safety signage and barricades as appropriate		No specific CMAs (Prior to V2 Reports being prepared)

					• Implement approved repairs to ensure safety and serviceability on fire trails Implement agreed CMAs as approved		
DA3A_LW19_023	1	13/12/2022	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_024	2	20/12/2022	Rock Fracturing and Soil Cracking	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • 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		No specific CMAs (Prior to V2 Reports being prepared)
DA3A_LW19_025	1	20/12/2022	Rock Displacement	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_026	1	21/12/2022	Soil Cracking	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_015 (Update)	2	7/11/2022	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • Review monitoring frequency		No specific CMAs (Prior to V2 Reports being prepared)

					• 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		
DA3A_LW19_016 (Update)	2	7/11/2022	Rock Fracturing, Fragmentation and Rockfall	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • 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		No specific CMAs (Prior to V2 Reports being prepared)
S148_01	3	22/12/2022	Soil Moisture	No	• Upfront mine planning • Soil moisture monitoring • Reporting • Update future predictions		No specific CMAs (Prior to V2 Reports being prepared)
DA3A_LW19_027	1	10/01/2023	Rock Fracturing and Rockfall	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_028	1	6/02/2023	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_029	1	18/01/2023	Gas Release	No	• Continue monitoring program		

					• Submit an Impact Report to BCD, DPE, DRG, Water NSW • Report in the EOP Report • Summarise actions and monitoring in AEMR		
DA3A_LW19_025 (Update)	1	20/12/2022, 17/01/2022 (update)	Rock Displacement, Rock Fracturing and Soil Cracking	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_030	2	15/02/2023	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • 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		No specific CMAs (Prior to V2 Reports being prepared)
DA3A_LW19_031	1	15/02/2023	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_032	1	15/02/2023	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_033	1	15/02/2023	Rockfall	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW.		

					• Report in the EOP Report and AR		
DA3A_LW19_034	1	15/02/2023	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
35b_01	3	27/02/2023	Groundwater	No	• Upfront mine planning • Groundwater monitoring • Implementation of Swamp Rehabilitation and Research Program • Reporting • Update future predictions		• The report was re-issued following agency consultation • Advised groundwater technical specialist to reassess groundwater impacts with results to be included in the EOP Report. • Data provisions supplied to BCD • Swamp monitoring continuing as per SRRP under the SIMMCP
DA3A_LW19_035	2	16/03/2023	Soil Cracking	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • 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		• The report was re-issued following agency consultation • No further actions were required
DA3A_LW19_036	1	21/03/2023	Soil Cracking	No	• Continue monitoring program • Impact Report submitted to key stakeholders • Impacts and reports summarised in the EOP and AR		

DA3A_LW19_037	1	28/03/2023	Rock Fracturing and Rockfall	No	**From the Landscape TARPs** • Continue monitoring program • Impact Report submitted to key stakeholders • Impacts and reports summarised in the EOP and AR		
	2				**From the Cultural Heritage TARPs** • Continue monitoring program • Condition assessment and photogenic record • Notify RAPs and Heritage NSW within 24 hours of any confirmed changes to the conditions of Aboriginal cultural heritage sites. • Summarise impacts and report in the EOP Report and AR. • Modify monitoring program if necessary • Trigger the development of site management plan to mitigate effects in consultation with Registered Aboriginal Parties and Landowner (WaterNSW) • Notify RAP's of impacts caused from mining • Notify Heritage NSW and complete Aboriginal Site Impact Recording Forms (ASIRF) for impacted sites.		• The report was re-issued following agency consultation • Develop a plan showing the location of all subsidence related impacts in Dendrobium Areas 3A and 3B, to be provided in the EOP Report. • Field visits to Longwall 19 Aboriginal Cultural Heritage Sites within study area undertaken with RAPs and representatives of the ILALC on 26-28 April 2023. • Compliance with requirements under the NPWS act and to continue to seek advice from Heritage NSW.
DA3A_LW19_038	1	28/03/2023	Rock Fracturing and Rockfall	No	**From the Landscape TARPs** • Continue monitoring program • Impact Report submitted to key stakeholders • Impacts and reports summarised in the EOP and AR		
	2				**From the Cultural Heritage TARPs** • Continue monitoring program • Condition assessment and photogenic record • Notify RAPs and Heritage NSW within 24 hours of any confirmed changes to the conditions of Aboriginal cultural heritage sites.		• The report was re-issued following agency consultation • Develop a plan showing the location of all subsidence related impacts in Dendrobium Areas 3A and 3B, to be provided in the EOP Report.

					• Summarise impacts and report in the EOP Report and AR. • Modify monitoring program if necessary • Trigger the development of site management plan to mitigate effects in consultation with Registered Aboriginal Parties and Landowner (WaterNSW) • Notify RAP's of impacts caused from mining • Notify Heritage NSW and complete Aboriginal Site Impact Recording Forms (ASIRF) for impacted sites.		• Field visits to Longwall 19 Aboriginal Cultural Heritage Sites within study area undertaken with RAPs and representatives of the ILALC on 26-28 April 2023. • Compliance with requirements under the NPWS act and to continue to seek advice from Heritage NSW.
DA3A_LW8_003 (Update)	1	12/04/2023	Rock Fracturing, Rockfall and Fragmentation	No	• Continue monitoring program • Submit an Impact Report to BCD, DPE, DRG, Water NSW • Report in the EOP Report Summarise actions and monitoring in AEMR		
DA3A_LW19_039	1	12/04/2023	Rockfall	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_040	1	12/04/2023	Rockfall and Fragmentation	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_041	2	12/04/2023	Rockfall	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required		• The report was re-issued following agency consultation • No further actions were required

					• Provide safety signage and barricades as appropriate • Implement approved repairs to ensure safety and serviceability on fire trails • Implement agreed CMAs as approved		
DA3A_LW19_042	1	12/04/2023	Rockfall and Fragmentation	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_043	2	17/04/2023	Rock Fracturing and Uplift	No	• Continue monitoring program • Submit an Impact Report to BCD, DPE, DRG, Water NSW • Report in the EOP Report • Summarise actions and monitoring in AEMR • Review monitoring frequency • Submit letter report to DPE, DRG and WaterNSW and seek advice on any CMA required • Implement agreed CMAs as approved (subject to agency feedback)		• The report was re-issued following agency consultation • No further actions were required
DA3A_LW19_044	1	19/04/2023	Iron Staining	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_045	1	26/04/2023	Iron Staining	No	• Continue monitoring program • Submit an Impact Report to BCD, DPE, DRG, Water NSW • Report in the EOP Report • Summarise actions and monitoring in AEMR		
DA3A_LW19_046	1	27/04/2023	Rockfall	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW.		

					• Report in the EOP Report and AR		
DA3A_LW19_047	1	27/04/2023	Rockfall	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_048	1	27/04/2023	Rock Fracturing and Rock Movement	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_049	1	27/04/2023	Soil Cracking	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_050	2	27/04/2023	Soil Cracking	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • 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		• The report was re-issued following agency consultation • Erected caution tape and signage at location of the crack on the closed vehicle access track • No further actions were required
DA3A_LW19_051	1	04/05/2023	Rock Fracturing	No	• Continue monitoring program • Submit an Impact Report to BCD, DPE, DRG, Water NSW • Report in the EOP Report • Summarise actions and monitoring in AEMR		

DA3A_LW19_052	1	04/05/2023	Rock Fracturing and Rockfall	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_053	1	04/05/2023	Rock Fracturing and Rockfall	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_054	1	04/05/2023	Rock Fracturing and Fragmentation	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_055	1	04/05/2023	Rock Fracturing and Rockfall	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_056	2	05/05/2023	Rock Fracturing and Rockfall	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • 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		Awaiting Agency Feedback
DA3A_LW19_057	1	05/05/2023	Rockfall	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		

DA3A_LW19_058	1	05/05/2023	Rock Fracturing and Fragmentation	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_059	1	05/05/2023	Rock Fracturing and Fragmentation	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_060	1	05/05/2023	Rock Fracturing, Displacement and Rockfall	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_061	2	05/05/2023	Rock Fracturing and Soil Cracking	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR • 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		Awaiting Agency Feedback
DA3A_LW19_062	1	05/05/2023	Rock Fracturing	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		
DA3A_LW19_063	1	10/05/2023	Rock Movement	No	• Continue monitoring program • Submit Impact Report to DPE, BCD, RR and WaterNSW. • Report in the EOP Report and AR		

Swamp 15b	2	29/05/2023	Soil Moisture	No	• Upfront mine planning • Soil moisture monitoring • Reporting • Update future predictions		Awaiting Agency Feedback
Swamp 15a	1	12/07/2023	Shallow Groundwater	No	• Upfront mine planning • Groundwater monitoring • Reporting • Update future predictions		
Swamp 15a	2	12/07/2023	Soil Moisture	No	• Upfront mine planning • Soil moisture monitoring • Reporting • Update future predictions		Awaiting Agency Feedback