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South32

Illawarra Metallurgical Coal

SOUTH32 ILLAWARRA METALLURGICAL COAL:

Dendrobium – Area 3B – Longwall 16

End of Panel Subsidence Monitoring Review Report for Dendrobium Longwall 16

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Associated reports:

WKA77 (January 2001) – Dendrobium Mine Project – Report on the prediction of mining subsidence parameters and the assessment of impacts on surface infrastructure – Longwalls 1 to 18 (in support of the EIS).

MSEC311 (October 2007) – The prediction of subsidence parameters and the assessment of mine subsidence impacts on natural features and surface infrastructure resulting from the extraction of proposed Longwalls 6 to 10 in Area 3A and future longwalls in Areas 3B and 3C at Dendrobium Mine (in support of the SMP Application and the Modification to the Development Consent).

MSEC459 (September 2012) – Dendrobium Area 3B – Longwalls 9 to 18 – subsidence predictions and impact assessments for natural features and surface infrastructure in support of the SMP Application.

MSEC792 (December 2015) – Dendrobium Area 3B – Longwalls 12 to 18 – Review of the subsidence predictions and impact assessments for natural and built features in Dendrobium Area 3B based on observed movements and impacts during Longwalls 9 and 10.

MSEC865 (November 2016) – The effects of the proposed modifications to the ends of Longwalls 12 to 18 in Area 3B at Dendrobium Mine on the subsidence predictions and impact assessments.

MSEC914 (August 2017) – The effects of the proposed modified commencing ends of Longwalls 15 to 18 in Area 3B at Dendrobium Mine on the subsidence predictions and impact assessments.

Background reports available at *www.minesubsidence.com*:

Introduction to Longwall Mining and Subsidence (Revision A)

General Discussion of Mine Subsidence Ground Movements (Revision A)

Mine Subsidence Damage to Building Structures (Revision A)

CONTENTS

1.0 BACKGROUND **1**

1.1. Introduction 1

1.2. Mining geometry 1

2.0 COMPARISONS BETWEEN THE MEASURED AND PREDICTED SUBSIDENCE MOVEMENTS **3**

2.1. Introduction 3

2.2. Wongawilli Creek closure lines 3

2.3. Avon Dam closure lines 5

2.4. Dendrobium Area 3B 3D and the Avon Dam 3D monitoring points 7

2.5. LA2 cross lines 8

2.6. WC12 cross line 9

2.7. WC15 cross lines 11

2.8. Swamp cross lines 12

2.9. ALS / LiDAR surveys 13

3.0 COMPARISONS BETWEEN THE OBSERVED AND ASSESSED IMPACTS FOR THE NATURAL AND BUILT FEATURES **18**

3.1. Surface deformations 18

3.2. Natural features 20

3.3. Built features 22

4.0 SUMMARY **23**

APPENDIX A. DRAWINGS **24**

LIST OF TABLES, FIGURES AND DRAWINGS

Tables

Tables are prefixed by the number of the section in which they are presented.

Table No.	*Description*	*Page*
Table 1.1	Mining geometry of the as-extracted longwalls	2
Table 2.1	Survey dates for the Wongawilli Creek closure lines for LW16	3
Table 2.2	Measured and predicted total closure at the Wongawilli Creek closure lines due to the mining of LW6 to LW16	4
Table 2.3	Survey dates for the Avon Dam closure lines during LW16	5
Table 2.4	Maximum measured and maximum predicted accumulated movements for the Avon Dam closure lines due to the mining of LW12 to LW16	6
Table 2.5	Maximum measured and predicted total closure across LA4A, LA4B and the Avon Dam due to the mining of LW9 to LW16	7
Table 2.6	Survey dates for the DA3B 3D monitoring points for LW16	7
Table 2.7	Survey dates for the LA2 cross lines for LW16	8
Table 2.8	Maximum measured and predicted total subsidence and closure at the LA2 RB2-Line due to the mining of part LW15 and LW16	9
Table 2.9	Maximum measured and predicted total subsidence and closure at the LA2 RB13-Line due to the mining of part LW15 and LW16	9
Table 2.10	Survey dates for the WC12 cross line for LW16	10
Table 2.11	Maximum measured and predicted accumulated subsidence and closure at the WC12 RB18-Line due to the mining of part LW15 and LW16	10

Table 2.12 Survey dates for the WC15 cross lines for LW16 11
Table 2.13 Maximum measured and predicted accumulated subsidence and closure at the WC15 RB9-Line due to the mining of LW14 to LW16 12
Table 2.14 Maximum measured and predicted accumulated subsidence and closure at the WC15 RB28-Line due to the mining of LW14 to LW16 12
Table 2.15 Maximum measured and predicted incremental subsidence and closure at the WC15 RB34-Line due to the mining of LW14 to LW16 12
Table 2.16 Survey dates for the SW23-Line during LW16 12
Table 2.17 Maximum measured and predicted total subsidence and closure at the SW23-Line due to the mining of LW14 to LW16 13
Table 3.1 Fracturing sites observed along WC15 attributed to the mining of LW16 19
Table 3.1 Fracturing sites observed adjacent to Den14 attributed to the mining of LW16 19
Table 3.2 Assessed and reported impacts for the natural features due to LW16 20
Table 3.3 Assessed and reported impacts for the built features due to LW16 22

Figures

Figures are prefixed by the number of the section in which they are presented.

Figure No.	*Description*	*Page*
Fig. 1.1	Surface and seam levels along the centreline of LW16	2
Fig. 2.1	Development of total closure for the Wongawilli Creek closure lines	4
Fig. 2.2	Measured and predicted total closure along Wongawilli Creek after LW16	4
Fig. 2.3	Measured and predicted accumulated closure for the Avon Dam closure lines	5
Fig. 2.4	Measured accumulated closure for Tributaries LA4A and LA4B and the Avon Dam	6
Fig. 2.5	Measured incremental horizontal movements at Dendrobium Mine	8
Fig. 2.6	Measured total closure for the LA2 cross lines due part LW15 and LW16	9
Fig. 2.7	Measured accumulated closure for the WC12 cross line due to part LW15 and LW16	10
Fig. 2.8	Measured accumulated closure for the WC15 cross lines due to LW14 to LW16	11
Fig. 2.9	Measured incremental changes in surface level due to the mining LW16	13
Fig. 2.10	Measured total changes in surface level due to the mining of LW9 to LW16	14
Fig. 2.11	Measured changes in surface level and predicted vertical subsidence along Cross-section 1	15
Fig. 2.12	Measured changes in surface level and predicted vertical subsidence along Cross-section 2	15
Fig. 2.13	Measured changes in surface level and predicted vertical subsidence along Cross-section 3	16
Fig. 2.14	Measured changes in surface level and predicted vertical subsidence along Long-section 1	16
Fig. 3.1	Surface deformations due to the mining of LW16	18
Fig. 3.2	Rock fractures identified along WC15 and adjacent to Den14	19

Drawings

Drawings referred to in this report are included in Appendix A at the end of this report.

Drawing No.	*Description*	*Revision*
MSEC1155-01	General layout and monitoring lines	01
MSEC1155-02	Natural features	01
MSEC1155-03	Built features	01
MSEC1155-04	Measured incremental horizontal movement vectors due to LW16	01

1.1. Introduction

Illawarra Metallurgical Coal (IMC) has completed the extraction of Longwall 16 (LW16) at Dendrobium Mine, which is in the Southern Coalfield of New South Wales. The locations of the longwalls in Area 3B at Dendrobium Mine are shown in Drawing No. MSEC1155-01, in Appendix A. The extraction of LW16 commenced on 25 February 2020 and it was completed on 4 November 2020.

Mine Subsidence Engineering Consultants (MSEC) was previously commissioned by IMC to prepare subsidence predictions and impact assessments for Dendrobium Longwalls 9 to 18 (LW9 to LW18) in Area 3B. Report No. MSEC459 (Revision B) was issued in September 2012 in support of the SMP Application for these longwalls.

IMC then shortened the finishing (i.e. eastern) end of LW16 by 281 m and shortened the commencing (i.e. western) end by 71 m from the extents that were indicated in the SMP Application. The maximum height of extraction in the Wongawilli Seam for LW15 to LW18 was also reduced from 4.6 m to 3.9 m. Reports Nos. MSEC865 (Rev. A) and MSEC914 (Rev. A) were issued in support of the applications for these modifications. The Subsidence Management Plan for LW16 was approved by the Department of Planning and Environment on the 16 December 2016.

The subsidence prediction model was reviewed and re-calibrated, based on the updated monitoring data from LW7 and LW8 in Area 3A and LW9 and LW10 in Area 3B. The subsidence predictions and impact assessments for the natural and built features were reviewed and updated based on the re-calibrated subsidence model and are provided in Report No. MSEC792 (Rev. C). The predictions provided in this End of Panel subsidence review report are based on the re-calibrated subsidence prediction model outlined in Reports Nos. MSEC792 and MSEC865.

In accordance with Condition 9 End of Panel Reporting of the Development Consent (Schedule 3) for the Area 3B longwalls, this report provides:

- comparisons between the measured and predicted subsidence effects at the monitoring lines and points in Dendrobium Area 3B due to the mining of LW16; and
- comparisons between the observed and predicted effects and impacts on the natural and built features within the SMP Area due to the mining of LW16.

Further details on the observed and assessed impacts for natural features, due to the mining of LW16, are provided in the reports by other consultants. The discussions provided in this report should be read in conjunction with those and all other relevant reports.

Chapter 2 of this report describes the locations of the ground monitoring lines and points which were surveyed during the mining of LW16. This section also provides comparisons between the measured and predicted effects due to the mining of this longwall.

Chapter 3 of this report describes the natural and built features near LW16. This section also provides comparisons between the observed and assessed impacts for these features due to the mining of this longwall. Further discussions on the observed and assessed impacts for natural features are provided in reports by other consultants.

Chapter 4 of this report provides a summary of the comparisons between the measured and predicted ground movements and the observed and assessed surface impacts due to the mining of LW16.

Appendix A includes all drawings associated with this report.

1.2. Mining geometry

The layout of the longwalls in Area 3B at Dendrobium Mine is shown in Drawing No. MSEC1155-01, in Appendix A. A summary of the as-extracted dimensions for LW9 to LW16 is provided in Table 1.1.

Table 1.1 Mining geometry of the as-extracted longwalls

Location	Longwall	Overall void length including installation heading (m)	Overall void width including first workings (m)	Overall tailgate chain pillar width (m)
Area 3B	LW9	2162	305	-
	LW10	2219	305	45
	LW11	2204	305	45
	LW12	2602	305	45
	LW13	2223	305	45
	LW14	1980	305	45
	LW15	1963	305	45
	LW16	1874	305	45

The mined lengths of the longwalls excluding the installation headings are approximately 9 m shorter than the overall void lengths provided in Table 1.1. The length of extraction for LW16, therefore, is approximately 1865 m. The longwall face widths excluding the first workings are approximately 294 m.

The longwalls in Area 3B have been extracted from the Wongawilli Seam, from the west towards the east, i.e. towards Wongawilli Creek. The natural surface and the seam levels along the centreline of LW16 are illustrated in Fig. 1.1.

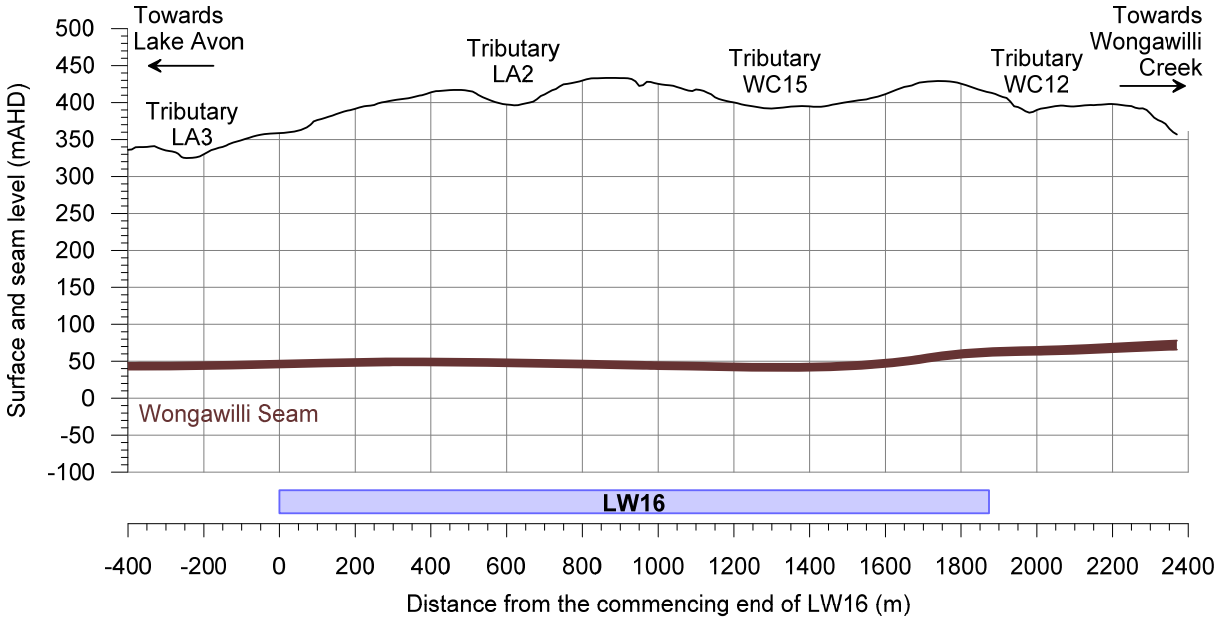

Fig. 1.1 Surface and seam levels along the centreline of LW16

The depth of cover to the Wongawilli Seam, directly above LW16, varies between a minimum of 305 m near the commencing (i.e. western) end of the longwall, and a maximum of 390 m near the middle of the longwall. The seam floor within the mining area generally dips from the south to the north, having an average dip around 2 %, or 1 in 50.

The extraction height varies along the length of LW16, depending on the local roof conditions, with a maximum mining height of 3.9 m. The predictions provided in this report have been based on the maximum proposed extraction height of 3.9 m, as adopted in Reports Nos. MSEC459, MSEC792 and MSEC865.

2.1. Introduction

The mine subsidence effects due to the mining of Dendrobium LW16 were monitored along several monitoring lines and monitoring points including the following:

- Wongawilli Creek closure lines;
- Avon Dam closure lines;
- Area 3B and Avon Dam 3D monitoring points;
- Tributary cross lines;
- Swamp cross lines; and
- Airborne laser scans of the area.

The locations of these survey lines and survey points are shown in Drawing No. MSEC1155-01, in Appendix A. Comparisons between the measured and predicted subsidence effects at these monitoring lines and points are provided in the following sections. The predicted subsidence effects have been obtained using the re-calibrated subsidence model presented in Reports Nos. MSEC792 and MSEC865.

2.2. Wongawilli Creek closure lines

The closure movements across Wongawilli Creek have been measured by IMC using 2D survey techniques at the Wong X C-Line, Wong X D-Line and Wong X E-Line. The Wong X A-Line and Wong X B-Line were not measured at the completion of LW16 due to their distances from this longwall.

The locations of the Wongawilli Creek closure lines are shown in Drawing No. MSEC1155-01. The survey dates for these monitoring lines are provided in Table 2.1.

Table 2.1 Survey dates for the Wongawilli Creek closure lines for LW16

Mining phase commitments	Mining phase survey dates	Post mining phase commitments
Completion of LW16	13 February 2013 (base survey) 4 March 2016 (end of LW11) 28 April 2017 (end of LW12) 14 June 2018 (end of LW13) 28 March 2019 (end of LW14) 28 March 2020 (end of LW15) 10 December 2020 (end of LW16)	Completion of each of the future longwalls in Area 3B

The monitoring lines each comprise two survey marks, with the marks located on either side of Wongawilli Creek and, therefore, they measure closure between the valley sides. Survey marks could not be located near the base of the valley due to the difficult terrain. The upsidence in the base of the valley, therefore, could not be measured.

The development of total closure for the Wongawilli Creek closure lines, due to the mining of LW6 to LW16, is illustrated in Fig. 2.1. The base survey for the Wong X D-Line was carried out after the completion of LW12 and, therefore, this line measured the additional movements due to LW13 to LW16 only. The base survey for the Wong X E-Line was carried out after the completion of LW14 and, therefore, this line measured the additional movements due to LW15 and LW16 only.

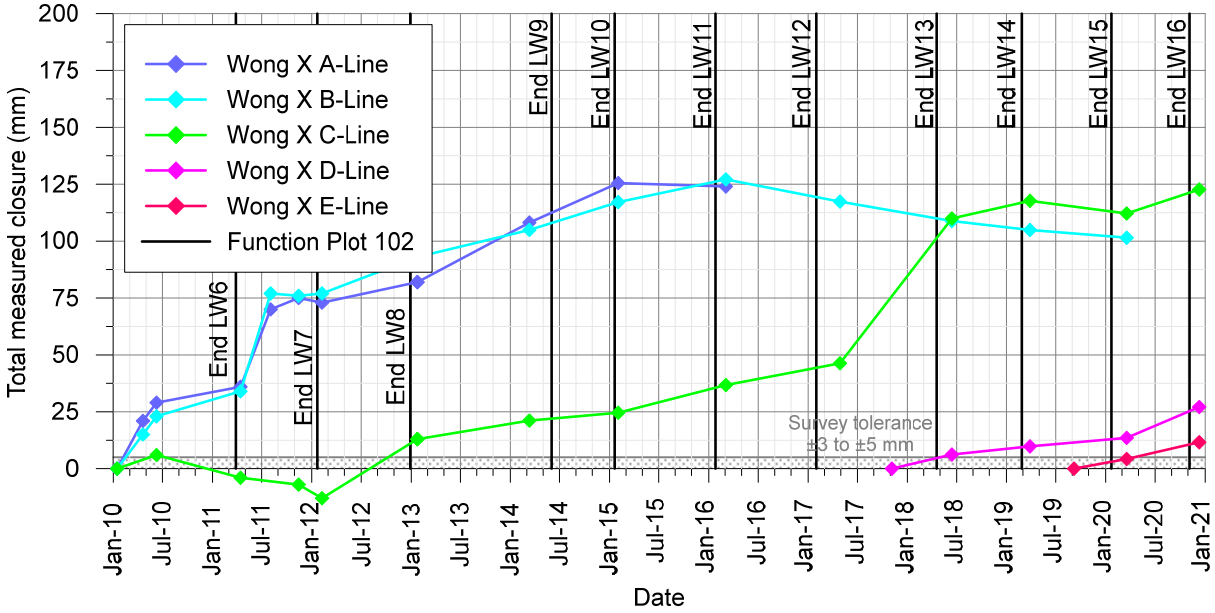

Fig. 2.1 Development of total closure for the Wongawilli Creek closure lines

The predictions of vertical subsidence, upsidence and closure for Wongawilli Creek, due to the mining of Dendrobium LW6 to LW19, were provided in Report No. MSEC865. The measured and predicted total closures along Wongawilli Creek after the completion of LW16 are illustrated in Fig. 2.2.

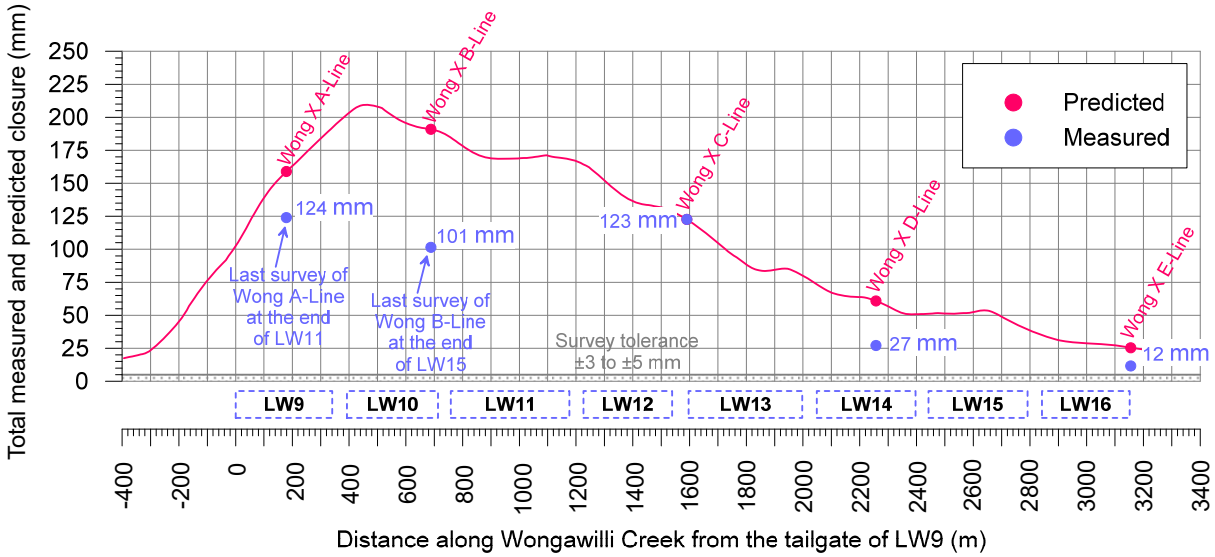

Fig. 2.2 Measured and predicted total closure along Wongawilli Creek after LW16

A summary of the maximum measured and maximum predicted total closure movements for each of the Wongawilli Creek closure lines, due to the mining of LW6 to LW16, is provided in Table 2.2. The predicted total closures consider the shortened finishing ends of LW11, LW12, LW14, LW15 and LW16.

Table 2.2 Measured and predicted total closure at the Wongawilli Creek closure lines due to the mining of LW6 to LW16

Location	Longwalls	Measured total closure (mm)	Predicted total closure (mm)
Wong X A-Line	LW6 to LW11	124	160
Wong X B-Line	LW6 to LW15	101	190
Wong X C-Line	LW6 to LW16	123	120
Wong X D-Line	LW13 to LW16	27	60
Wong X E-Line	LW15 and LW16	12	30

The accuracies of the measured closure movements are in the order of ±5 mm.

The measured total closure at the Wong X C-Line of 123 mm is similar to but slightly greater than the predicted total closure of 120 mm. The exceedance of 3 mm represents less than 3 % of the predicted value and it is in the order of survey tolerance. The maximum measured total closures at the remaining Wongawilli Creek closure lines are less than the predicted values at the completion of LW16.

It is considered that the movements measured using the Wongawilli Creek closure lines are reasonably consistent with the predictions provided in Reports Nos. MSEC792 and MSEC865.

2.3. Avon Dam closure lines

The closure across the Avon Dam has been measured by IMC using the Avon Dam A-Line to E-Line. The locations of these monitoring lines are shown in Drawing No. MSEC1155-01. The discussions on the Avon Dam 3D monitoring points are included in Section 2.4.

The survey dates for the Avon Dam closure lines are provided in Table 2.3. The base surveys were carried out just prior to the commencement of LW12 and, therefore, the closure lines have measured the accumulated movements due to the mining of LW12 to LW16.

Table 2.3 Survey dates for the Avon Dam closure lines during LW16

Mining phase commitments	Mining phase survey dates	Post mining phase commitments
Completion of LW16	12 February 2016 (base survey) 30 August 2016 (end of LW12) 23 May 2018 (end of LW13) 2 April 2019 (end of LW14) 5 February 2020 (end of LW15) 20 May 2020 23 July 2020 9 October 2020 9 December 2020 (end of LW16)	Completion of each of the future longwalls in Area 3B

The monitoring lines each comprise two survey marks, with the marks located on either side of the Avon Dam and, therefore, they measure closure or opening between the valley sides. Survey marks could not be located near the base of the valley due to the stored water in the dam. The upsidence in the base of the valley, therefore, could not be measured.

The development of the measured accumulated movements across the Avon Dam closure lines during the mining of LW12 to LW16 are illustrated in Fig. 2.3. The mining of LW16 has resulted in a 2 mm decrease in the closure measured at the A-Line, a 5 mm decrease in the opening measured at the B-Line and increased openings ranging between 2 mm and 12 mm at the remaining monitoring lines.

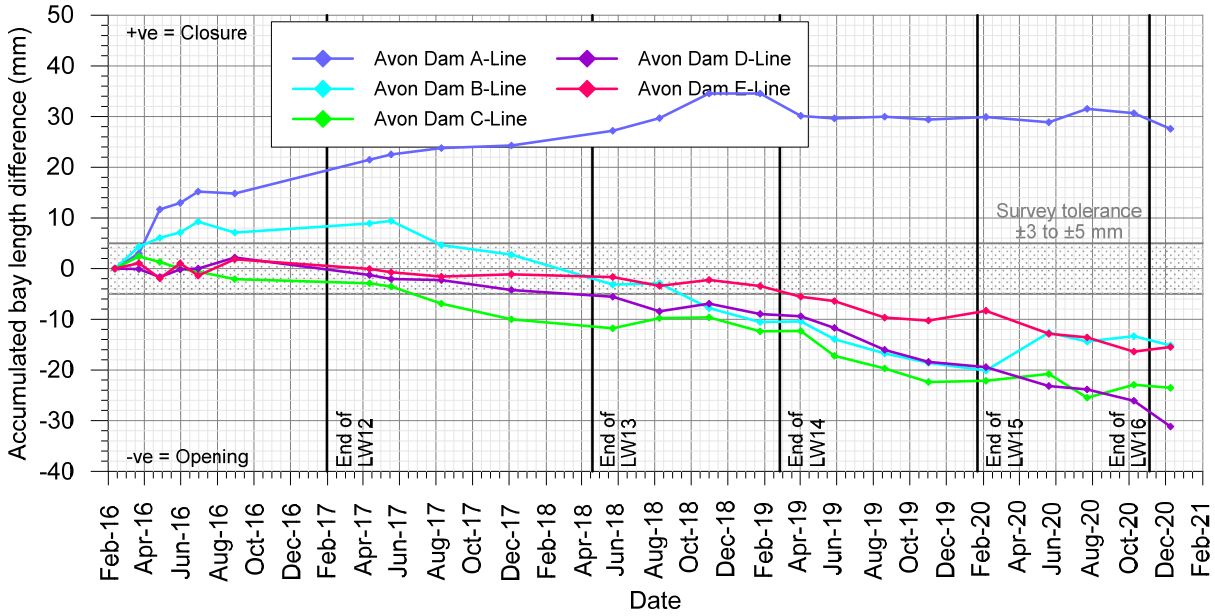

Fig. 2.3 Measured and predicted accumulated closure for the Avon Dam closure lines

A summary of the maximum measured and maximum predicted accumulated movements for each of the Avon Dam closure lines, due to the mining of LW12 to LW16, is provided in Table 2.2. The predicted closures due to the earlier extracted LW9 to LW11 are negligible, i.e. less than 20 mm. The measured values are based on the latest survey dated 9 December 2020. The vertical subsidence was not measured using these monitoring lines.

Table 2.4 Maximum measured and maximum predicted accumulated movements for the Avon Dam closure lines due to the mining of LW12 to LW16

Location	Measured accumulated closure (mm)	Predicted accumulated closure (mm)
Avon Dam A-Line	28	70
Avon Dam B-Line	-15 (opening)	90
Avon Dam C-Line	-24 (opening)	90
Avon Dam D-Line	-31 (opening)	30
Avon Dam E-Line	-15 (opening)	< 20

The accuracies of the measured closure movements are in the order of ±5 mm.

The measured total closure at the Avon Dam A-Line is less than the predicted value at the completion of LW16. Net opening movements have been measured at the Avon Dam B-Line to E-Line due to the conventional subsidence effects (i.e. horizontal movements towards the mining area) being greater that the valley-related effects (i.e. closure). The magnitudes of the measured opening movements are similar to or less than the magnitudes of the predicted closure movements.

The movements across Avon Dam and two tributaries to the dam (Refs. LA4A and LA4B) have also been measured by IMC using the Avon Dam GPS (Marks Den3B-05A, Den3B-06 and Den3B-07). The base survey was carried out on the 26 February 2013, i.e. prior to the commencement of LW9. Subsequent surveys were carried out on the same dates as the Avon Dam closure lines, as summarised in Table 2.3.

The development of the measured accumulated movements across LA4A (Den3B-06 to Den3B-07), LA4B (Den3B-05A to Den3B-06) and the Avon Dam (Den3B-05A to Den3B-07) during the mining of LW12 to LW16 are illustrated in Fig. 2.4. The extraction of LW16 has resulted in negligible change (i.e. less than 2 mm) in the closure measured at the LA4A monitoring line and increased openings ranging between 9 mm to 24 mm at the LA4B and Avon Dam monitoring lines, respectively.

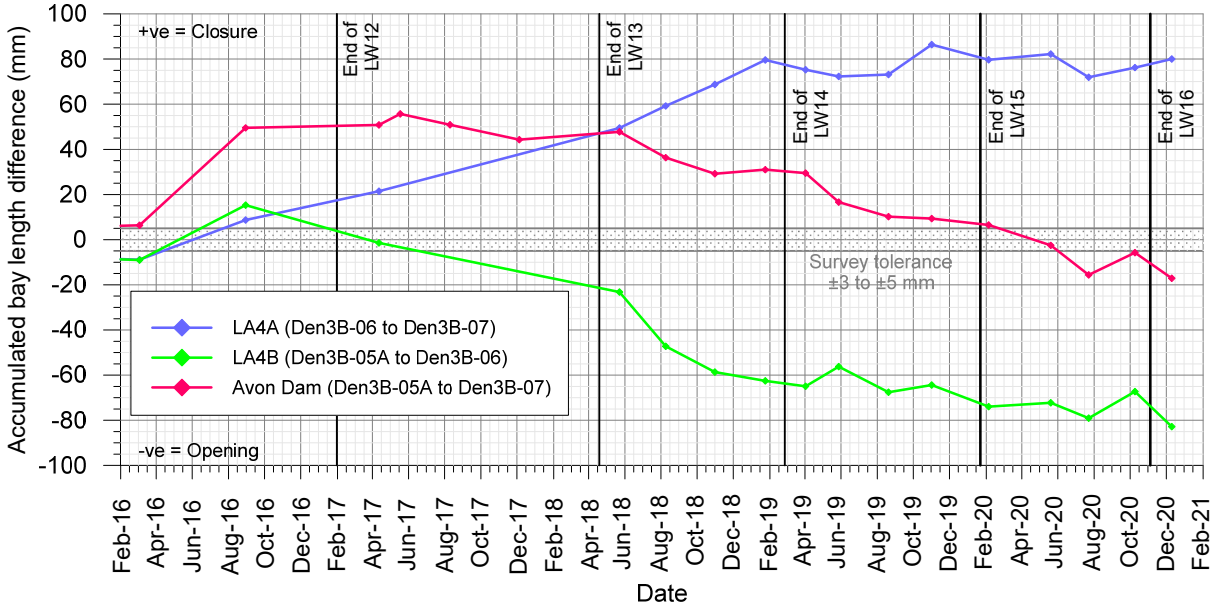

Fig. 2.4 Measured accumulated closure for Tributaries LA4A and LA4B and the Avon Dam

A summary of the total measured and total predicted closures across LA4A, LA4B and Avon Dam, due to the mining of LW9 to LW16, is provided in Table 2.5. The measured values are based on the latest survey dated 9 December 2020. The vertical subsidence was not measured using these monitoring lines.

Table 2.5 Maximum measured and predicted total closure across LA4A, LA4B and the Avon Dam due to the mining of LW9 to LW16

Location	Measured accumulated closure (mm)	Predicted accumulated closure (mm)
LA4A (Den3B-06 to Den3B-07)	80	170
LA4B (Den3B-05A to Den3B-06)	-83 (opening)	170
Avon (Den3B-05A to Den3B-07)	-17 (opening)	80

The accuracies of the measured closure movements are in the order of ±5 mm.

The measured total closure at the LA4A monitoring line is less than the predicted value at the completion of LW16. Net opening movements have been measured at the LA4B and Avon monitoring lines due to the conventional subsidence effects (i.e. horizontal movements towards the mining area) being greater that the valley-related effects (i.e. closure). The magnitudes of the measured opening movements are less than the magnitudes of the predicted closure movements.

The maximum measured total closure across Lake Avon is less than the maximum predicted value at the completion of LW16. It is considered that the ground movements measured using these monitoring lines are consistent with the predictions provided in Reports Nos. MSEC792 and MSEC865.

2.4. Dendrobium Area 3B 3D and the Avon Dam 3D monitoring points

The far-field horizontal movements near LW16 have been measured by IMC using the Dendrobium Area 3B 3D monitoring points (DA3B 3D) and the Avon Dam 3D monitoring points. The locations of these monitoring points are shown in Drawing No. MSEC1155-01.

The survey dates for the DA3B 3D monitoring points for LW16 are provided in Table 2.6. The survey dates and monitoring commitments for the Avon Dam 3D monitoring points are the same as the Avon Dam closure lines provided in Table 2.3.

Table 2.6 Survey dates for the DA3B 3D monitoring points for LW16

Mining phase commitments	Mining phase survey dates	Post mining phase commitments
Completion of LW16	26 February 2013 (base survey) 4 March 2016 (end of LW11) 9 March 2017 (end of LW12) 15 May 2018 (end of LW13) 23 April 2019 (end of LW14) 24 April 2020 (end of LW15) 10 December 2020 (end of LW16)	Completion of each of the future longwalls in Area 3B

The measured incremental horizontal movement vectors for DA3B 3D and the Avon Dam 3D monitoring points, due to the mining of LW16, are shown in Drawing No. MSEC1155-04. The accuracies of the measured absolute positions (i.e. eastings and northings) are in the order of ±20 mm.

The vectors of incremental horizontal movement are typically orientated towards LW16 and skewed towards the east, i.e. towards the longwall finishing end, or in the downslope direction. The greatest movements have been measured directly above LW16 and, to lesser extents, above the previously extracted LW15. Only low level incremental horizontal movements have been measured outside the extents of the mining area.

The comparison between the maximum measured incremental horizontal movements at the DA3B 3D and Avon Dam 3D monitoring points with those previously measured in Dendrobium Area 1 (DA1 3D) and Dendrobium Area 2 (DA2 3D), Dendrobium Area 3A (DA3A 3D), as well as other collieries in the Southern Coalfield, is provided in Fig. 2.5. The mean and the 95 % confidence level for the 3D monitoring data at Dendrobium Mine are also shown in this figure.

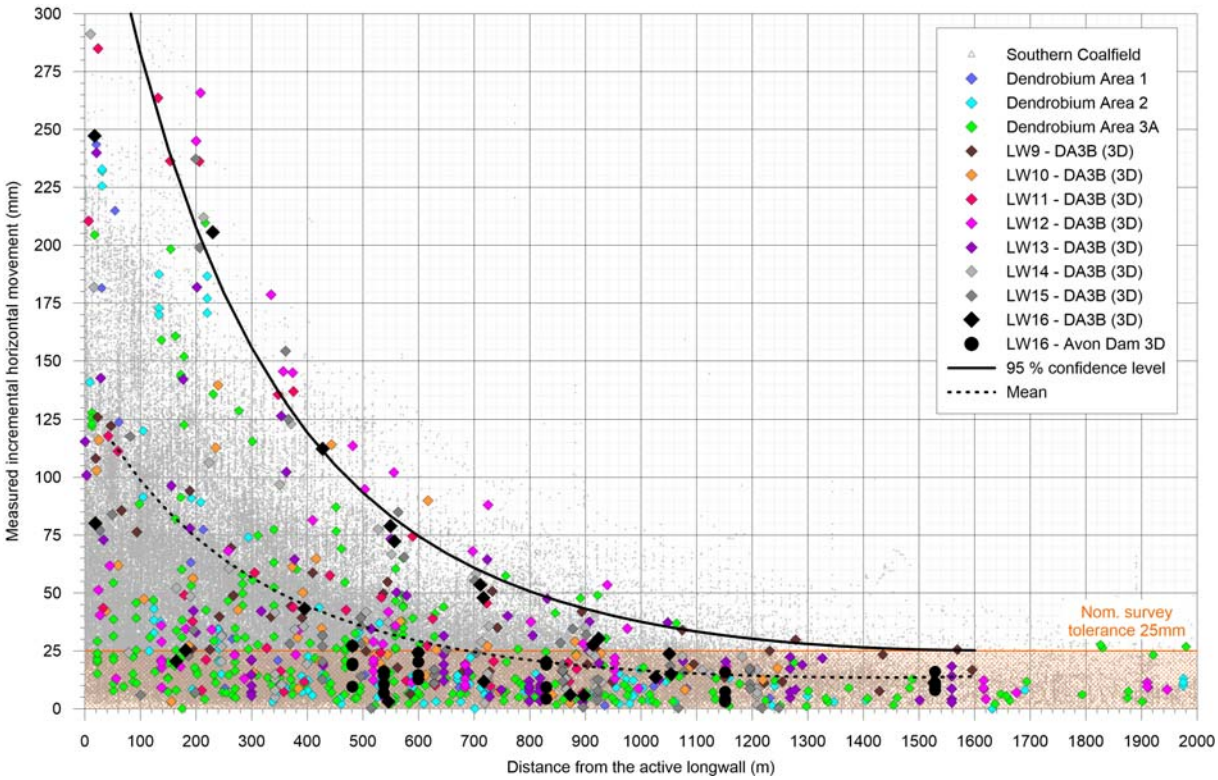

Fig. 2.5 Measured incremental horizontal movements at Dendrobium Mine

The measured incremental horizontal movements due to the mining of LW16 (i.e. black diamonds and circles) are typically within the range of those measured at similar distances from previously extracted longwalls at Dendrobium Mine (i.e. blue, cyan, green, brown, orange, red, magenta, purple and grey diamonds) and elsewhere in the Southern Coalfield (i.e. grey triangles).

2.5. LA2 cross lines

The mine subsidence effects for LA2 (a tributary to Lake Avon) have been measured by IMC using 2D survey techniques using the LA2 RB2-Line and LA2 RB13-Line. The locations of these monitoring lines are shown in Drawing No. MSEC1155-01. The survey dates for the LA2 cross lines for LW16 are provided in Table 2.7.

Table 2.7 Survey dates for the LA2 cross lines for LW16

Mining phase commitments	Mining phase survey dates	Post mining phase commitments
First survey 100 m before lines, then monthly surveys. Final survey when mining 400 m past lines	6 September 2019 (base survey) 9 April 2020 5 May 2020 3 June 2020 1 July 2020 10 December 2020 (end of LW16)	First survey 100 m before lines, then monthly surveys. Final survey when mining 400 m past lines

The development of the measured total closures at the LA2 cross lines are illustrated in Fig. 2.6. These two monitoring lines were established during the mining of LW15 and, therefore, they do not include the effects of LW9 to LW14 and part of LW15. These monitoring lines have short lengths and are located near the valley base and, therefore, they may not measure the maximum closure within the valley.

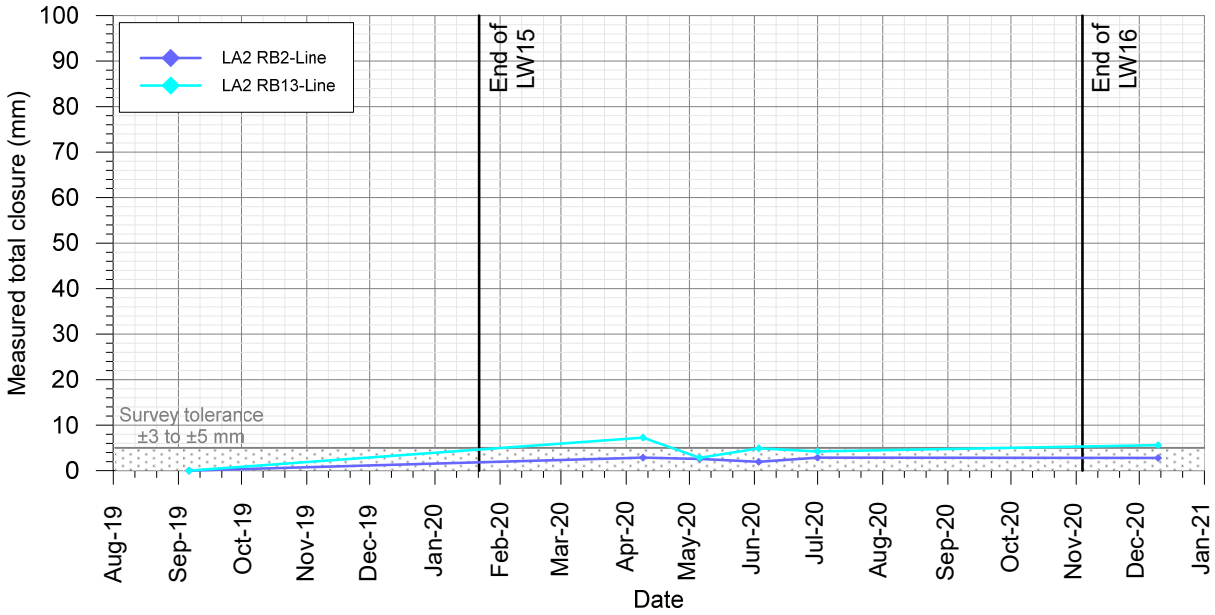

Fig. 2.6 Measured total closure for the LA2 cross lines due part LW15 and LW16

Only low-level closure movements have been measured at the LA2 cross lines due to the mining of part LW15 and LW16. These movements are similar to the order of survey tolerance.

Summaries of the maximum measured and predicted total subsidence and closure at the LA2 cross lines, after the completion of LW16, are provided in Table 2.8 and Table 2.9. The predicted subsidence values have been derived from the predicted subsidence contours illustrated in Report No. MSEC865. The predicted closures are based on a combination of the conventional horizontal movements and valley related movements, taking the equivalent heights of the valleys within half-depths of cover from the valley bases.

Table 2.8 Maximum measured and predicted total subsidence and closure at the LA2 RB2-Line due to the mining of part LW15 and LW16

Type	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	18	3
Predicted	< 20	30

Table 2.9 Maximum measured and predicted total subsidence and closure at the LA2 RB13-Line due to the mining of part LW15 and LW16

Type	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	19	6
Predicted	< 20	110

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.

Only low-level vertical subsidence and closure have been measured at the LA2 RB2-Line and LA2 RB13-Line. The ground movements measured using LA2 cross lines are less than the predictions provided in Reports Nos. MSEC792 and MSEC865.

2.6. WC12 cross line

The mine subsidence effects for WC12 (a tributary to Wongawilli Creek) have been measured by IMC using 2D survey techniques using the WC12 RB18-Line. The location of this monitoring line is shown in Drawing No. MSEC1155-01. The survey dates for the WC12 cross line for LW16 are provided in Table 2.10.

Table 2.10 Survey dates for the WC12 cross line for LW16

Mining phase commitments	Mining phase survey dates	Post mining phase commitments
Monthly once the longwall face is nominally 100 m before the cross line until it is 400 m past	6 September 2019 (base survey) 9 October 2020 12 November 2020 10 December 2020 (end of LW16)	Monthly once the longwall face is nominally 100 m before the cross line until it is 400 m past

The development of the measured accumulated closure at the WC12 cross line is illustrated in Fig. 2.7. The monitoring line was established during the mining of LW15 and, therefore, it does not include the effects of LW9 to LW14 and part of LW15. This monitoring line has a short length and is located near the valley base and, therefore, it may not measure the maximum closure within the valley.

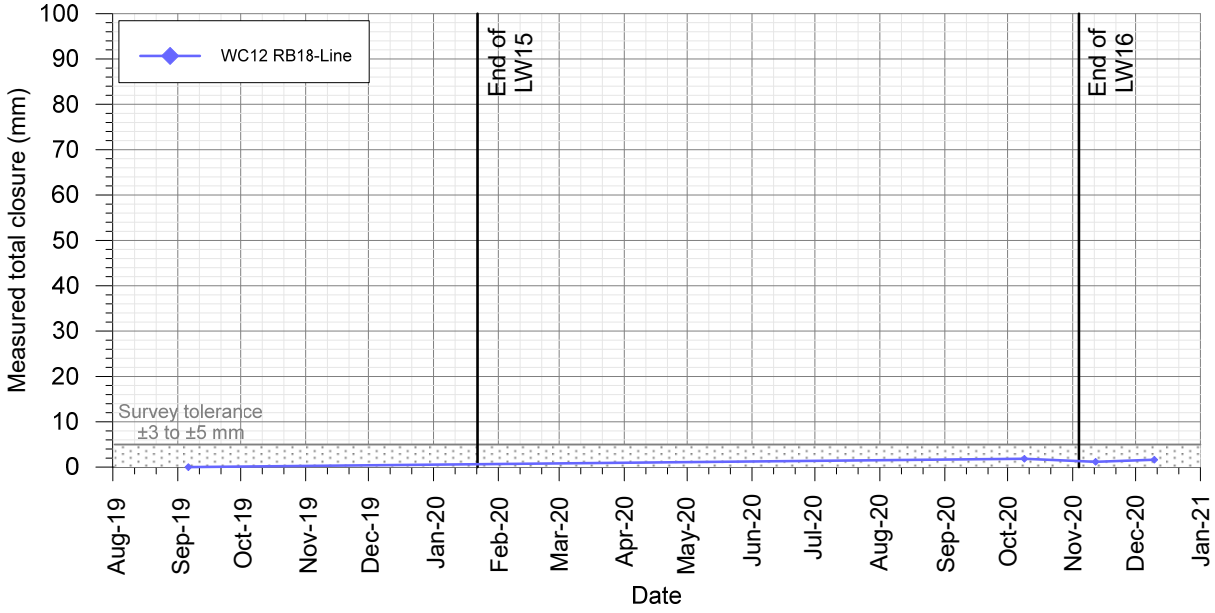

Fig. 2.7 Measured accumulated closure for the WC12 cross line due to part LW15 and LW16

The extraction of LW16 has resulted in negligible change (i.e. less than 2 mm) in the closure measured at the WC12 RB18-Line. The measured movement is in the order of survey tolerance.

A summary of the maximum measured and predicted total subsidence and closure at the WC12 cross line, after the completion of LW16, is provided in Table 2.11. The predicted subsidence value has been derived from the predicted subsidence contours illustrated in Report No. MSEC865. 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 2.11 Maximum measured and predicted accumulated subsidence and closure at the WC12 RB18-Line due to the mining of part LW15 and LW16

Type	Maximum accumulated subsidence (mm)	Maximum accumulated closure (mm)
Measured	-2 (Uplift)	2
Predicted	< ±20	150

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.

Only low-level vertical subsidence and closure have been measured at the WC12 RB18-Line. The ground movements measured using this monitoring line are less than the predictions provided in Reports Nos. MSEC792 and MSEC865.

2.7. WC15 cross lines

The mine subsidence effects for WC15 (a tributary to Wongawilli Creek) have been measured by IMC using 2D survey techniques using the WC15 RB9-Line, WC15 RB28-Line and WC15 RB34-Line. The locations of the WC15 cross lines are shown in Drawing No. MSEC1155-01. The survey dates for these monitoring lines for LW16 are provided in Table 2.12.

Table 2.12 Survey dates for the WC15 cross lines for LW16

Mining phase commitments	Mining phase survey dates	Post mining phase commitments
Monthly once the longwall face is nominally 100 m before the cross line until it is 400 m past	13 December 2018 (base survey) 28 March 2019 (end of LW14) 18 March 2020 (end of LW15) 4 August 2020 3 September 2020 9 October 2020 12 November 2020 10 December 2020 (end of LW16)	Monthly once the longwall face is nominally 100 m before the cross line until it is 400 m past

The development of the measured accumulated closures at the WC15 cross lines are illustrated in Fig. 2.8. The monitoring lines were established during the mining of LW14 and, therefore, they do not include the effects of LW9 to LW13 and part of LW14. These 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.

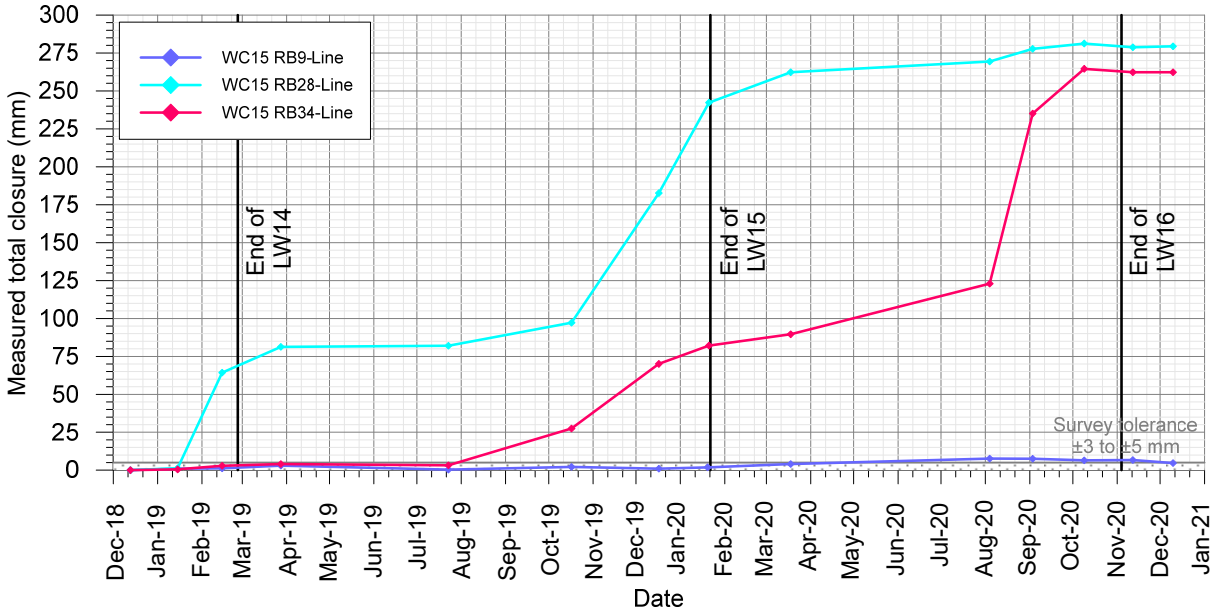

Fig. 2.8 Measured accumulated closure for the WC15 cross lines due to LW14 to LW16

The extraction of LW16 has resulted in negligible change (i.e. less than 2 mm) in the closure measured at the WC15 RB9-Line. The measured closures at the WC15 RB28-Line and W15 RB34-Line increased by 17 mm to 174 mm, respectively, due to the mining of this longwall.

Summaries of the maximum measured and predicted accumulated subsidence and closure at the WC15 closure lines, due to the mining of LW14 to LW16, are provided in Table 2.13 to Table 2.15. The predicted subsidence values have been derived from the predicted subsidence contours illustrated in Report No. MSEC865. The predicted closures are based on a combination of the conventional horizontal movements and valley related movements, taking the equivalent heights of the valleys within half-depths of cover from the valley bases.

Table 2.13 Maximum measured and predicted accumulated subsidence and closure at the WC15 RB9-Line due to the mining of LW14 to LW16

Type	Maximum accumulated subsidence (mm)	Maximum accumulated closure (mm)
Measured	-1 (Uplift)	5
Predicted	< ±20	280

Table 2.14 Maximum measured and predicted accumulated subsidence and closure at the WC15 RB28-Line due to the mining of LW14 to LW16

Type	Maximum accumulated subsidence (mm)	Maximum accumulated closure (mm)
Measured	355	279
Predicted	500	350

Table 2.15 Maximum measured and predicted incremental subsidence and closure at the WC15 RB34-Line due to the mining of LW14 to LW16

Type	Maximum accumulated subsidence (mm)	Maximum accumulated closure (mm)
Measured	658	262
Predicted	1125	430

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 subsidence measured at WC15 RB28-Line and WC15 RB34-Line of 355 mm and 658 mm, respectively, are less than the predicted values. Low-level net uplift was measured at WC15 RB9-Line which is in the order of the survey tolerance for absolute height. The closures measured at the WC15 RB9-Line, WC15 RB28-Line and WC15 RB34-Line are less than their predicted values at the completion of LW16.

The ground movements measured using the WC15 cross lines are less than the predictions provided in Reports Nos. MSEC792 and MSEC865.

2.8. Swamp cross lines

The mine subsidence effects at the swamps and their associated drainage lines have been measured by IMC using 2D survey techniques. Only the SW23-Line across Swamp 23 was measured during the mining of LW16.

The locations of the swamp cross lines are shown in Drawing No. MSEC1155-01. The survey dates for the SW23-Line are provided in Table 2.16.

Table 2.16 Survey dates for the SW23-Line during LW16

Mining phase commitments	Mining phase survey dates	Post mining phase commitments
First survey 100 m before lines then monthly surveys, final survey when mining 400 m past lines	26 June 2018 (base survey) 26 March 2019 (end of LW14) 18 March 2020 (end of LW15) 3 June 2020 11 December 2020 (end of LW16)	First survey 100 m before lines then monthly surveys, final survey when mining 400 m past lines

A summary of the maximum measured and predicted total subsidence and closure for the SW23-Line is provided in Table 2.17. The base survey was carried out after the completion of LW13 and, therefore, the results for this monitoring line are due to LW14 to LW16 only.

The measured values for SW23-Line are based on the latest survey dated 11 December 2020. The predicted subsidence values have been derived from the predicted subsidence contours illustrated in Report No. MSEC865. The predicted closures are based on a combination of the conventional horizontal movements and valley related movements, taking the equivalent heights within half-depths of cover from the valley bases.

Table 2.17 Maximum measured and predicted total subsidence and closure at the SW23-Line due to the mining of LW14 to LW16

Type	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	*Not measured*	5
Predicted	< 20	160

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 total closure measured using the SW23-Line is considerably less than the predicted value provided in Reports Nos. MSEC792 and MSEC865. The vertical subsidence was not measured at this monitoring line.

2.9. ALS / LiDAR surveys

The changes in surface level due to the mining in Area 3B have been measured using Airbourne Laser Scan (ALS) / Light Detection and Ranging (LiDAR) surveys.

The original survey carried out in January 2013 (i.e. prior to the extraction of LW9) does not cover the full extent of LW16. Hence, the survey carried out in January 2016 (i.e. prior to the mining of LW12) has been adopted as the base survey. The post mining surface level contours have been determined from the subsequent surveys carried out in March 2017 after LW12, May 2018 after LW13, March 2019 after LW14, February 2020 after LW15 and November 2020 after LW16.

The measured incremental changes in surface level due to the mining of LW16 only are shown in Fig. 2.9. These contours have been determined by taking the differences between the surface levels measured before and after the extraction of this longwall. The data located outside the predicted limit of vertical subsidence (i.e. incremental 20 mm subsidence contour) have been removed for clarity.

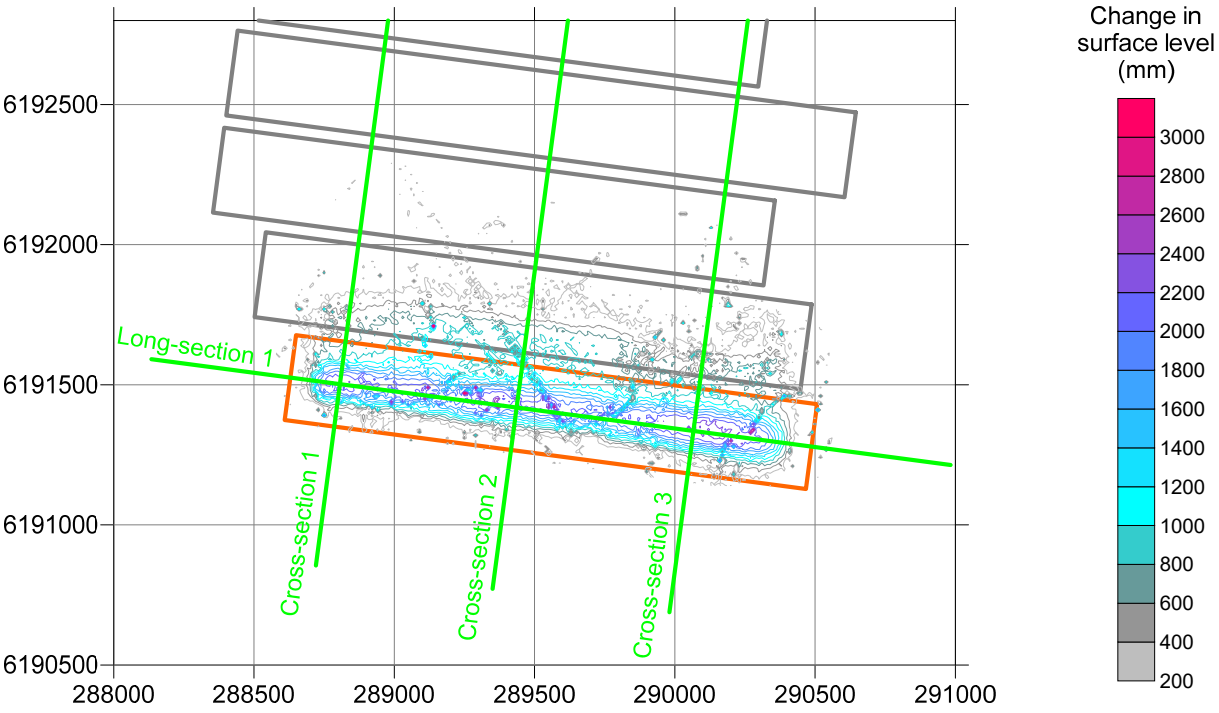

Fig. 2.9 Measured incremental changes in surface level due to the mining LW16

The measured total changes in surface level due to the mining of LW12 to LW16 are shown in Fig. 2.10. These contours have been determined by taking the differences between the surface levels measured after the completion of LW11 and after the completion of LW16. The data located outside the predicted limit of vertical subsidence (i.e. total 20 mm subsidence contour) have been removed for clarity. The extent of the latest ALS survey covers the area above LW13 to LW16 and, therefore, the contours are not shown above the earlier longwalls.

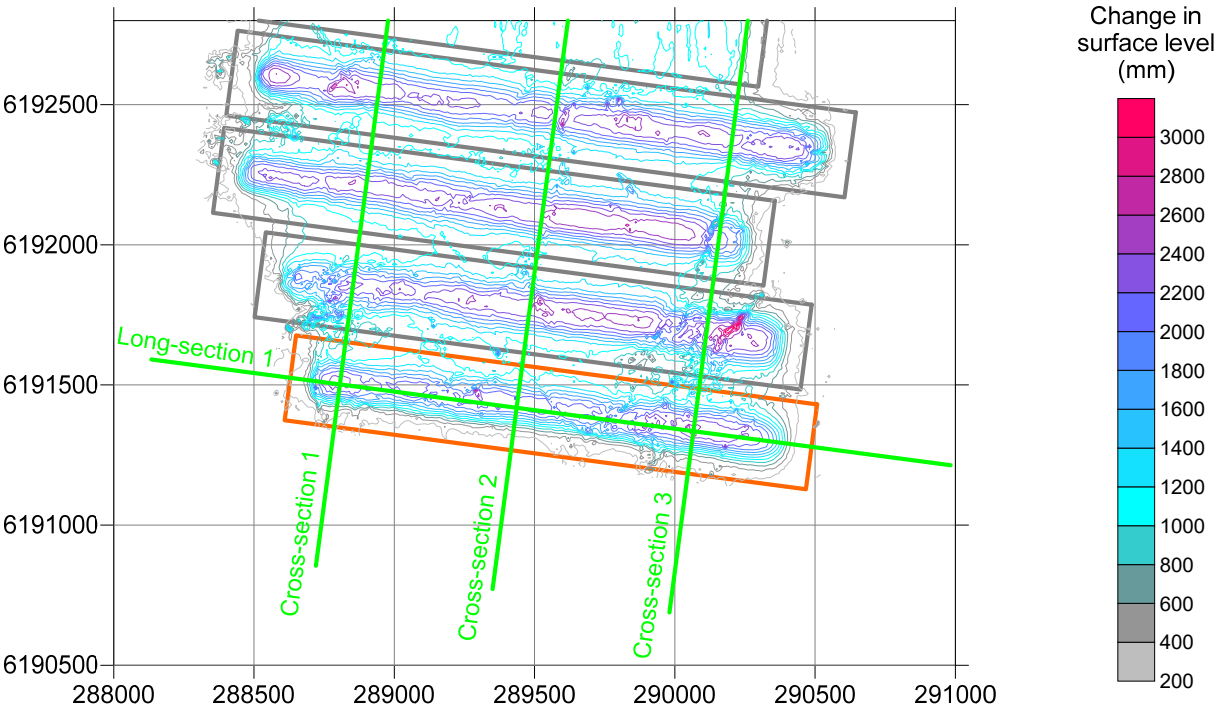

Fig. 2.10 Measured total changes in surface level due to the mining of LW9 to LW16

The LiDAR surveys have an accuracy for absolute level in the order of ±100 mm. The accuracy of the measured changes in surface level (i.e. the difference between two surveys), therefore, is in the order of ±200 mm.

The contours of the measured changes in surface level, developed from the LiDAR surveys, show the changes in the heights of points at fixed positions in space (i.e. eastings and northings). This differs from traditional subsidence contours that include both the vertical and horizontal components of the movements of points fixed to the surface. Horizontal movements are usually included in the subsidence profiles, as traditional ground monitoring data is based on the movements of survey marks that are fixed to the ground.

The contours can contain artefacts (i.e. locally increased or decreased movements), particularly in the locations of steeply incised terrain, such as at the cliffs and steep slopes. These artefacts can be seen in Fig. 2.9 and Fig. 2.10 as the localised areas of dark purple to red contours above the longwalls and the lower level subsidence outside the extents of the longwalls.

The change in surface level at a fixed position in space (i.e. easting and northing), therefore, can be large in the locations of cliffs and steep slopes and does not provide a true indication of the actual vertical subsidence at a point on the ground. However, where the ground is reasonably flat, the contours of the measured changes in surface level should provide a good indication of the actual vertical subsidence.

The comparisons of the measured changes in surface level and the predicted vertical subsidence along Cross-sections 1 to 3 and Long-section 1 are provided in Fig. 2.11 to Fig. 2.14. The locations of these sections are indicated in Fig. 2.9 and Fig. 2.10. The extent of the latest ALS survey covers the area above LW13 to LW16 and, therefore, the profiles are not shown above the earlier longwalls The predicted profiles of vertical subsidence have been derived from the predicted subsidence contours illustrated in Report No. MSEC865.

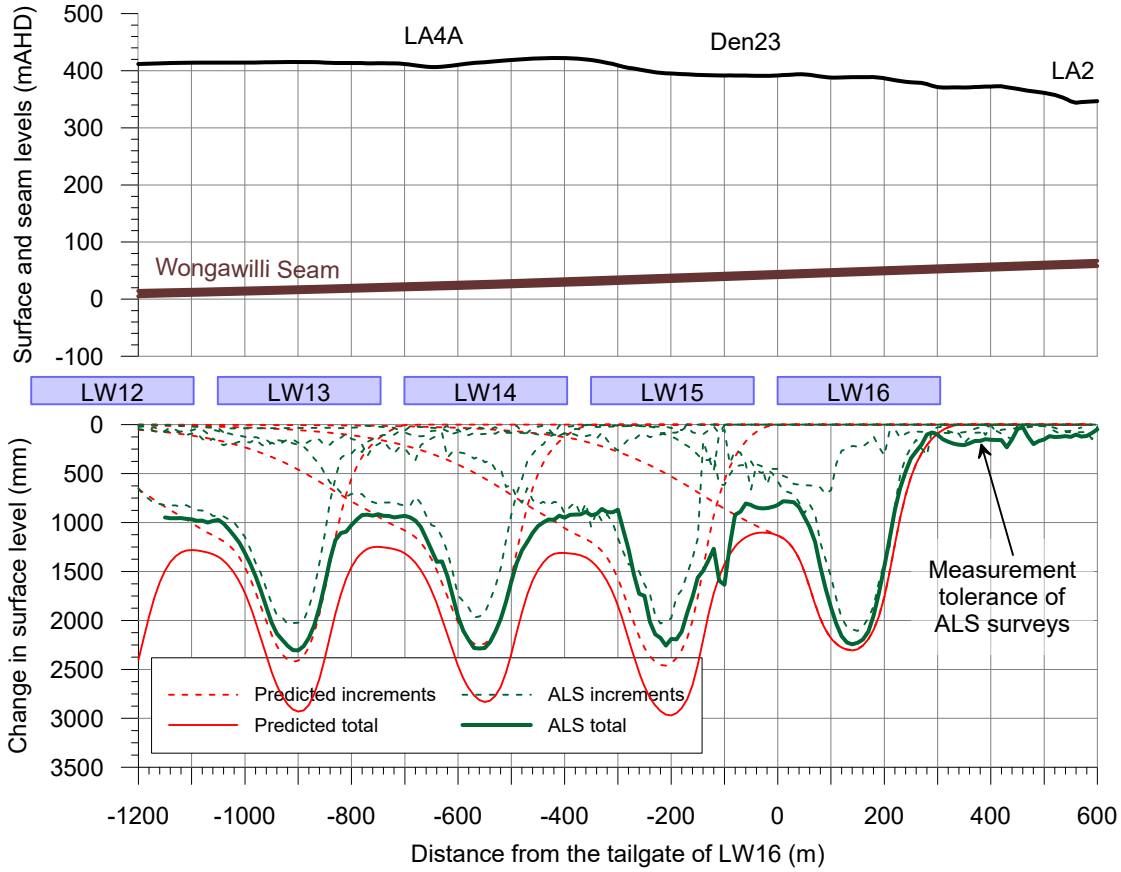

Fig. 2.11 Measured changes in surface level and predicted vertical subsidence along Cross-section 1

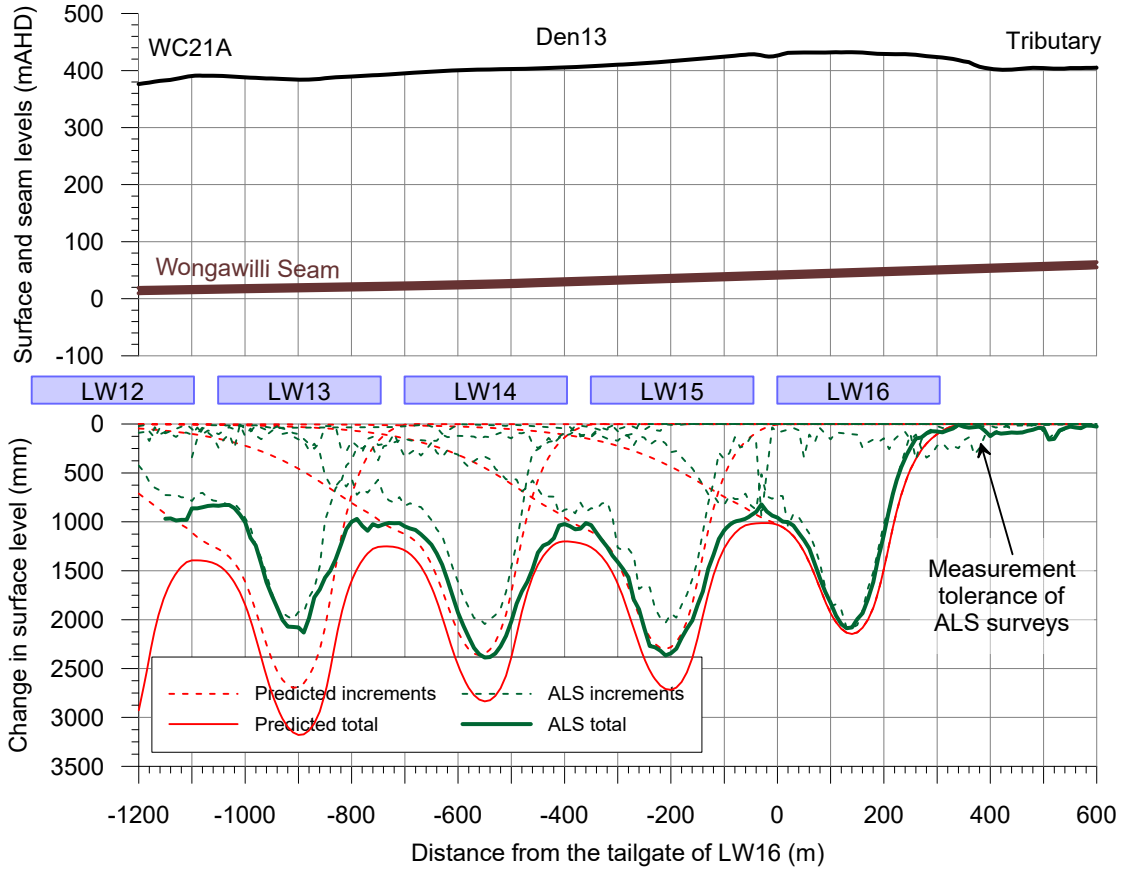

Fig. 2.12 Measured changes in surface level and predicted vertical subsidence along Cross-section 2

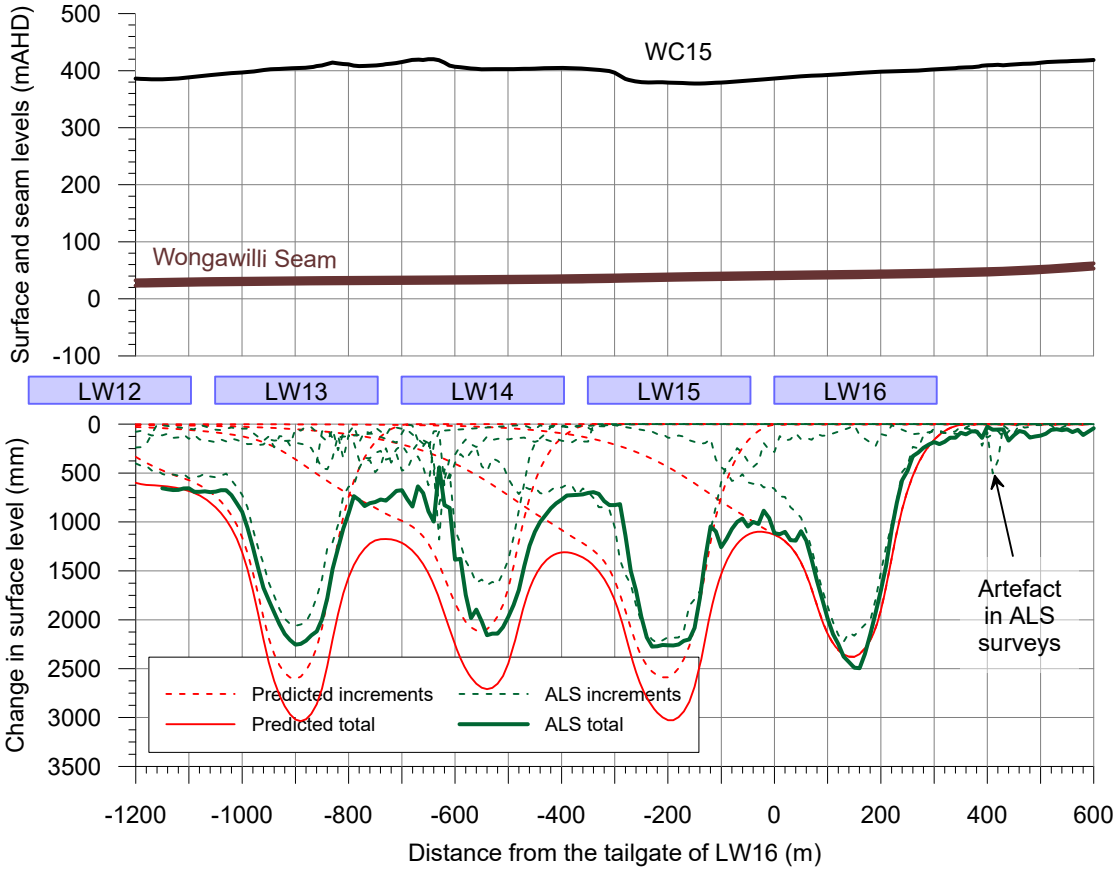

Fig. 2.13 Measured changes in surface level and predicted vertical subsidence along Cross-section 3

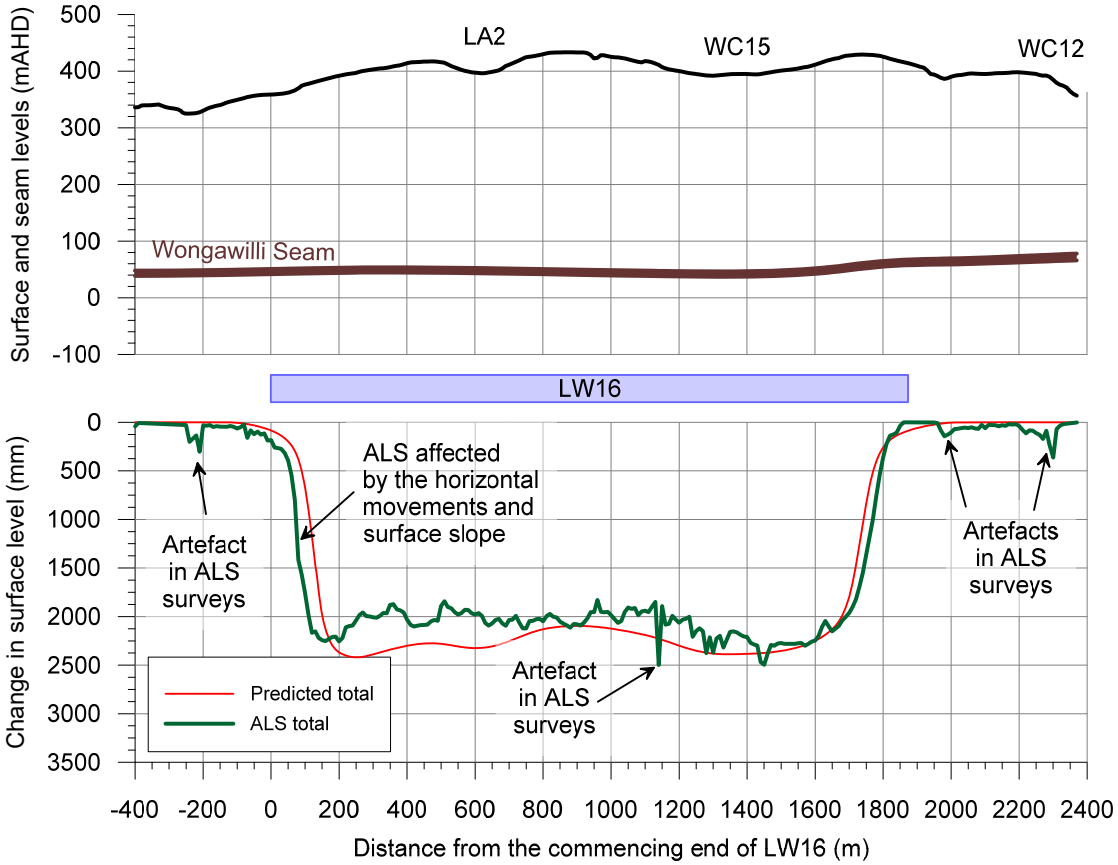

Fig. 2.14 Measured changes in surface level and predicted vertical subsidence along Long-section 1

The profiles of the measured changes in surface level reasonably match the predicted profiles of vertical subsidence along each of the cross-sections and long-section. The maximum measured changes in surface level above each of the longwalls are similar to or 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 change in surface level along Cross-section 3 (refer to Fig. 2.13) is slightly greater than the predicted vertical subsidence above LW16. However, the difference between the measured and predicted movements are in the order of accuracy of the measurement method.

The measured change in surface level along Long-section 1 (refer to Fig. 2.14) is greater than the predicted vertical subsidence above the commencing end of LW16 (i.e. left side of figure). However, this may be partly due to the surveying tolerance and the effects of the horizontal movements and sloping terrain on the LiDAR surveys. The ground directly above the commencing end of LW16 has moved towards the longwall (i.e. following the extraction face). The natural surface dips towards the west in this location (i.e. towards Lake Avon). The mining-induced horizontal movement, therefore, results in the measured changes in level at a fixed position to be greater than the true vertical subsidence above the commencing end of LW16.

There are localised areas outside of the longwalls where the measured changes in surface level exceed the predicted vertical subsidence. However, these are artefacts of the LiDAR surveys and are not real movements. Elsewhere, the low-level movements are in the order of accuracy of the measurement method.

It can be inferred from the slopes of the profiles, that the measured changes in grade are similar to the predicted tilts along each of 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 Reports Nos. MSEC792 and MSEC865.

3.1. Surface deformations

The surface deformations due to the mining of LW16 have been identified by the IMC Environmental Field Team and are described in the accompanying IMC landscape report. The locations of the soil cracking and rock fracturing identified during the mining of LW16 are illustrated in Fig. 3.1.

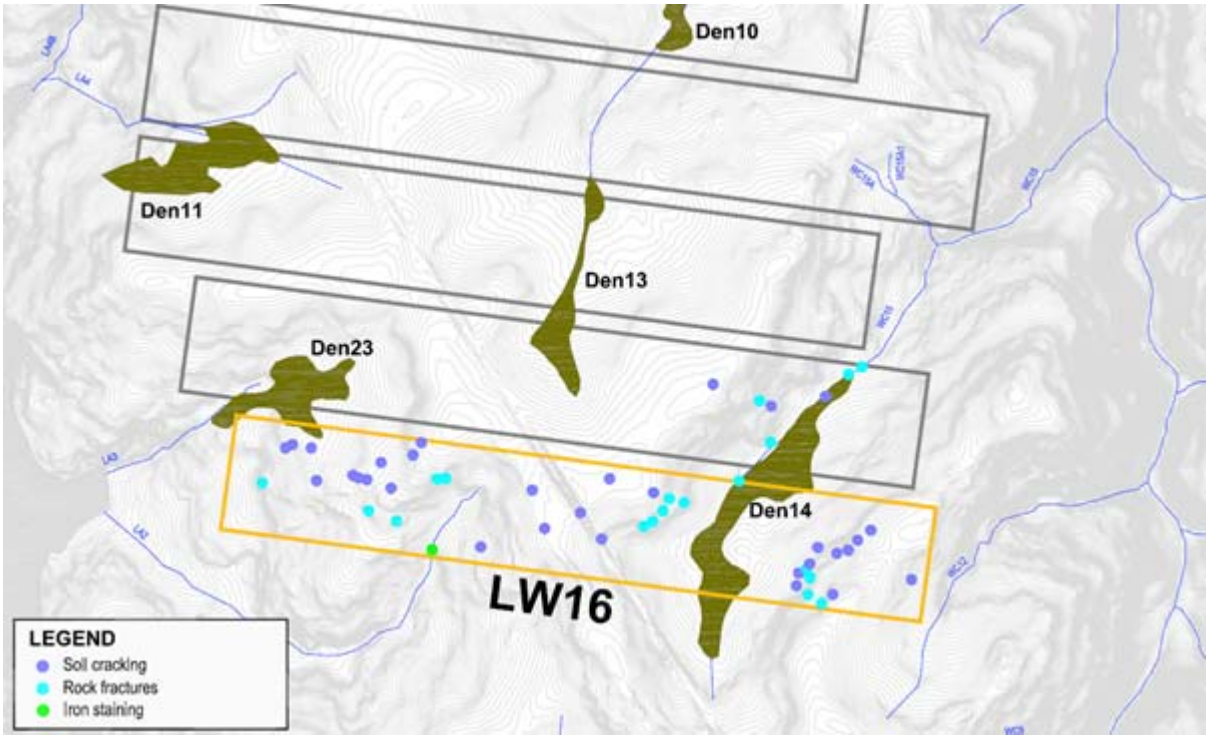

Fig. 3.1 Surface deformations due to the mining of LW16

Soil cracking (i.e. blue circles) was identified predominately above LW16 along or near the fire trails, seismic tracks, railway corridor and bases of steep slopes. Rock fracturing (i.e. cyan circles) was also identified predominately above LW16 at the rock outcrops on the sides of the ridgelines. Isolated cracking and fracturing was also recorded above the eastern end of LW15.

The soil crack and rock fracture widths were generally less than 50 mm representing 63 % of cases. The crack and fracture ranged between 50 mm and 100 mm in 23 % of cases, between 100 mm and 200 mm in 6 % of cases, between 200 mm and 300 mm in 3 % of cases. Localised erosion occurred at two sites causing surface deformations with widths up to 0.75 m. Elsewhere, the maximum crack width was 250 mm.

New rock fracturing was identified along stream WC15 at one site (DA3B_LW16_028) and additional fracturing was identified at two other sites (DA3B_LW14_017 and DA3B_LW14_019) after the mining of LW16. Fracturing was previously recorded along this tributary due to the mining of LW13 (8 sites), LW14 (8 sites) and LW15 (3 sites).

New rock fracturing was identified at one site (DA3B_LW16_012) and localised erosion was identified at another site (DA3B_LW16_030) adjacent to swamp Den14 after the mining of LW16. Fracturing or soil cracking was not previously recorded within or adjacent to this swamp.

Summaries of the sites along WC15 and adjacent to Den14 with fracturing or cracking attributed to the mining of LW16 are provided in Table 3.1 and Table 3.2, respectively. The locations of these sites are also illustrated in Fig. 3.2.

Table 3.1 Fracturing sites observed along WC15 attributed to the mining of LW16

Site ID	Location	Longwall when fracturing was first observed	Maximum fracture width (mm)	Description
DA3B_LW14_017	Channel 30	LW14	25	Fracturing initially observed during LW14 with additional fractures after LW16. Surface water flow diversion observed
DA3B_LW14_019	Near tributary	LW14	100	Fracturing initially observed during LW14 with additional fractures after LW16. Surface water flow diversion observed
DA3B_LW16_028	Pool 34	LW16	20	Surface water flow diversion observed after LW16

Table 3.2 Fracturing sites observed adjacent to Den14 attributed to the mining of LW16

Site ID	Location	Longwall when fracturing was first observed	Maximum fracture or crack width (mm)	Description
DA3B_LW16_012	Adjacent swamp	LW16	37	Multiple fractures located adjacent to Den14
DA3B_LW16_030	Adjacent swamp	LW16	500	Localised erosion adjacent between Den14 and WC15

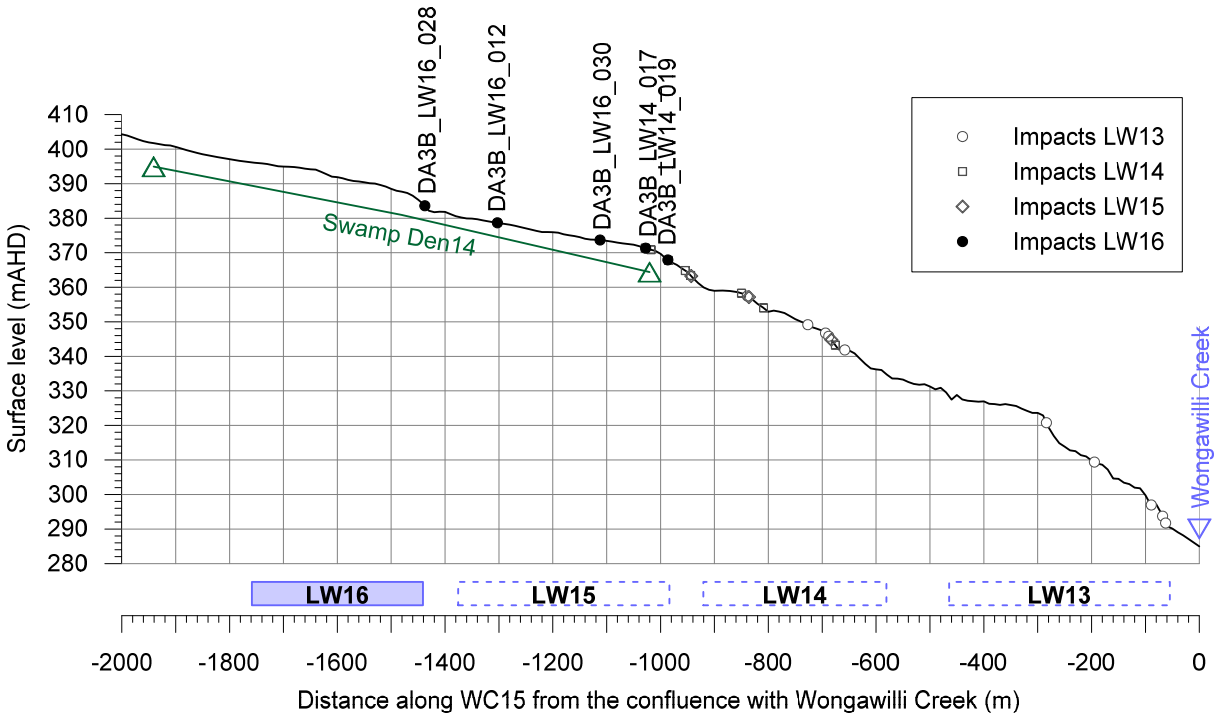

Fig. 3.2 Rock fractures identified along WC15 and adjacent to Den14

Iron staining was observed along stream LA2 after the mining of LW16. Fracturing and surface water diversions were not observed along this tributary. However, fracturing and soil cracking were observed further up the valley sides on the western valley side in one location (DA3B_LW16_017).

Further details of these surface deformations are provided in the accompanying IMC landscape report.

3.2. Natural features

The natural features near LW16 are shown in Drawing No. MSEC1155-02, in Appendix A, and include:

- Wongawilli Creek;
- drainage lines;
- cliffs;
- rock outcrops;
- steep slopes;
- swamps; and
- Aboriginal heritage sites.

The MSEC assessed impacts for the natural features due to the mining of LW9 to LW18 are provided in Report No. MSEC459, which supported the SMP Application. These assessments have been reviewed and updated based on the re-calibrated subsidence model and are provided in Reports Nos. MSEC792 and MSEC865. More detailed assessments for the natural features are also provided in other consultants' reports supporting the SMP Application.

Comparisons between the MSEC assessments and the reported impacts for the natural features listed above, due to the mining of LW16, are provided in Table 3.3. The reported impacts are based on those recorded by IMC Environmental Field Team that are described in the accompanying landscape report.

Table 3.3 Assessed and reported impacts for the natural features due to LW16

Natural feature	MSEC assessed impacts	Reported impacts
Wongawilli Creek	Very localised additional **ponding** or **flooding** developing in the locations of existing pools, steps or cascades due to vertical subsidence or tilt.	No reported impacts due to the mining-induced vertical subsidence or tilt.
	Minor **fracturing** of the bedrock within 400 m of the longwalls due to strain.	No new fracturing identified along the creek due to the mining of LW16. Fracturing was previously observed between LW6 and LW9, first observed during the mining of LW9.
	Low-likelihood that **surface water flow diversions** would occur due to fracturing of the bedrock.	No new surface water flow diversions (i.e. Type 3 impacts) identified along the creek due to the mining of LW16. One Type 3 impact was previously observed between LW6 and LW9, where fracturing was first observed during the mining of LW9.
Drainage lines	Localised additional **ponding**, **flooding** or **scouring** along sections of the drainage lines located directly above the longwall.	No reported impacts.
	Buckling and **fracturing** of the bedrock along the drainage lines above or within 400 m of the longwalls.	Rock fracturing identified at 3 sites along WC15 due to the mining of LW16. Fracturing previously identified at 19 other sites along WC15 due to the mining of LW13, LW14 and LW15. Iron staining identified along LA2; Fracturing was not observed along this tributary; however, fracturing and soil cracking were recorded further up the valley sides. Refer to the IMC landscape report for further details.
	Surface water flow diversions into the dilated strata beneath the drainage lines which are directly mined beneath.	Surface water diversion identified along WC15 in one new location (DA3B_LW16_028) due to the mining of LW16. Surface water diversions previously recorded along this stream at two other sites (DA3B_LW14_017 and DA3B_LW14_019) where additional fracturing was observed due to the mining of LW16. Refer to the IMC landscape report for further details.

Natural feature	MSEC assessed impacts	Reported impacts
Drainage lines (continued)	**Water quality** – refer to the accompanying water quality report. **Terrestrial ecology** – refer to the accompanying terrestrial ecology report. **Aquatic ecology** – refer to the accompanying aquatic ecology report.	
Cliffs	Fracturing resulting in isolated **rockfalls** for the cliffs that are located within and just outside the mining area. Large-scale cliff instabilities are not expected.	Fracturing observed in the minor cliff located along the ridgeline above LW16, with widths up to 40 mm. Minor rock falls observed. Refer to the IMC landscape report for further details.
Rock outcrops	Fracturing of bedrock which could result in **rockfalls** along the exposed rockfaces. Fracture widths up to approximately 300 mm previously observed at the Mine.	Fracturing and minor rock falls at the rock outcrops located on the valley sides of LA2, LA3 and WC15 above LW16. Refer to the IMC landscape report for further details
Steep slopes	**Soil slippage** resulting in tension cracks and compression ridges. Soil cracks between approximately 100 mm and 400 mm previously observed at the Mine.	Soil cracking observed on or near the fire trails, seismic tracks and railway corridor. Crack widths vary between 14 mm and 95 mm. Refer to the IMC landscape report for further details.
Swamps	**Fracturing** of the underlying strata which could result in the **diversion of surface water**.	Groundwater levels lower than baseline and/or recession rates greater than baseline for Swamps 11, 14 and 23. No changes in soil moisture levels at these swamps. Refer to the IMC landscape report for further details.
Aboriginal heritage sites	Impacts on overhang sites include fracturing of sandstone, rock falls, or water seepage through joints which may affect artwork.	Refer to the accompanying cultural heritage report.

The extraction of LW6 to LW16 has resulted in one Type 3 impact along Wongawilli Creek. A Type 3 impact is defined as *fracturing in a rockbar or upstream pool resulting in reduction in standing water level based on current rainfall and surface water flow*. The total length of Wongawilli Creek located within a distance of 400 m of the as-extracted longwalls is more than 2 km. The rate of Type 3 impacts along the creek due the mining of LW6 to LW16, therefore, is considered to be very low.

The longwalls at Dendrobium Mine were setback from Wongawilli Creek so that the predicted closure is less than 200 mm. It was assessed that the likelihood of significant fracturing resulting in surface water flow diversions along Wongawilli Creek would be very low, i.e. affecting less than 10 % of the pools and channels. It is considered that the observed rate of impact (i.e. one Type 3 impact along the 2 km length of Wongawilli Creek) is similar to the MSEC assessments provided in Reports Nos. MSEC459, MSEC792 and MSEC865.

Rock fracturing was observed along WC15 in one location above LW16 (DA3B_LW16_028) and additional fracturing was observed in two locations above LW15 (DA3B_LW14_017 and DA3B_LW14_019) due to the mining of LW16. Fracturing was not observed outside the mining area due to the mining of this longwall.

Surface water diversion (i.e. Type 3 impact) was observed at one new site along WC15 (DA3B_LW16_028) due to the mining of LW16. There are seven previous sites with identified or possible Type 3 impacts located along WC15 due to the mining of LW13 to LW15, being Rockbars 0/1, Rockbar 5, Rockbar 18, Rockbar 21, Rockbar 25, Rockbar 26 and Pool 30/Channel 30. There are also two previous sites with identified or possible Type 3 impacts located along LA4A and LA4B which were previously observed due to the mining of LW12 and LW13. There were no new surface water diversions identified outside the mining area due to the mining of LW16.

It is considered, therefore, that the observed impacts on the natural features due to the mining of LW16 are consistent with the MSEC assessments provided in Reports Nos. MSEC459, MSEC792 and MSEC865. Further assessments of natural features have been provided by other specialist consultants on the project, which are described in the relevant reports accompanying the *End of Panel* report.

3.3. Built features

The built features near LW16 are shown in Drawing No. MSEC1155-03, in Appendix A, and include:

- Fire trails and four-wheel drive tracks;
- Disused Maldon Dombarton Railway Corridor;
- Avon Dam; and
- Survey control marks.

Cordeaux Dam Wall is located more than 5 km north of LW16, at its closest point. The Upper Cordeaux No. 2 Dam Wall is located more than 6 km south-east of LW16, at its closest point. It is unlikely that these dam walls would experience measurable far-field horizontal movements due to the mining of LW16 and, therefore, they have not been assessed further.

The MSEC assessed impacts for the built features due to the mining of Dendrobium LW9 to LW18 are provided in Report No. MSEC459, which supported the SMP Application. These assessments were reviewed and updated based on the re-calibrated subsidence model and are provided in Reports Nos. MSEC792 and MSEC865.

Comparisons between the MSEC assessments and the reported impacts for the built features listed above, due to the mining of LW16, are provided in Table 3.4. The reported impacts are based on those recorded by IMC Environmental Field Team that are described in the accompanying landscape report.

Table 3.4 Assessed and reported impacts for the built features due to LW16

Built feature	MSEC assessed impacts	Reported impacts
Fire trails and four-wheel drive tracks	Cracking of unsealed road surfaces.	Soil / surface cracking observed on or near the fire trails, seismic tracks and railway corridor, with widths ranging between approximately 8 mm and 250 mm. Refer to the IMC landscape report for further details.
Disused Maldon-Dombarton Railway	Possible fracturing of rock cuttings, spalling, and/or mobilisation of rock joints.	Surface cracking and rock fracturing along the alignment of the railway corridor above LW16.
Avon 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.

It has been considered that the observed impacts on the surface infrastructure, due to the mining of LW16, are similar to or less than the MSEC assessments provided in Reports Nos. MSEC459, MSEC792 and MSEC865.

4.0 SUMMARY

The mine subsidence effects due to the mining of LW16 were measured using the Wongawilli Creek closure lines, Avon Dam closure lines, Area 3B and Avon Dam 3D monitoring points, tributary cross lines, swamp cross lines and airborne laser scans of the area.

The measured ground movements after the extraction of LW16 are similar to or less than the predicted values based on the re-calibrated subsidence model outlined in Reports Nos. MSEC792 and MSEC865. It is considered, therefore, that the ground movements measured due to the mining of LW16 are consistent with the predictions provided in Reports Nos. MSEC792 and MSEC865.

Soil cracking and rock fracturing were observed directly above LW16 and the previously extracted LW15. The crack and fracture widths vary between approximately 4 mm and 250 mm. However, the fracture and crack withs were generally less than 50 mm (in 63 % of cases). Localised erosion occurred at two sites causing surface deformations with widths up to 0.75 m. It was assessed that soil and fracture widths between approximately 100 mm and 400 mm could occur directly above the extracted longwalls and that more isolated surface impacts could occur up to 400 m outside of the longwalls.

Surface water diversion (i.e. Type 3 impact) was observed at one new site along WC15 due to the mining of LW16. Iron staining was also recorded along LA2; however, fracturing was not identified along the alignment of this stream. It was assessed that surface water diversions could occur along the streams that are directly mined beneath.

It is considered, therefore, that the observed surface impacts on the natural and built features, due to the mining of LW16, are consistent with the MSEC assessments provided in Reports Nos. MSEC792 and MSEC865. Further assessments for the natural features have been provided by the specialist consultants on the project and the findings in this report should be read in conjunction with the findings provided in the accompanying specialist reports.

APPENDIX A. DRAWINGS

I:\Projects\Dendrobium\Area 3\MSEC1155 - Area 3B - Longwall 16 End of Panel Report\AcadData\MSEC1155-01 General Layout.dwg

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ILLAWARRA COAL

DENDROBIUM COLLIERY - AREA 3B
LONGWALL 16 END OF PANEL REPORT
GENERAL LAYOUT & MONITORING LINES

DATE:	SCALE:	DRAWING No:	Rev No
9 Feb 2021	1:20000	MSEC1155-01	01

AREA 3B

AREA 3A

LW9 LW10 LW11 LW12 LW13 LW14 LW15 LW16 LW6 LW7 LW8

Swamp1b Swamp1a Swamp5 Swamp8

TRIBUTARY OF DONALDS CASTLE CREEK

DONALDS CASTLE CREEK

TRIBUTARY OF WONGAWILLI CREEK

WONGAWILLI CREEK

DISUSED MALDON-DOMBARTON RAILWAY CORRIDOR

LAKE AVON

AVON1

Den11 Den12 Den13 Den14 Den23 Den33 Den34

Fire Road 6A Fire Road 6N Fire Road 6P Fire Road 6Q

LA4B-Line LA4A-Line Avon Dam Line AvonDam A-Line AvonDam B-Line AvonDam C-Line AvonDam D-Line AvonDam E-Line

LA2-RB2 Line LA2-RB13 Line

SW 1-Line SW 1A-Line SW 1B-Line SW 2-Line SW 3-Line SW 4-Line SW 5-Line

DCCXA Line DCCXD Line DCCXE Line

WC21E-Line WC21F-Line WC21G-Line WC21H-Line WC21I-Line WC21J-Line WC21K-Line WC21L-Line (Lower) WC21 L-Line (Upper) WC21XF Line

WC15 9-Line WC15 28-Line WC15 34-Line

WONG X C Line WONG X D Line WONG X E Line

Start LW16: 25-Feb-2020

End LW16: 4-Nov-2020

NDC-C DA3b-83 NDC-D DA3b-84 NDC-E DA3b-87

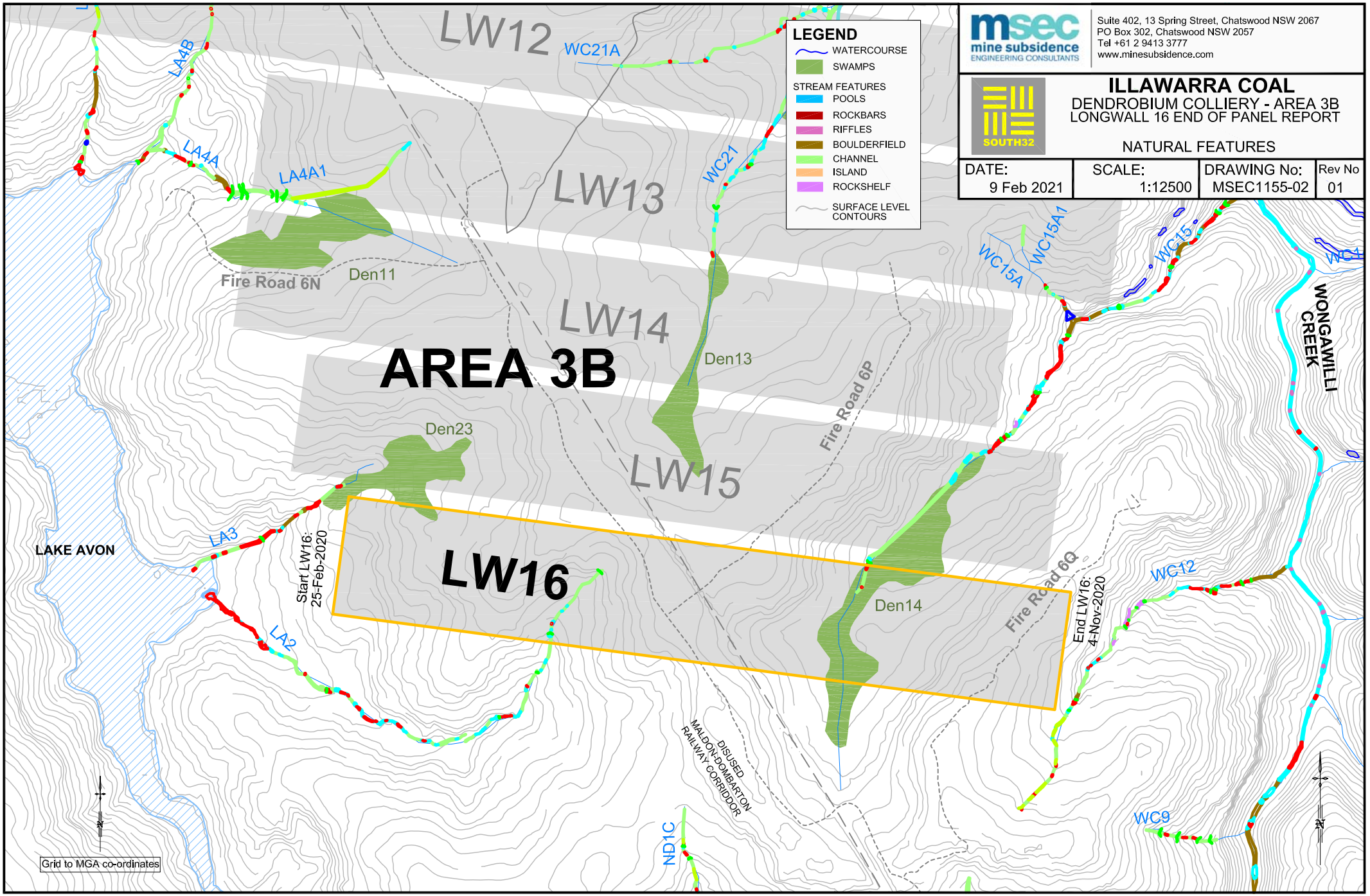
288000 289000 290000 291000 292000

6194000 6193000 6192000 6191000

Grid to MGA co-ordinates

LEGEND
- MONITORING LINES
- MONITORING POINTS
- MONITORED DURING LW15

I:\Projects\Dendrobium\Area 3\MSEC1155 - Area 3B - Longwall 16 End of Panel Report\AcadData\MSEC1155-02 Natural Features.dwg



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ILLAWARRA COAL

DENDROBIUM COLLIERY - AREA 3B
LONGWALL 16 END OF PANEL REPORT

NATURAL FEATURES

DATE:	SCALE:	DRAWING No:	Rev No
9 Feb 2021	1:12500	MSEC1155-02	01

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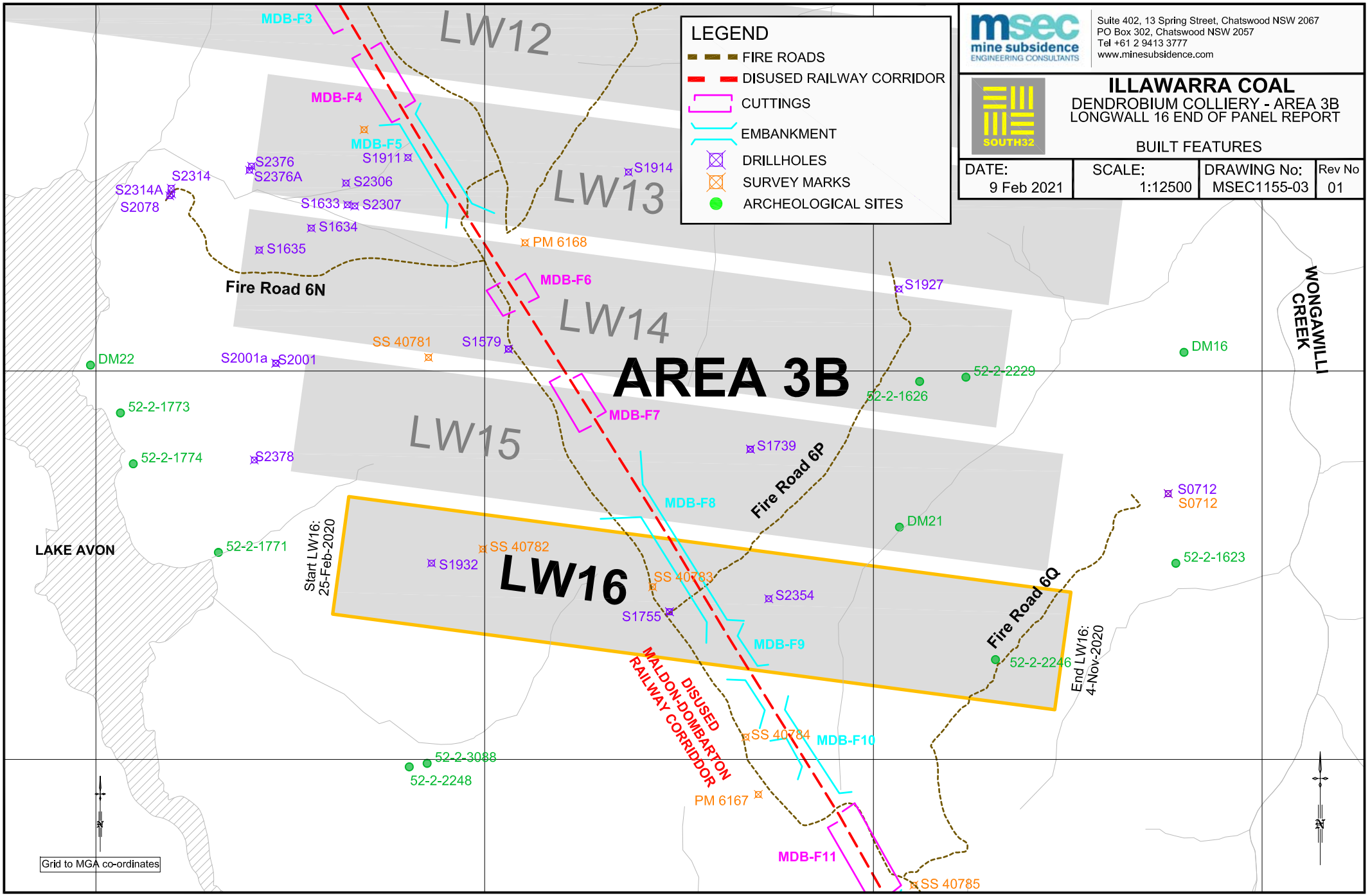

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DENDROBIUM COLLIERY - AREA 3B
LONGWALL 16 END OF PANEL REPORT

BUILT FEATURES

DATE:	SCALE:	DRAWING No:	Rev No
9 Feb 2021	1:12500	MSEC1155-03	01

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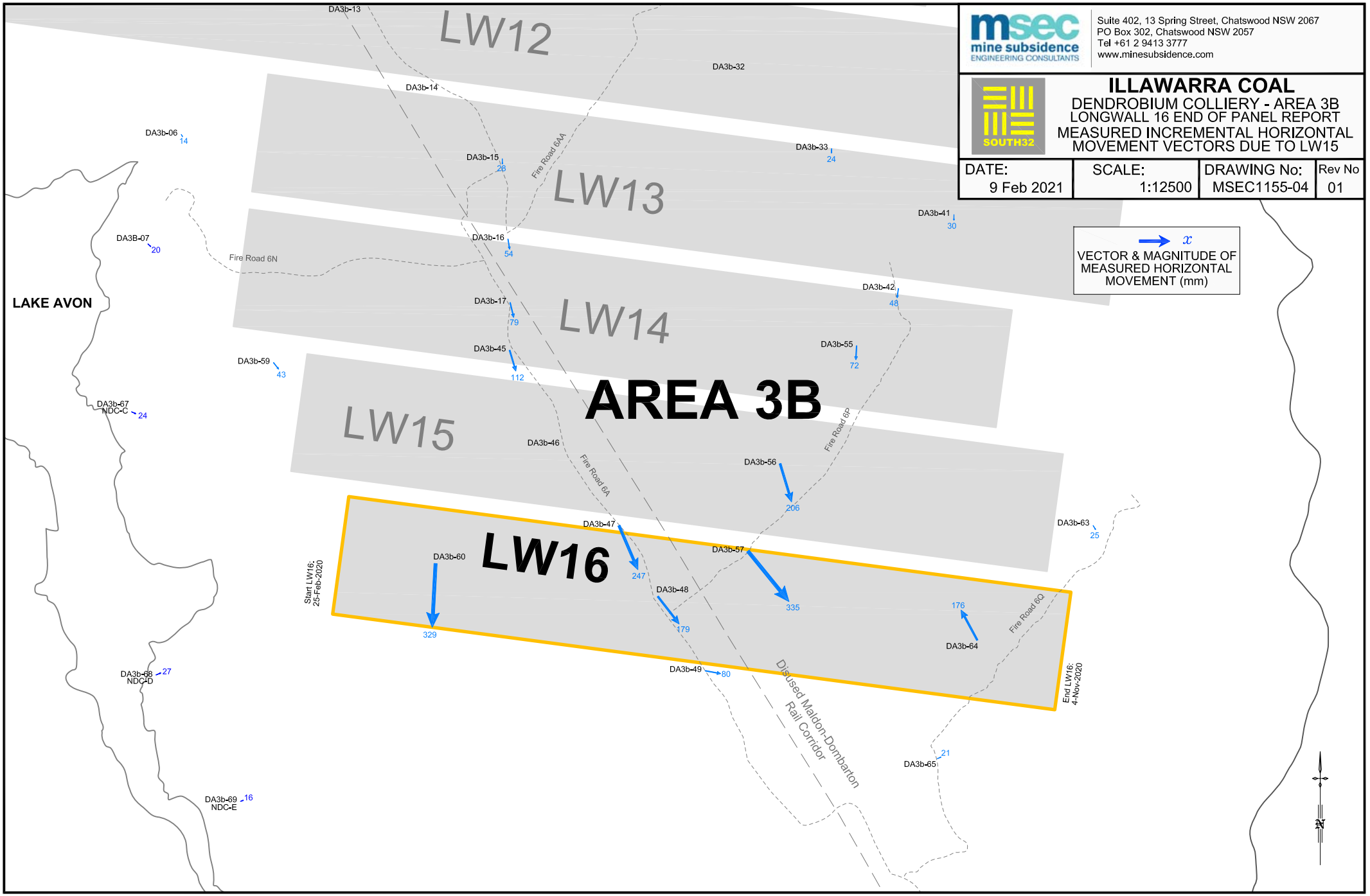

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ILLAWARRA COAL

DENDROBIUM COLLIERY - AREA 3B
LONGWALL 16 END OF PANEL REPORT
MEASURED INCREMENTAL HORIZONTAL MOVEMENT VECTORS DUE TO LW15

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