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Illawarra Coal

SOUTH32 ILLAWARRA COAL:

Dendrobium - Area 3B - Longwall 14

End of Panel Subsidence Monitoring Review Report for Dendrobium Longwall 14

DOCUMENT REGISTER

Revision	Description	Author	Checker	Date
01	Draft Issue	JB	-	9 May 19
A	Final Issue	JB	PD	20 May 19

Report produced for: Compliance with conditions attached to the SMP Approval set by Industry and Investment NSW (now DP&E).

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.

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)

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Drawings

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MSEC1039-01	General layout and monitoring lines	A
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1.1. Introduction

Illawarra Coal (IC) has completed the extraction of Longwall 14 (LW14) 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. MSEC1039-01, in Appendix A. The extraction of LW14 commenced on the 22 May 2018 and it was completed on the 26 February 2019.

Mine Subsidence Engineering Consultants (MSEC) was previously commissioned by IC 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.

IC then shortened the commencing (i.e. western) end of LW14 by 50 m and shortened the finishing (i.e. eastern) end of this longwall by 337 m from the extents that were indicated in the SMP Application. Report No. MSEC865 (Rev. A) was issued in support of the application for these modifications. The Subsidence Management Plan for LW14 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 resulting from the extraction of LW14; and
- comparisons between the observed and predicted effects and impacts on the natural and built features within the SMP Area resulting from the extraction of LW14.

Further details on the observed and assessed impacts for natural features, resulting from the extraction of LW14, 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 extraction of LW14. This section also provides comparisons between the measured and predicted effects resulting from the extraction of this longwall.

Chapter 3 of this report describes the natural and built features near LW14. This section also provides comparisons between the observed and assessed impacts for these features resulting from the extraction 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 extraction of LW14.

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. MSEC1039-01, in Appendix A. A summary of the as-extracted dimensions for LW9 to LW14 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

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 LW14, therefore, is approximately 1971 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 LW14 are illustrated in Fig. 1.1.

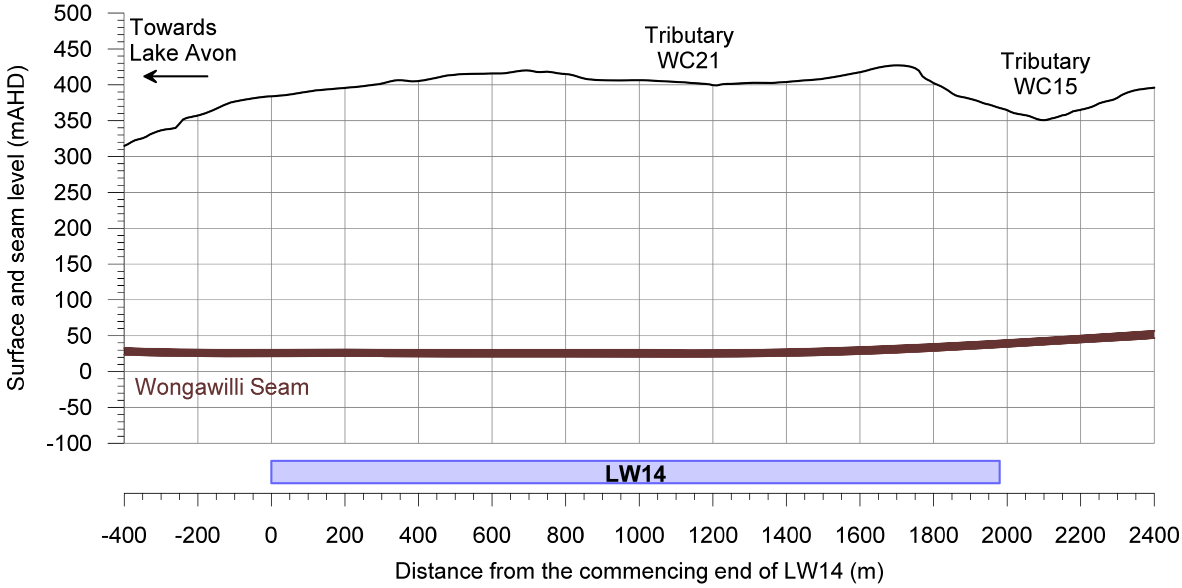

Fig. 1.1 Surface and seam levels along the centreline of LW14

The depth of cover to the Wongawilli Seam, directly above LW14, varies between a minimum of 330 m above the finishing (i.e. eastern) end of the longwall, and a maximum of 395 m above the western part 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 LW14, depending on the local roof conditions, with an average height of approximately 3.9 m. The predictions provided in this report have been based on the maximum proposed extraction height of 4.6 m, as adopted in Reports Nos. MSEC459, MSEC792 and MSEC865.

2.1. Introduction

The mine subsidence movements resulting from the extraction of Dendrobium LW14 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;
- Donalds Castle Creek cross lines;
- WC15 and WC21 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. MSEC1039-01, 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 parameters 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 IC using 2D survey techniques at the Wong X B-Line, Wong X C-Line and Wong X D-Line. The Wong X A-Line was not measured at the completion of LW12 to LW14 due to its distance north-east of these longwalls.

The locations of the Wongawilli Creek closure lines are shown in Drawing No. MSEC1039-01. 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 LW14

Mining phase commitments	Mining phase survey dates	Post mining phase commitments
Completion of LW14	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)	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 the 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 extraction of LW6 to LW14, 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 and LW14 only.

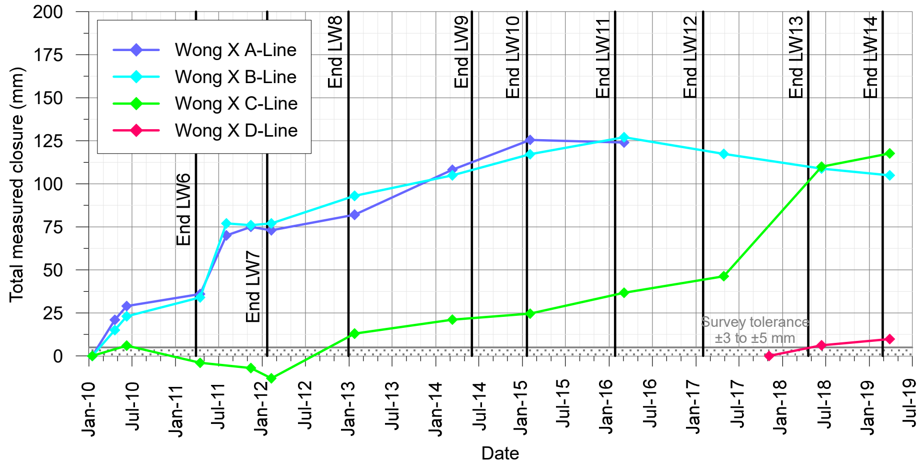

Fig. 2.1 Development of total closure for the Wongawilli Creek closure lines

There was a reduction in the total closure measured at the Wong X B-Line and increases in the total closures measured at the Wong X C-Line and Wong X D-Line due to the extraction of LW14.

The predictions of vertical subsidence, upsidence and closure for Wongawilli Creek, resulting from the extraction of Dendrobium LW6 to LW19, were provided in Report No. MSEC865. The measured and predicted total closures along Wongawilli Creek after the completion of LW14 are illustrated in Fig. 2.2.

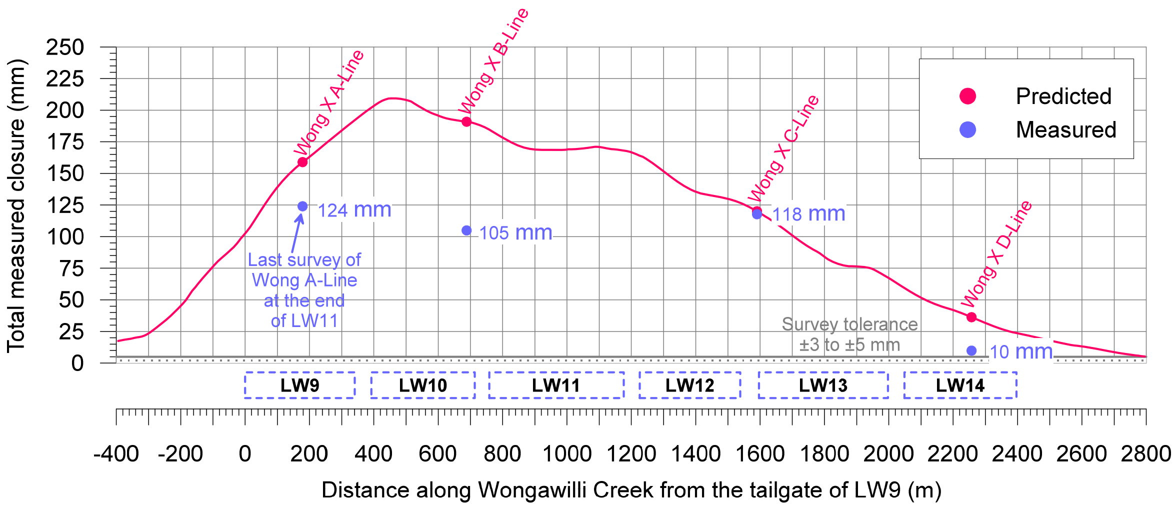

Fig. 2.2 Measured and predicted total closure along Wongawilli Creek after LW14

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

Table 2.2 Measured and predicted total closure at the Wongawilli Creek closure lines due to the extraction of LW6 to LW14

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 LW14	105	190
Wong X C-Line	LW6 to LW14	118	120
Wong X D-Line	LW13 and LW14 only	10	40

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

The maximum measured total closures at each of the Wongawilli Creek closure lines are similar to or less than the predicted values at the completion of LW14. It is considered that the movements measured using the Wongawilli Creek closure lines are 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 IC using the Avon Dam A-Line to E-Line. The locations of these monitoring lines are shown in Drawing No. MSEC1039-01. 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 extraction of LW12 to LW14 only.

Table 2.3 Survey dates for the Avon Dam closure lines during LW14

Mining phase commitments	Mining phase survey dates	Post mining phase commitments
Completion of LW14	12 February 2016 (base survey) 30 August 2016 (end of LW12) 23 May 2018 (end of LW13) 9 August 2018 31 October 2018 24 January 2019 2 April 2019 (end of LW14)	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 the closure 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 closures across the Avon Dam closure lines during the extraction of LW12 to LW14 are illustrated in Fig. 2.3. The extraction of LW14 has only resulted in a small increase in the closure measured at the A-Line and small increases in the openings measured at each of the other monitoring lines.

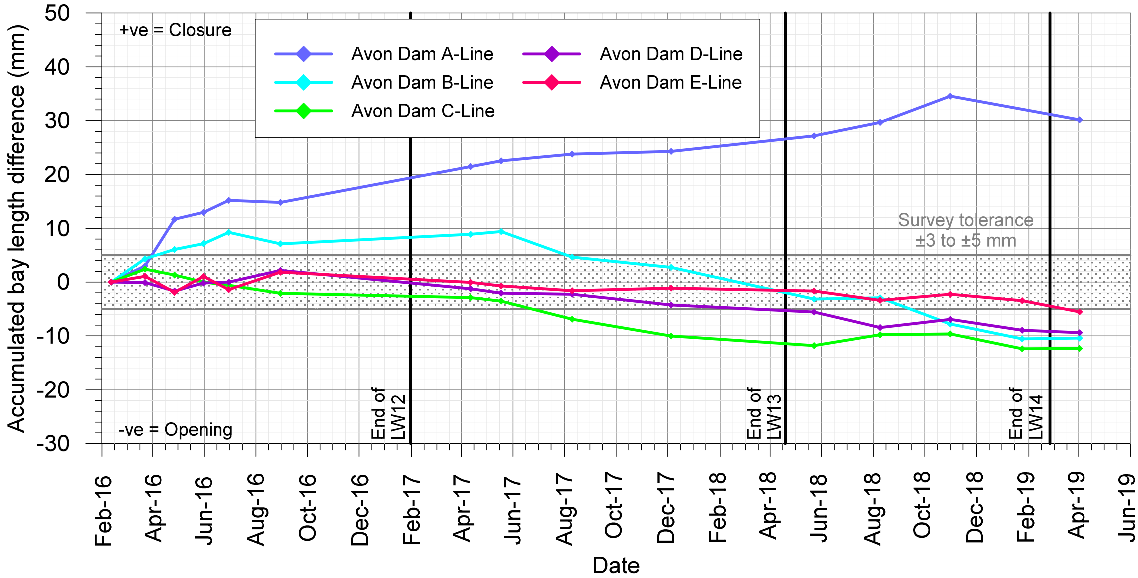

Fig. 2.3 Measured and predicted accumulated closure for the Avon Dam closure lines

A summary of the maximum measured and maximum predicted accumulated movements for each of the Avon Dam closure lines, due to the extraction of LW12 to LW14, 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 2 April 2019.

Table 2.4 Maximum measured and maximum predicted accumulated movements for the Avon Dam closure lines due to the extraction of LW12 to LW14

Location	Measured accumulated closure (mm)	Predicted accumulated closure (mm)
Avon Dam A-Line	30	60
Avon Dam B-Line	-10 (opening)	70
Avon Dam C-Line	-12 (opening)	30
Avon Dam D-Line	-9 (opening)	< 20
Avon Dam E-Line	-6 (opening)	< 20

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

The maximum measured total movements at the Avon Dam closure lines are less than the predicted values at the completion of LW14. It is considered that the ground movements measured using these monitoring lines are consistent with the predictions provided in Reports Nos. MSEC792 and MSEC865.

The closure across Avon Dam and two tributaries to the dam (Refs. LA4A and LA4B) have also been measured by IC 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 closures across LA4A (Den3B-06 to Den3B-07), LA4B (Den3B-05A to Den3B-06) and the Avon Dam (Den3B-05A to Den3B-07) during the extraction of LW12 to LW14 are illustrated in Fig. 2.4.

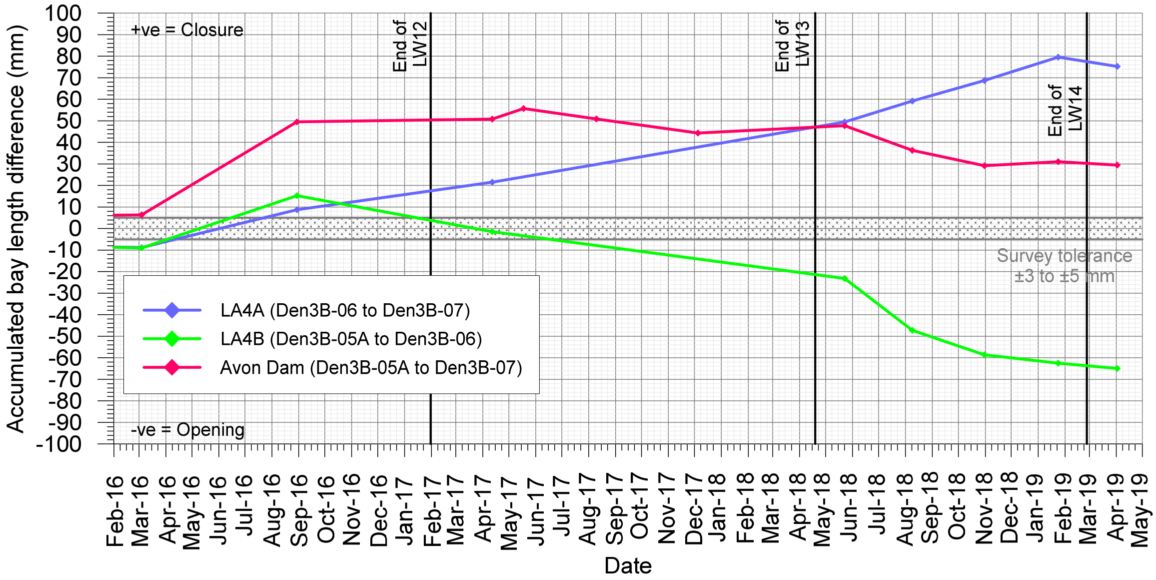

Fig. 2.4 Measured accumulated closure for Tributaries LA4A and LA4B and the Avon Dam

A summary of the total measured and total predicted closures across LA4A, LA4B and Avon Dam is provided in Table 2.5. The measured closure is less than the predicted final closure at the completion of LW14. 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 extraction of LW9 to LW14

Location	Measured accumulated closure (mm)	Predicted accumulated closure (mm)
LA4A (Den3B-06 to Den3B-07)	75	150
LA4B (Den3B-05A to Den3B-06)	-65 (opening)	150
Avon (Den3B-05A to Den3B-07)	29	70

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

The maximum measured total closure movements across the LA4A and the Avon Dam monitoring lines are less than the predicted values at the completion of LW14. Opening was measured across the LA4B monitoring line as the far-field horizontal movement of Mark Den3B-06, towards the longwall mining area, was greater than the valley closure effects across the tributary to Lake Avon. The net movement measured across the LA4B monitoring line is dependent on the positions of the two survey marks on the valley sides.

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 LW14 have been measured by IC 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. MSEC1039-01.

The survey dates for the DA3B 3D monitoring points for LW14 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 LW14

Mining phase commitments	Mining phase survey dates	Post mining phase commitments
Completion of LW14	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)	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 extraction of LW14, are shown in Drawing No. MSEC1039-04. 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 LW14 and skewed towards the east, i.e. towards the longwall finishing end. The greatest movements have been measured directly above LW14 and, to lesser extents, above the previously extracted LW13. 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.

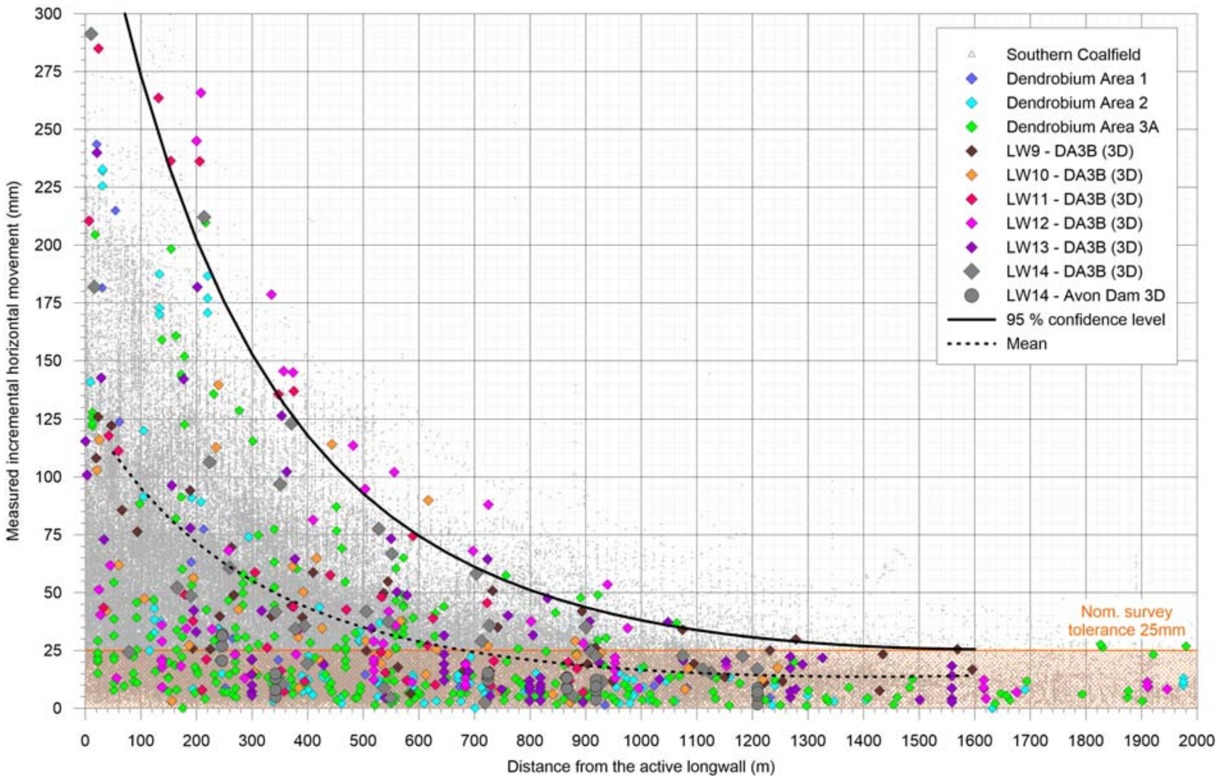

Fig. 2.5 Measured incremental horizontal movements at Dendrobium Mine

The measured incremental horizontal movements resulting from the extraction of LW14 (i.e. dark grey 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 and purple diamonds) and elsewhere in the Southern Coalfield (i.e. grey triangles).

2.5. Donalds Castle Creek cross lines

The mine subsidence movements across Donalds Castle Creek were measured by IC using 2D survey techniques using the DCCXE-Line and DCCXF-Line. The DCCXA-Line, DCCXB-Line, DCCXC-Line and DCCXD-Line were not measured during LW14 due to their distances north of this longwall. The locations of the Donalds Castle Creek cross lines are shown in Drawing No. MSEC1039-01. The survey dates for these monitoring lines are provided in Table 2.7.

Table 2.7 Survey dates for the Donalds Castle Creek cross lines during LW14

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	13 February 2013 (base survey) 4 March 2016 (end of LW11) 28 April 2017 (end of LW12) 14 June 2018 (end of LW13) 22 August 2018 (F-Line only) 28 March 2019 (end of LW14)	Completion of each of the future longwalls in Area 3B

The development of the measured total closures at the DCCXE-Line and DCCXF-Line are illustrated in Fig. 2.6. The DCCXF-Line was established on the 8 May 2015 and therefore it does not include the effects of LW9 and LW10.

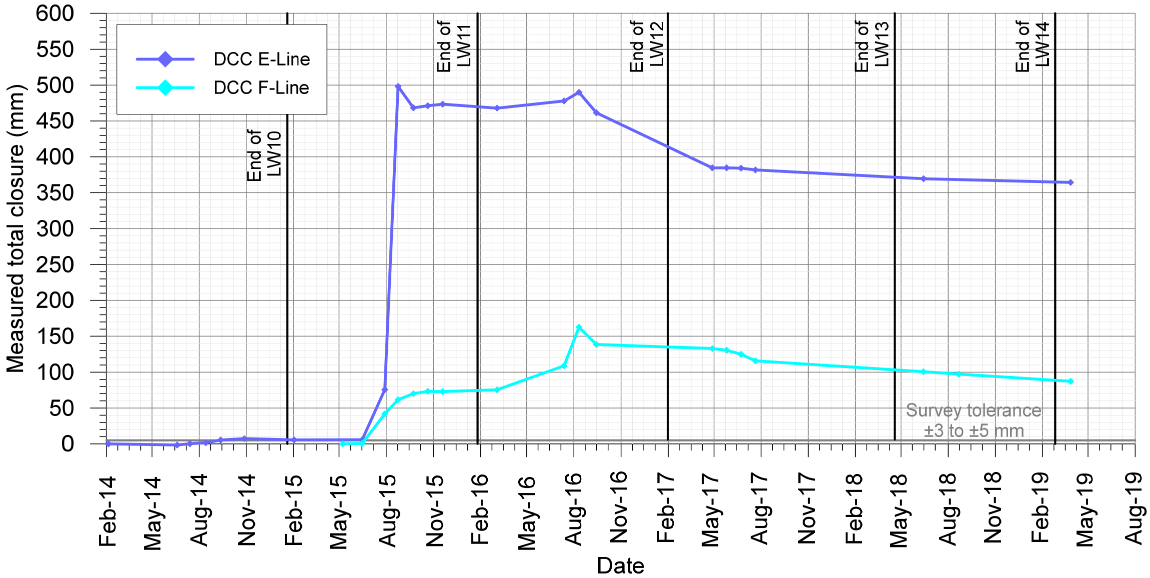

Fig. 2.6 Measured total closure for the Donalds Castle Creek cross lines

There were small reductions in the total closures measured at the DCCXE-Line and DCCXF-Line due to the extraction of LW14. Only small changes were observed as these monitoring lines as they are located more than 700 m from the active longwall.

Summaries of the maximum measured and predicted total vertical subsidence and closure for the DCCXE-Line and DCCXF-Line, after the completion of LW14, are provided in Table 2.8 and Table 2.9, respectively. 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 DCCXE-Line resulting from the extraction LW9 to LW14

Location	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	2536	364
Predicted	2575	375

Table 2.9 Maximum measured and predicted total subsidence and closure at the DCCXF-Line resulting from the extraction LW11 to LW14

Location	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	905	87
Predicted	1375	200

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 measured total vertical subsidence and closure for the DCCXE-Line and DCCXF-Line are less than the predicted values at the end of LW14. The ratios of the maximum measured to maximum predicted total vertical subsidence are 0.98 for the DCCXE-Line and 0.66 for the DCCXF-Line. The ratios of the maximum measured to maximum predicted total closure are 0.97 for the DCCXE-Line and 0.44 for the DCCXF-Line.

It is considered, therefore, that the ground movements measured using Donalds Castle Creek cross lines are consistent with the predictions provided in Reports Nos. MSEC792 and MSEC865.

2.6. WC15 cross lines

The mine subsidence movements across WC15 (a tributary to Wongawilli Creek) have been measured by IC using 2D survey techniques using the WC15 RB9-Line, WC15 RB28-Line and WC15 RB34-Line. These monitoring lines were established in December 2018 during the mining of LW14.

The locations of the WC15 cross lines are shown in Drawing No. MSEC1039-01. The survey dates for these monitoring lines for LW14 are provided in Table 2.10.

Table 2.10 Survey dates for the WC15 cross lines for LW14

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) 15 January 2019 15 February 2019 28 March 2019 (end of LW14)	Monthly once the longwall face is nominally 100 m before the cross line until it is 400 m past

The development of the measured incremental closures at the WC15 cross lines are illustrated in Fig. 2.7. The monitoring lines were established during the mining of LW14 and, therefore, they do not include the effects of LW9 to LW13.

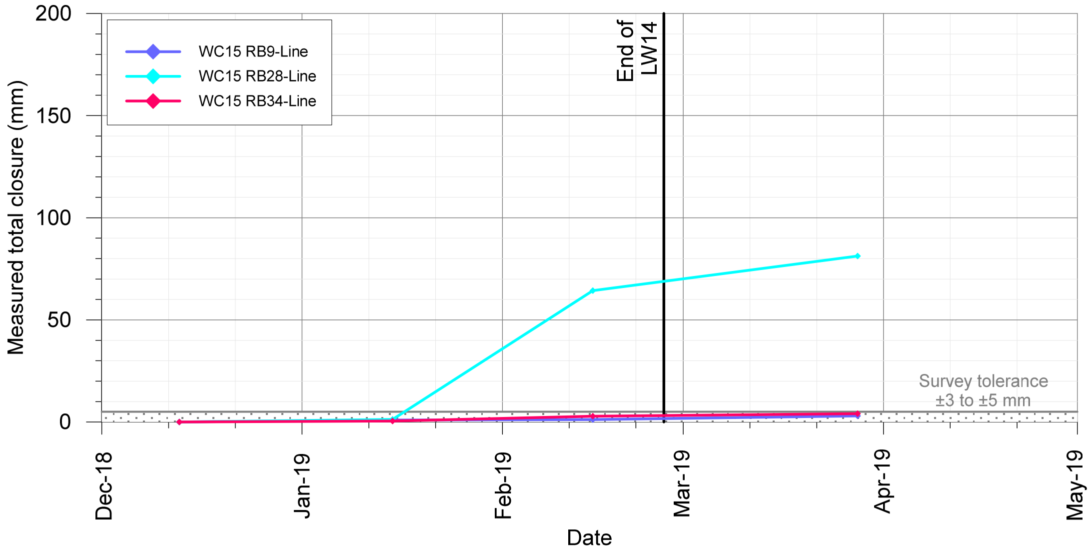

Fig. 2.7 Measured incremental closure for the WC15 cross lines

Summaries of the maximum measured and predicted incremental subsidence and closure at the WC15 closure lines, due to the extraction of LW14, are provided in Table 2.11 to Table 2.13. 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 2.11 Maximum measured and predicted incremental subsidence and closure at the WC15 RB9-Line resulting from the extraction of LW14

Type	Maximum incremental subsidence (mm)	Maximum incremental closure (mm)
Measured	-19 (Uplift)	3
Predicted	< ±20	60

Table 2.12 Maximum measured and predicted incremental subsidence and closure at the WC15 RB28-Line resulting from the extraction of LW14

Type	Maximum incremental subsidence (mm)	Maximum incremental closure (mm)
Measured	-7 (Uplift)	81
Predicted	< ±20	80

Table 2.13 Maximum measured and predicted incremental subsidence and closure at the WC15 RB34-Line resulting from the extraction of LW14

Type	Maximum incremental subsidence (mm)	Maximum incremental closure (mm)
Measured	-17 (Uplift)	4
Predicted	< ±20	60

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.

Low level net uplift in the order of the survey tolerance for absolute height were measured at each of the WC15 RB9-Line, WC15 RB28-Line and WC15 RB34-Line. The closure measured at the WC15 RB28-Line was similar to the predicted value. Only low level closure movements similar to the order of survey tolerance were measured at the WC15 RB9-Line and WC15 RB34-Line.

It is considered, therefore, that the ground movements measured using WC15 cross lines are consistent with the predictions provided in Reports Nos. MSEC792 and MSEC865.

2.7. WC21 cross lines

The mine subsidence movements across WC21 (a tributary to Wongawilli Creek) have been measured by IC using 2D survey techniques using the WC21 F-Line, WC21 H-Line, WC21 I-Line, WC21 J-Line, WC21 K-Line, WC21 L-Line (lower) and WC21 L-Line (upper). The WC21 A-Line, B-Line, C-Line, D-Line, E-Line and G-Line were not measured during LW14.

The locations of the WC21 cross lines are shown in Drawing No. MSEC1039-01. The survey dates for these monitoring lines for LW14 are provided in Table 2.14.

Table 2.14 Survey dates for the WC21 cross lines for LW14

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	13 February 2013 (base survey) 4 March 2016 (end of LW11) 28 April 2017 (end of LW12) 14 June 2018 (end of LW13) 25 September 2018 25 October 2018 11 December 2018 15 January 2019 28 March 2019 (end of LW14)	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 WC21 cross lines are illustrated in Fig. 2.8. The WC21 H-Line was established on the 21 October 2015 and, therefore, it does not include the effects of LW9 and LW10. The WC21 I-Line, J-Line, K-Line, L-Line (lower) and L-Line (upper) were established on the 5 October 2016 and, therefore, they do not include the effects of LW9 to LW11.

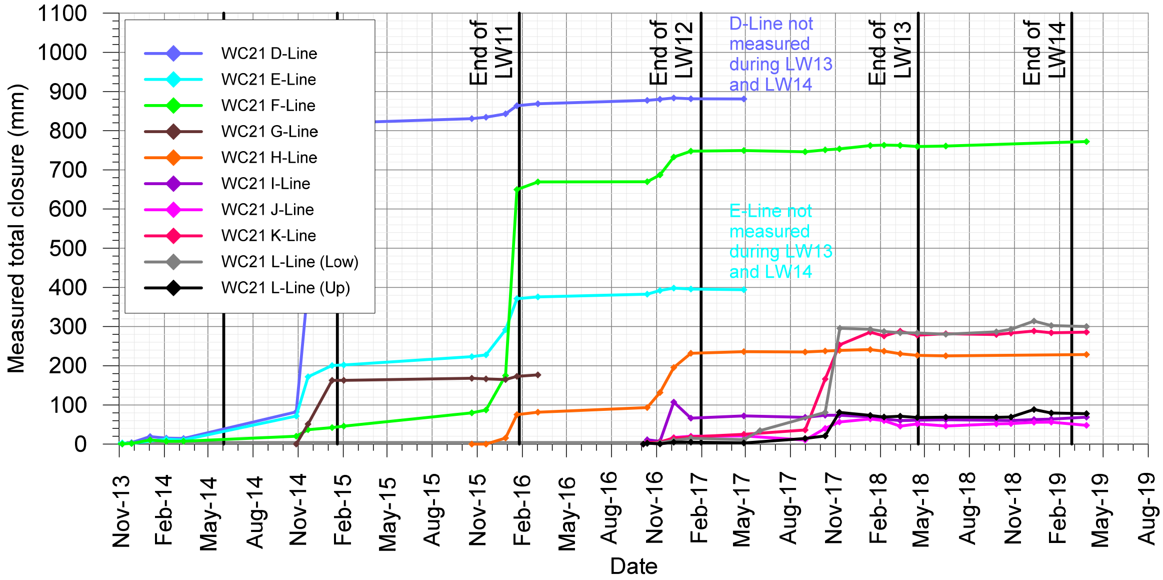

Fig. 2.8 Measured total closure for the WC21 cross lines

There were small changes in the total closures measured at the WC21 cross lines due to the extraction of LW14. These monitoring lines are located at distances ranging between 150 m and 875 m north of LW14, above the previously extracted longwalls.

Summaries of the maximum measured and predicted total subsidence and closure at the WC21 cross lines, after the completion of LW14, are provided in Table 2.15 to Table 2.20. 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 2.15 Maximum measured and predicted total subsidence and closure at the WC21 F-Line resulting from the extraction of LW9 to LW14

Type	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	1752	772
Predicted	3150	825

Table 2.16 Maximum measured and predicted total subsidence and closure at the WC21 H-Line resulting from the extraction of LW11 to LW14

Type	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	814	228
Predicted	1575	300

Table 2.17 Maximum measured and predicted total subsidence and closure at the WC21 I-Line (SW10-Line) resulting from the extraction of LW11 to LW14

Type	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	2527	69
Predicted	3450	350

Table 2.18 Maximum measured and predicted total subsidence and closure at the WC21 J-Line resulting from the extraction of LW12 to LW14

Type	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	886	48
Predicted	1400	275

Table 2.19 Maximum measured and predicted total subsidence and closure at the WC21 K-Line resulting from the extraction of LW12 to LW14

Type	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	1289	286
Predicted	2225	675

Table 2.20 Maximum measured and predicted total subsidence and closure at the WC21 L-Line (lower and upper) resulting from the extraction of LW12 to LW14

Type	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	1992	300
Predicted	3100	675

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 measured total vertical subsidence and closure for the WC21 cross lines are less than the predicted values at the completion of LW14. The measured vertical subsidence movements range between 52 % and 73 % of the predicted values, with an average of 61 %. The measured closures range between 17 % and 94 % of the predicted values, with an average of 49 %.

It is considered, therefore, that the ground movements measured using WC21 cross lines are consistent with the predictions provided in Reports Nos. MSEC792 and MSEC865.

2.8. Swamp cross lines

The mine subsidence movements across the swamps and their associated drainage lines have been measured by IC using 2D survey techniques using the SW4-Line, SW10-Line, SW11-Line, SW13-Line and SW23-Line. The locations of the swamp cross lines are shown in Drawing No. MSEC1039-01. The survey dates for these monitoring lines are provided in Table 2.21.

Table 2.21 Survey dates for the swamp cross lines during LW14

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	9 February 2015 (base survey) 17 February 2016 (end of LW11) 28 February 2017 (end of LW12) 15 May 2018 (end of LW13) 26 June 2018 (SW4 and SW11) 25 July 2018 (SW4, SW 11 and SW23) 22 August 2018 (SW 11 and SW23) 25 September 2018 (SW13 only) 25 October 2018 (SW13 only) 11 December 2018 (SW13 only) 17 January 2019 (SW13 only) 15 February 2019 (SW13 only) 26 March 2019 (all lines)	First survey 100 m before lines then monthly surveys, final survey when mining 400 m past lines

Summaries of the maximum measured and predicted total subsidence and closure along the swamp cross lines, resulting from the extraction of LW11 to LW14, are provided in Table 2.22 to Table 2.26. The base survey for the SW23-Line was carried out after the completion of LW13 and, therefore, the results for this monitoring line are due to LW14 only.

The measured values for SW4-Line, SW10-Line, SW11-Line, SW13-Line and SW23-Line are based on the latest survey dated 26 March 2019. 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 2.22 Maximum measured and predicted total subsidence and closure at the SW4-Line resulting from the extraction of LW11 to LW14

Type	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	2037	190
Predicted	2700	425

Table 2.23 Maximum measured and predicted total subsidence and closure at the SW10-Line resulting from the extraction of LW11 to LW14

Type	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	2286	69
Predicted	3450	350

Table 2.24 Maximum measured and predicted total subsidence and closure at the SW11-Line resulting from the extraction of LW11 to LW14

Type	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	*Not measured*	-16 (opening)
Predicted	250	125

Table 2.25 Maximum measured and predicted total subsidence and closure at the SW13-Line resulting from the extraction of LW11 to LW14

Type	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	1375	39
Predicted	1925	175

Table 2.26 Maximum measured and predicted total subsidence and closure at the SW23-Line resulting from the extraction of LW14 only

Type	Maximum total subsidence (mm)	Maximum total closure (mm)
Measured	*Not measured*	15
Predicted	< 20	50

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 total vertical subsidence and closure at the SW4-Line, SW10-Line, SW11-Line, SW13-Line and SW23-Line are all less than the predicted values. The measured vertical subsidence movements range between 66 % and 75 % of the predicted values. The measured closures (excluding the SW11-Line) range from less than 20 % to 45 % of the predicted values. Opening of less than 20 mm was measured at the SW11-Line.

It is considered, therefore, that the ground movements measured using Swamp cross lines are consistent with the predictions provided in Reports Nos. MSEC792 and MSEC865.

2.9. ALS / LiDAR surveys

The changes in surface level due to the extraction of LW9 to LW14 have been measured using Airbourne Laser Scan (ALS) / Light Detection and Ranging (LiDAR) surveys. The initial surface level contours have been determined from the base survey carried out in January 2013, prior to the extraction of LW9. The post mining surface level contours have been determined from the subsequent surveys carried out in February 2014 after LW9, in January 2015 after LW10, in April 2016 after LW11, in March 2017 after LW12, in May 2018 after LW13 and in March 2019 after LW14.

The measured incremental changes in surface level due to the extraction of LW14 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.

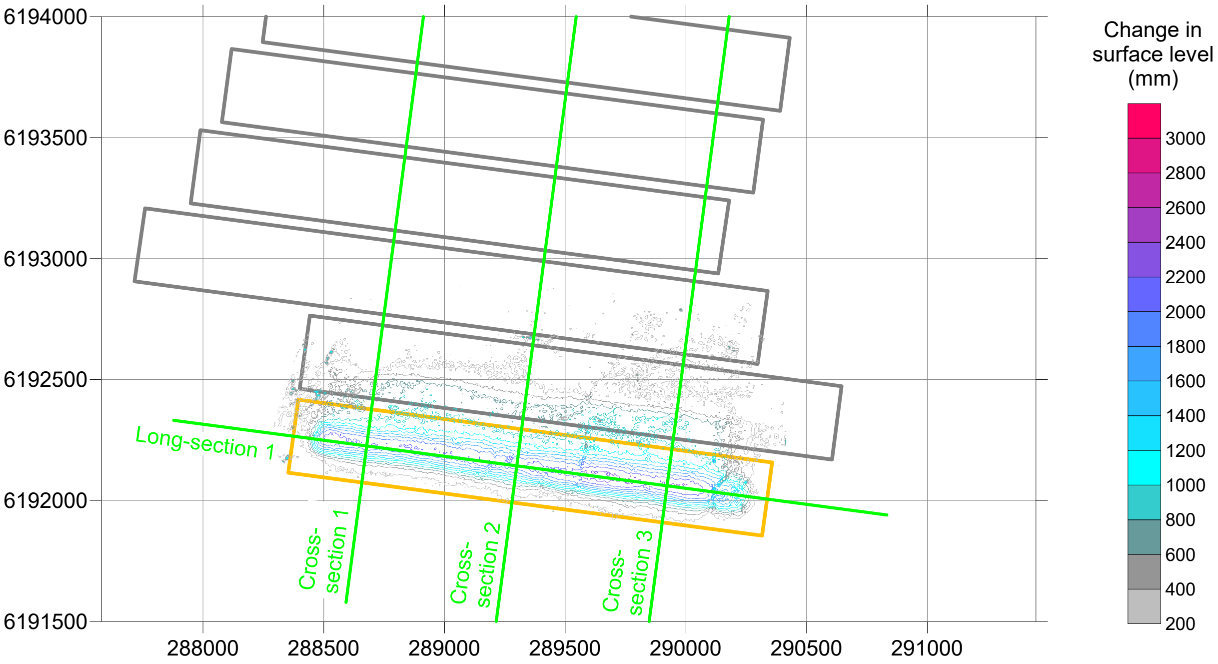

Fig. 2.9 Measured incremental changes in surface level due to the extraction LW14

The measured total changes in surface level due to the extraction of LW9 to LW14 are shown in Fig. 2.10. These contours have been determined by taking the differences between the surface levels measured before the extraction of LW9 and after the completion of LW14. The data located outside the predicted limit of vertical subsidence (i.e. total 20 mm subsidence contour) have been removed for clarity.

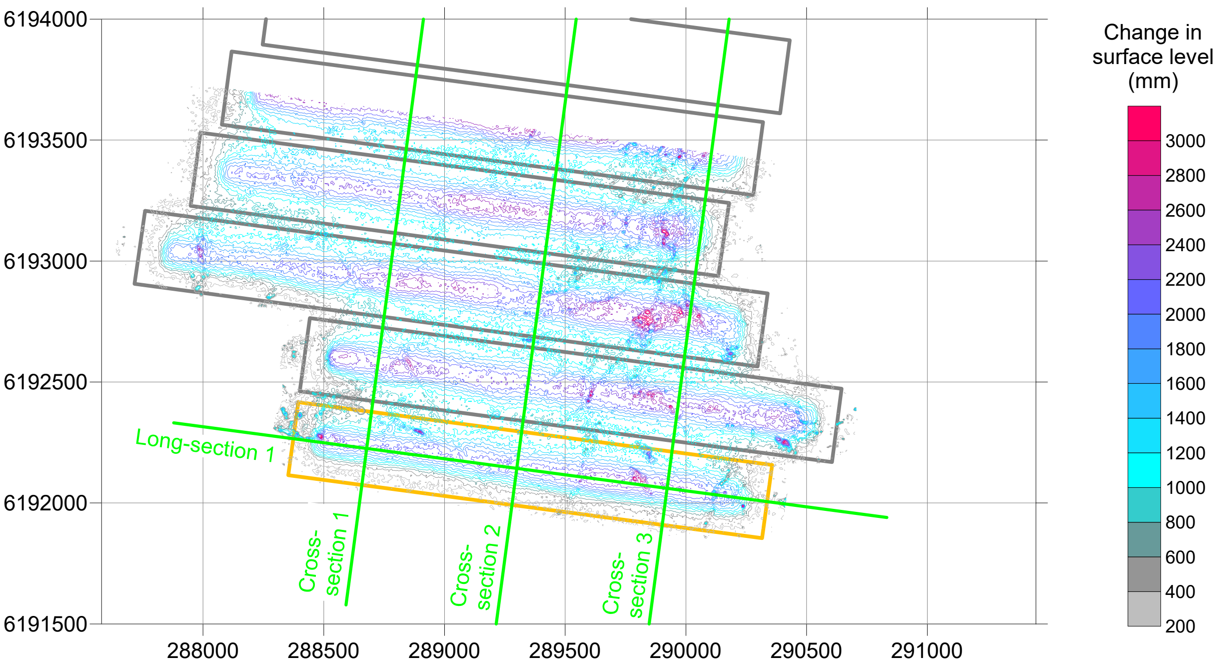

Fig. 2.10 Measured total changes in surface level due to the extraction of LW9 to LW14

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.

Locally increased movements were apparent in the total changes in surface level contours near Swamp 23 (not shown in Fig. 2.10, as it is located south of the predicted limit of vertical subsidence, which was used to crop the data for clarity). However, these localised movements were not visible in the incremental changes in surface level, indicating that these effects occurred prior to the mining of LW14. A site inspection of the area identified a fallen tree and flattened vegetation that could partly account for these apparent movements. The variable vegetation distribution within the swamp can also affect the LiDAR surveys by making it more difficult to filter out the non-ground laser strikes. Other apparent localised movements are also likely to be due to the effects of the horizontal movements and sloping terrain on the LiDAR surveys.

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 predicted profiles of vertical subsidence have been derived from the predicted subsidence contours illustrated in Report No. MSEC865.

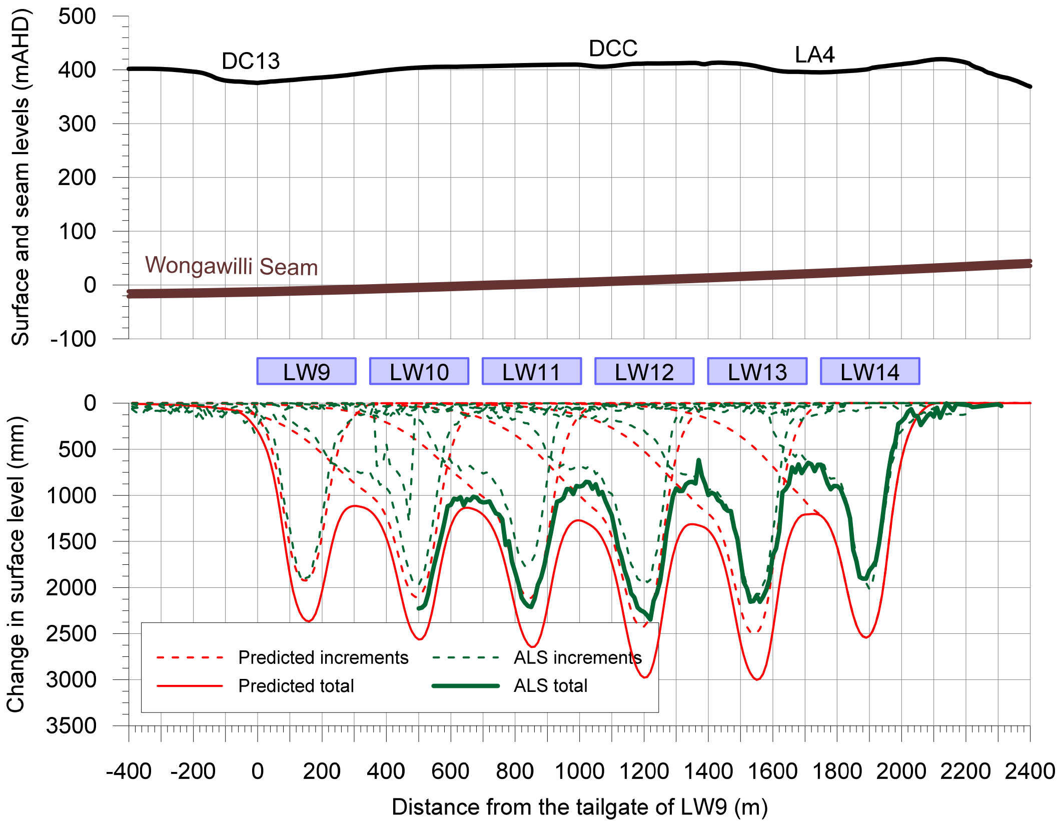

Fig. 2.11 Measured changes in surface level and predicted vertical subsidence along Cross-section 1

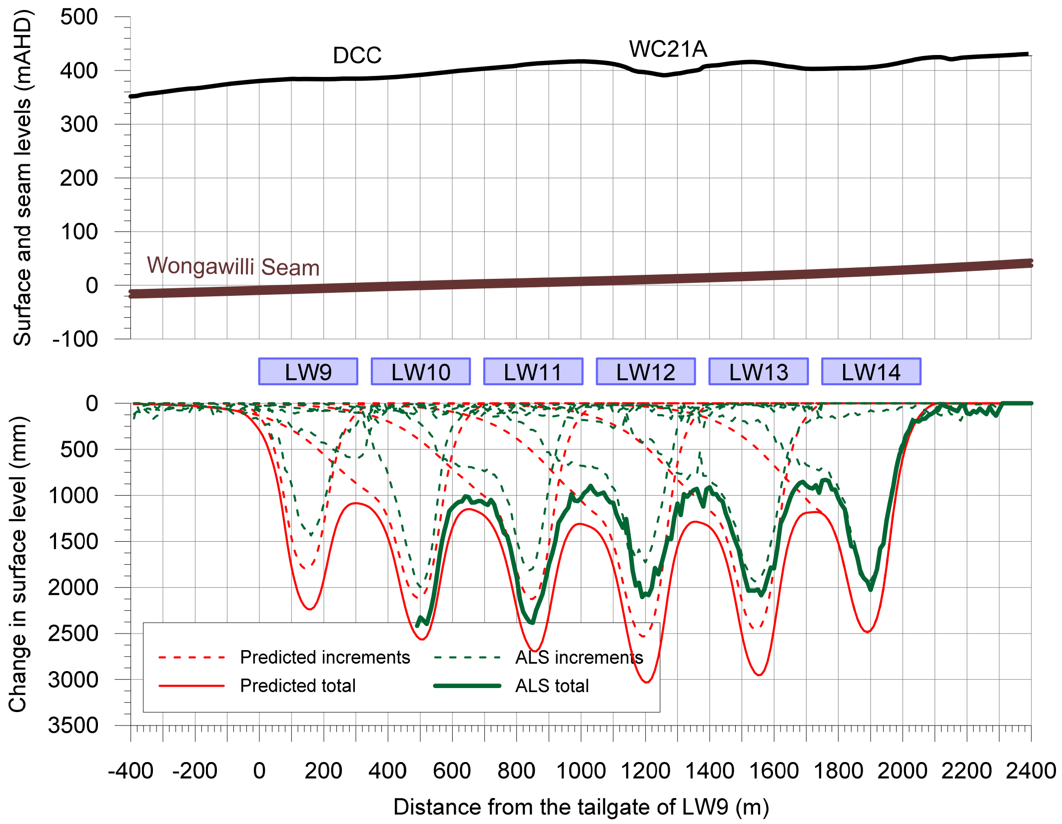

Fig. 2.12 Measured changes in surface level and predicted vertical subsidence along Cross-section 2

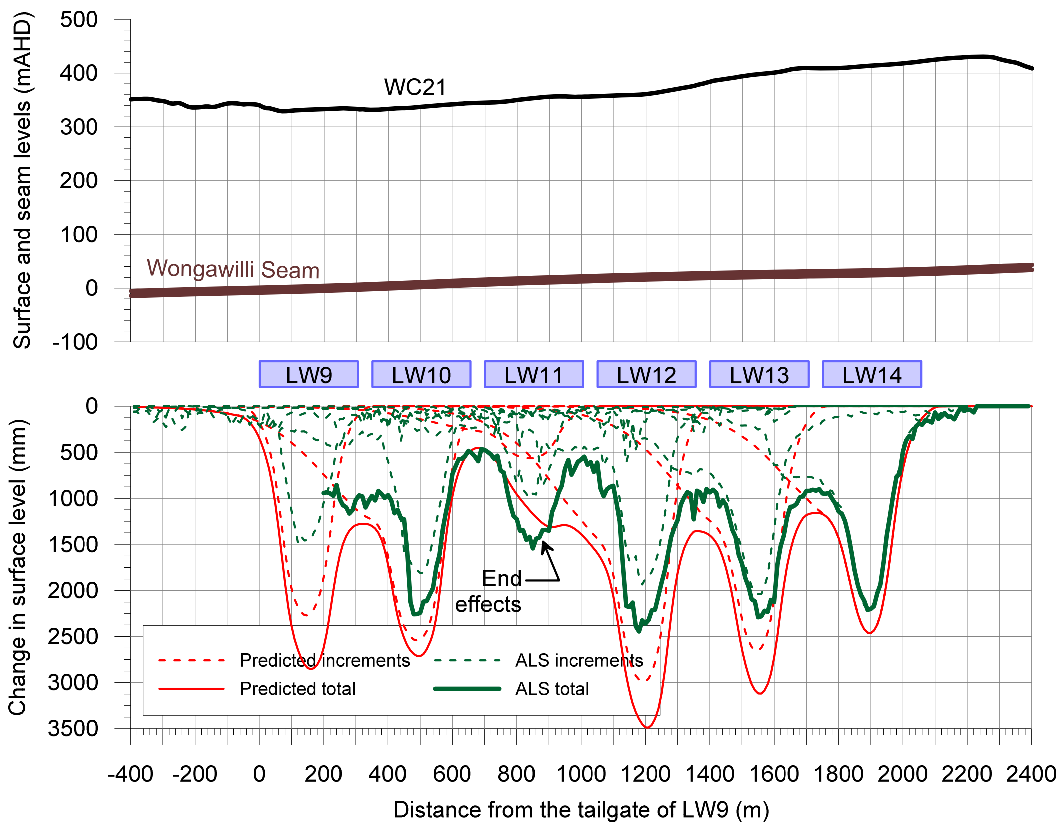

Fig. 2.13 Measured changes in surface level and predicted vertical subsidence along Cross-section 3

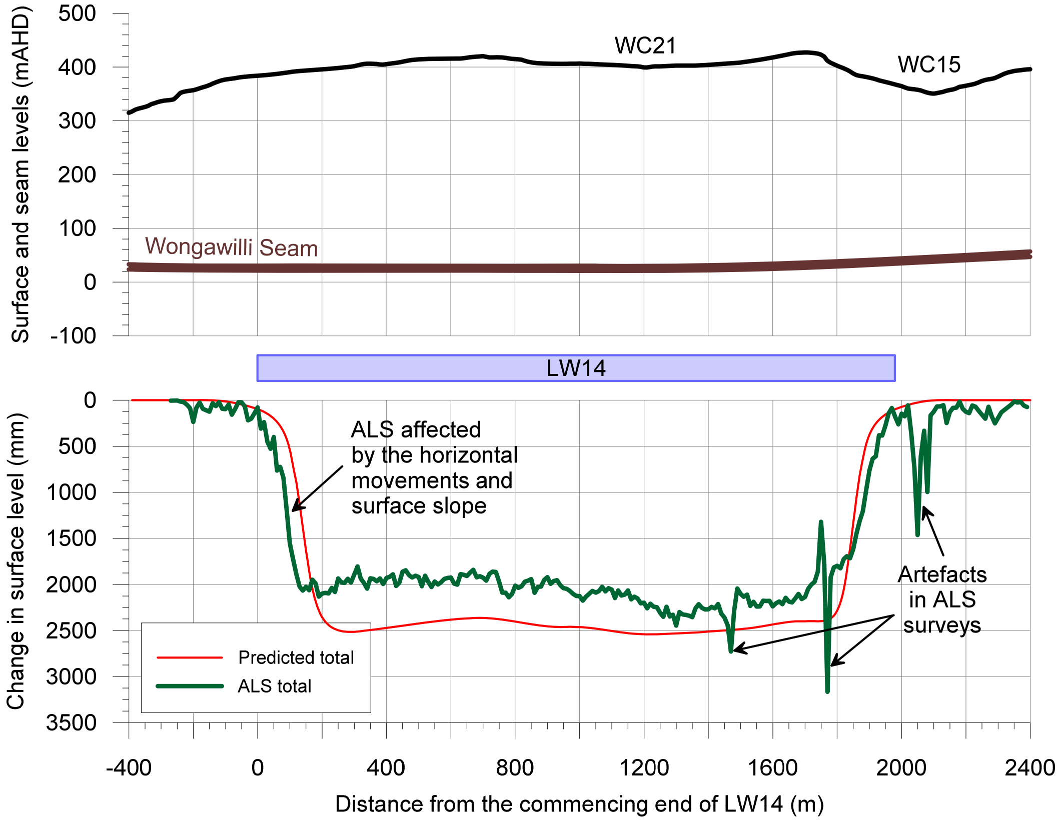

Fig. 2.14 Measured changes in surface level and predicted vertical subsidence along Long-section 1

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 less than the maximum predicted values. Also, the measured changes in surface level above each of the chain pillars are similar to, but slightly 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 LW11. This cross-section is located close to the finishing end of LW11 and, therefore, the predictions are influenced by the longwall end effects. 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 LW14 (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 LW14 has moved towards the longwall (i.e. following the extraction face) as illustrated in the horizontal movement vectors in Drawing No. MSEC1039-04. 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 LW14.

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.

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 extraction of LW14 have been identified by the IC Environmental Field Team and are described in the accompanying IC landscape report. The locations of the soil cracking and rock fracturing identified during the extraction of LW14 is illustrated in Fig. 3.1.

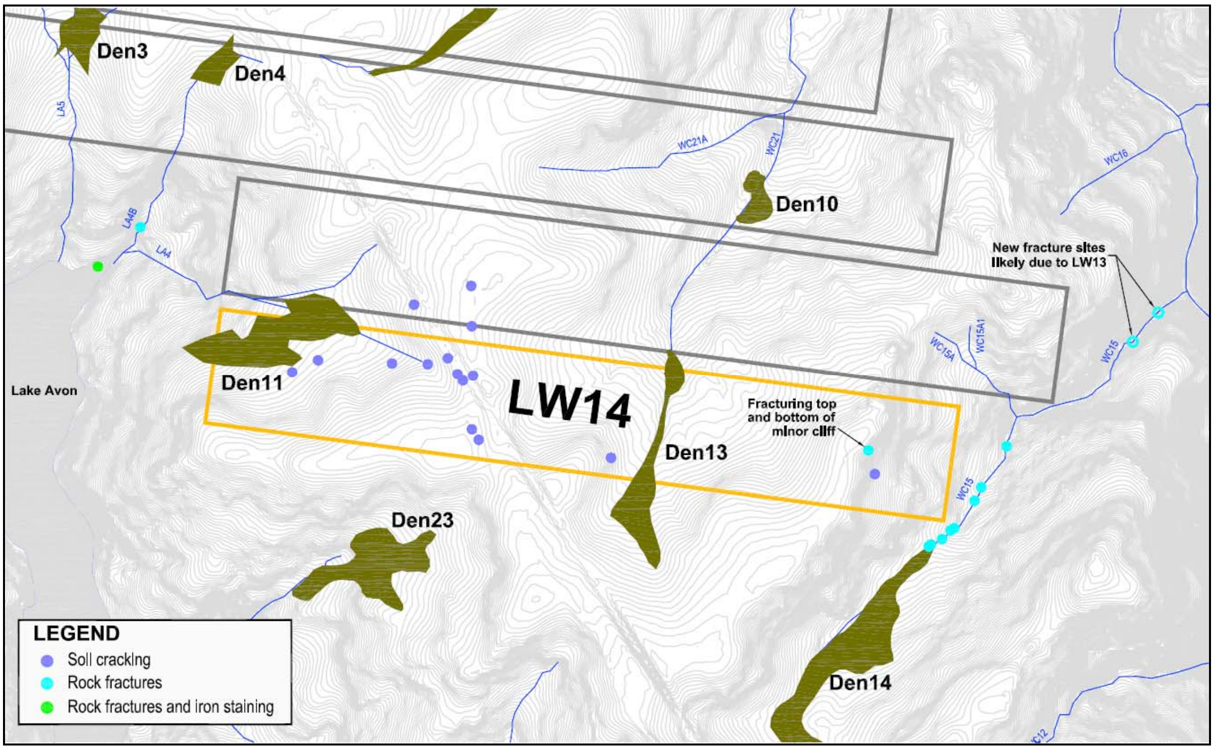

Fig. 3.1 Surface deformations due to the extraction of LW14

Soil cracking (i.e. blue circles) was identified at 16 sites along or near the fire trails, seismic tracks and the railway corridor. The soil cracking was predominately identified directly above LW14 but some sites were located above the previously extracted LW13. The maximum crack widths typically ranged between 7 mm and 50 mm, with a maximum crack width of 60 mm measured at one site. Rock fracturing also occurred at the top and bottom of a minor cliff, on the ridgeline above the eastern end of LW14, which had a maximum width of 150 mm.

Rock fracturing was identified at eight sites along WC15 due to the extraction of LW14. Fracturing was previously observed at six sites along this tributary at the completion LW13, with two additional sites identified in the current surveys that are considered to be due to LW13 (i.e. eight sites in total for LW13).

A summary of the eight sites with rock fractures along WC15 due to the extraction of LW14 is provided in Table 3.1. The locations of these sites are also illustrated in Fig. 3.2.

Table 3.1 Fracturing sites observed along WC15 due to LW14

Site ID	Location	Maximum fracture width (mm)
DA3B_LW14_016	Rockbar 25	30
DA3B_LW14_017	Channel 30	25
DA3B_LW14_018	Pool 30	15
DA3B_LW14_019	Rockbar 28	50
DA3B_LW14_020	Rockbar 26	50
DA3B_LW14_021	Rockbar 21	10
DA3B_LW14_022	Rockbar 18	50
DA3B_LW14_023	Pool 22	1

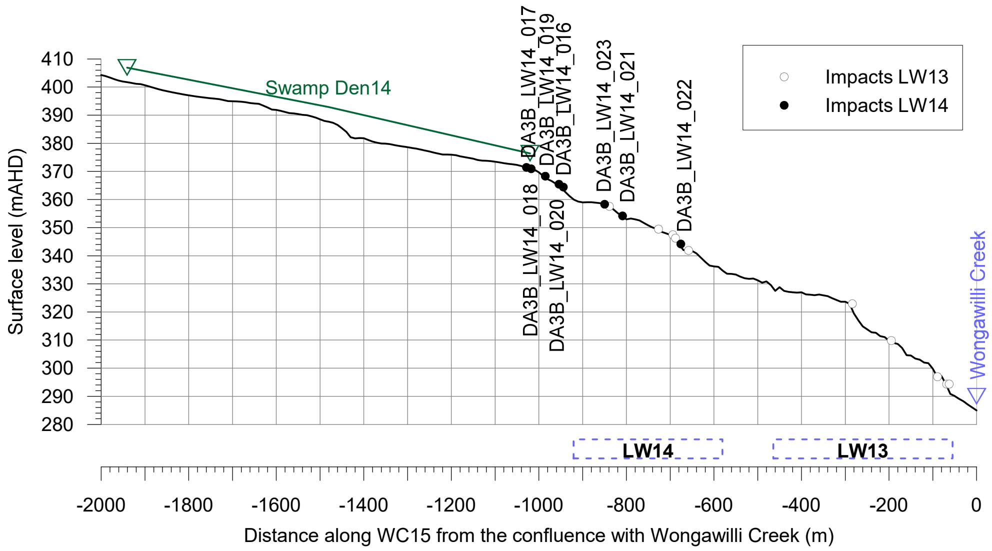

Fig. 3.2 Rock fractures identified along WC15

The maximum fracture widths along WC15 due to the extraction of LW14 ranged between 1 mm and 50 mm. The impacts are located at distances between 30 m and 140 m from the longwall finishing end. No surface water diversions (i.e. Type 3 impacts) were observed at these sites during the inspections. However, some fractures are located along the main channel and surface water diversions are possible during higher flow conditions.

Rock fracturing and iron staining (i.e. green circle in Fig. 3.1) was identified at one site along LA4 (Ref. DA3B_LW14_015). Fracturing was initially observed at this site during LW13 with additional fracturing occurring due to LW14. The maximum fracture width was 10 mm. No surface water diversion (i.e. Type 3 impact) was observed along this tributary during the inspections.

Rock fracturing and a small rockfall was identified at one site along tributary LA4B (Ref. DA3B_LW13_044). However, it is likely that these impacts occurred during LW13 but they were not identified at that time due to thick vegetation. The maximum fracture width was 100 mm. No surface water diversion (i.e. Type 3 impact) was observed along this tributary during the inspections.

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

3.2. Natural features

The natural features near Dendrobium LW14 are shown in Drawing No. MSEC1039-02, in Appendix A, and include:

- Wongawilli Creek;
- Donalds Castle Creek;
- drainage lines;
- cliffs;
- rock outcrops;
- steep slopes;
- swamps; and
- archaeological sites.

The MSEC assessed impacts for the natural features resulting from the extraction 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. More detailed assessments for the natural features were also provided in other consultants' reports.

Comparisons between the MSEC assessments and the reported impacts for the natural features listed above, resulting from the extraction of LW14, are provided in Table 3.2. The reported impacts are based on those recorded by IC Environmental Field Team that are described in the accompanying landscape report.

Table 3.2 Assessed and reported impacts for the natural features due to LW14

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 LW14. 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 LW14. One Type 3 impact was previously observed between LW6 and LW9, where fracturing was first observed during the mining of LW9.
Donalds Castle Creek	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.
	Fracturing of the bedrock directly above the longwall, however, the majority of this section of the creek has soil accumulations (i.e. only isolated outcropping of bedrock above the longwall). Also, possible for some minor **fracturing** of the bedrock outside and within 400 m of the longwalls due to strain.	No reported impacts.
	Surface water flow diversions could occur directly above the longwall due to fracturing of the bedrock	No reported impacts.
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 fractures due to LW14 identified along WC15 (eight locations), LA4 (one location) and LA4B (one location). The fracture widths along WC15 and LA4 varied between 1 mm and 50 mm and the fracture width along LA4B was up to 100 mm. The impacts occurred at distances ranging between 30 m and 300 m from the longwall mining area. Refer to the IC landscape report for further details.
	Surface water flow diversions into the dilated strata beneath the drainage lines which are directly mined beneath.	No new surface water diversions identified due to the mining of LW14. However, fracturing along WC15 is located along the main channel and surface water diversions are possible during higher flow conditions. Surface water diversions previously observed along WC15 due to LW13. Refer to the IC landscape report for further details.
	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 at the top and bottom of a minor cliff located along the ridgeline above the eastern end of LW14, with widths up to 150 mm. No rock falls identified at the minor cliff.

Natural feature	MSEC assessed impacts	Reported impacts
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 spalling of Lake Avon rock ledge. Fracture widths varied up to approximately 100 mm and rock fall of approximately 3 m^3.
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 varied between 7 mm and 60 mm. Refer to the IC 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 recession rates greater than baseline for Swamps 13 and 14. Soil moisture levels lower than baseline in Swamp 23. Refer to the IC 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.	Fracturing in the back wall of Site 1-DB1 due to the mining of LW14. Refer to the accompanying archaeological report for further details.

The extraction of LW6 to LW14 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 2 km. The rate of Type 3 impacts along the creek due the mining of LW6 to LW14, 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, LA4 and LA4B at distances ranging between 30 m and 300 m from the longwall mining area. It was assessed that rock fracturing could occur along the streams up to approximately 400 m from the mining area.

No new surface water diversions were identified due to the mining of LW14. However, fracturing along WC15 is located along the main channel and surface water diversions are possible during higher flow conditions. There are seven sites with identified or with possible Type 3 impacts along WC15 due to the mining of both LW13 and LW14, being Rockbars 0/1, Rockbar 5, Rockbar 18, Rockbar 21, Rockbar 25, Rockbar 26 and Pool 30/Channel 30.

To date, there is a total of nine Type 3 impact sites along the unnamed streams that are located outside but within 400 m of the completed LW9 to LW14 in Area 3B. These comprise the seven sites along WC15 (due to LW13 and LW14), one site along LA4 (due to LW12 and LW13) and one site along LA4B (due to LW12 and LW13). However, there are also 61 other rockbars that are located outside and within 400 m of the longwall mining area that did not experienced Type 3 impacts.

The observed impact rate of rockbars located along the unnamed streams located outside and within 400 m of LW9 to LW14 therefore is 13 %. Whilst the assessed rate of impact was not provided in Reports Nos. MSEC459, MSEC792 or MSEC865, the proportion of affected sites is considered low when compared with the affected sites located directly above the longwall mining area.

It is considered, therefore, that the observed impacts on the natural features due to the extraction of LW14 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 LW14 are shown in Drawing No. MSEC1039-03, 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 LW14, at its closest point. The Upper Cordeaux No. 2 Dam Wall is located more than 6 km south-east of LW14, at its closest point. It is unlikely that these dam walls would experience measurable far-field horizontal movements resulting from the extraction of LW14 and, therefore, they have not been assessed further.

The MSEC assessed impacts for the built features resulting from the extraction 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, resulting from the extraction of LW14, are provided in Table 3.3. The reported impacts are based on those recorded by IC Environmental Field Team that are described in the accompanying landscape report.

Table 3.3 Assessed and reported impacts for the built features due to LW14

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 7 mm and 60 mm. Refer to the IC 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 above LW14 near the alignment of the railway corridor.
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, resulting from the extraction of LW14, are similar to or less than the MSEC assessments provided in Reports Nos. MSEC459, MSEC792 and MSEC865.

4.0 SUMMARY

The mine subsidence movements due to the extraction of LW14 were measured using the Wongawilli Creek closure lines, Avon Dam closure lines, Area 3B and Avon Dam 3D monitoring points, Donalds Castle Creek cross lines, WC15 and WC21 cross lines, swamp cross lines and airborne laser scans of the area.

The measured ground movements after the extraction of LW14 were 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 extraction of LW14 are consistent with the predictions provided in Reports Nos. MSEC792 and MSEC865.

Soil cracking and rock fracturing were observed directly above LW14, the previously extracted LW13 and along the streams at distances up to 300 m outside of the longwall. The crack and fracture widths varied between approximately 1 mm and 150 mm, with the majority of the surface deformations having widths of 50 mm or less. 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.

No new surface water diversions via fracturing in the streams were identified due to the mining of LW14. However, fracturing along WC15 is located along the main channel and surface water diversions are possible during higher flow conditions. To date, there is a total of nine Type 3 impact sites along the unnamed streams that are located outside but within 400 m of the completed LW9 to LW14 in Area 3B. This represents an impact rate of approximately 13 % of the rockbars located outside and within 400 m of the longwall mining area. The proportion of affected sites is considered low when compared with the affected sites located directly above the longwall mining area.

It is considered, therefore, that the observed surface impacts on the natural and built features, resulting from the extraction of LW14, 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

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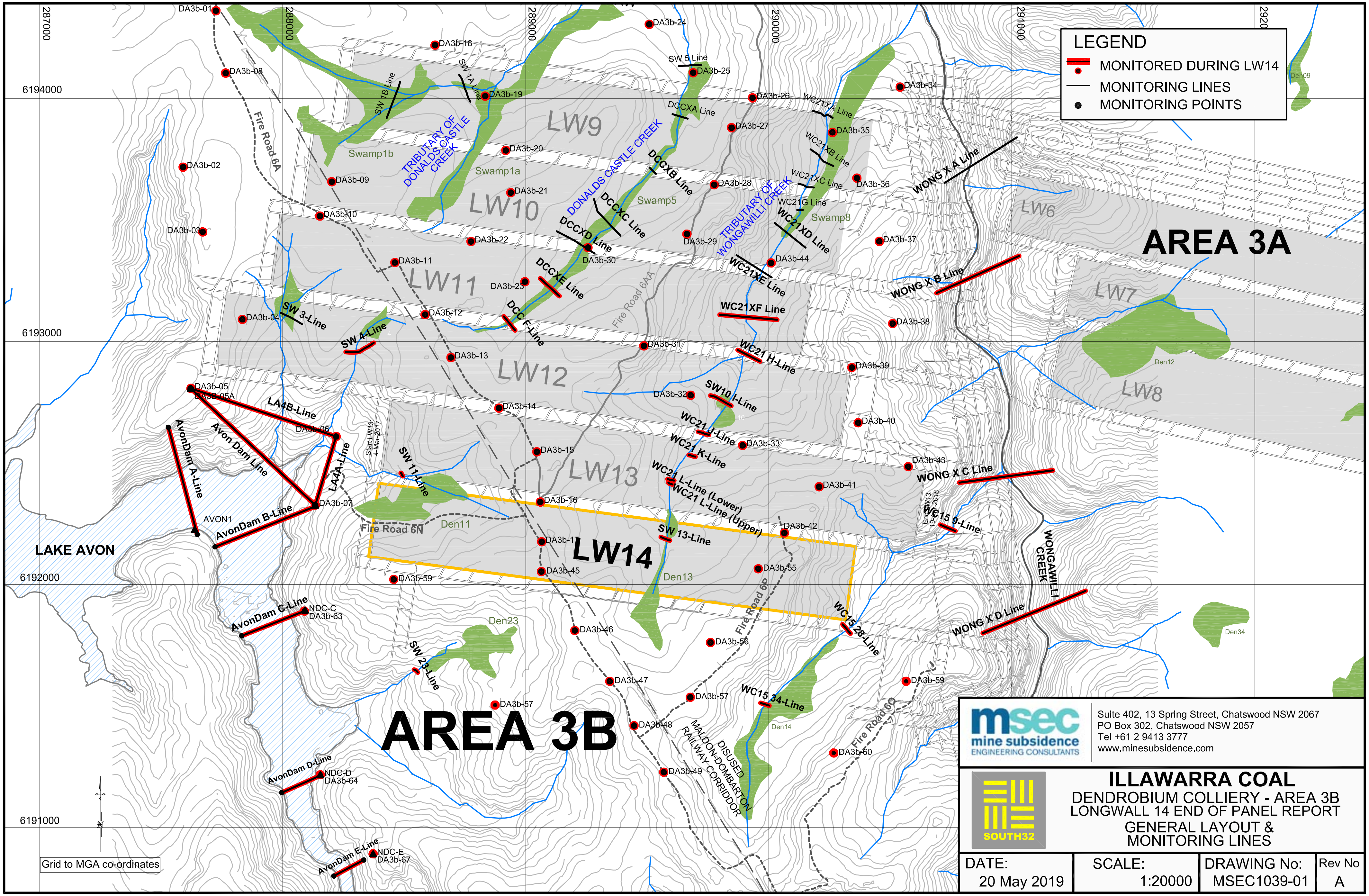

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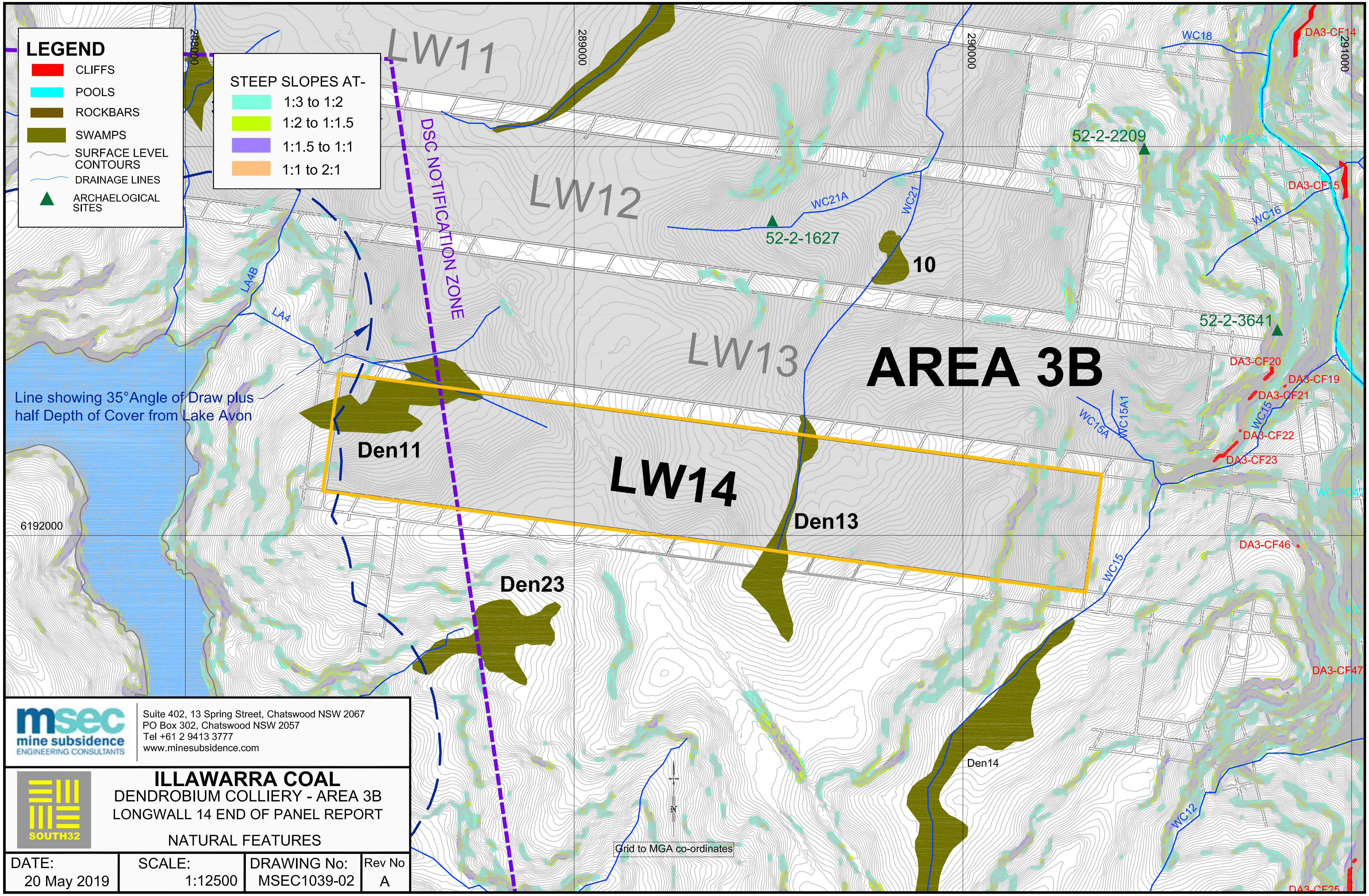

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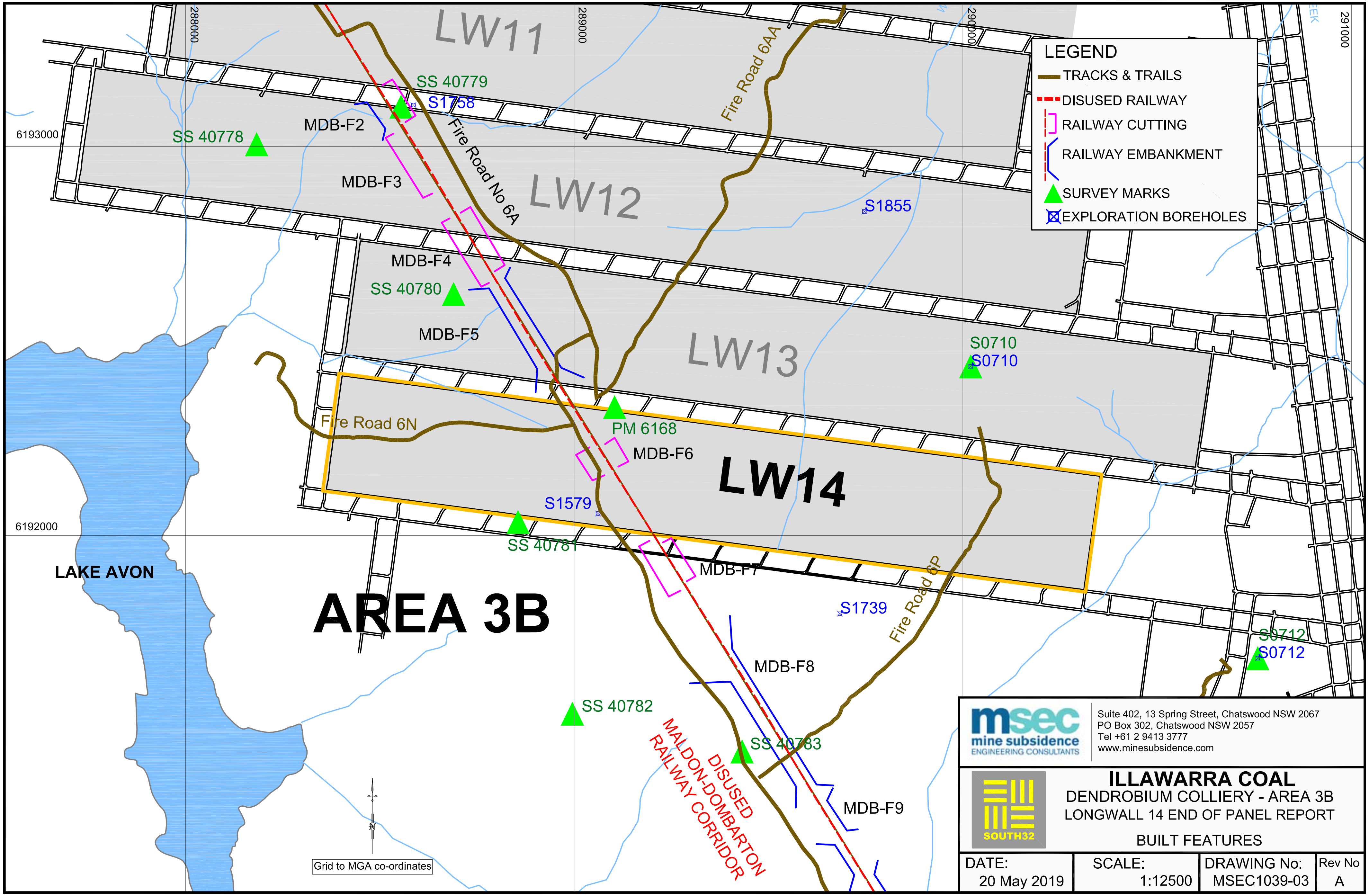

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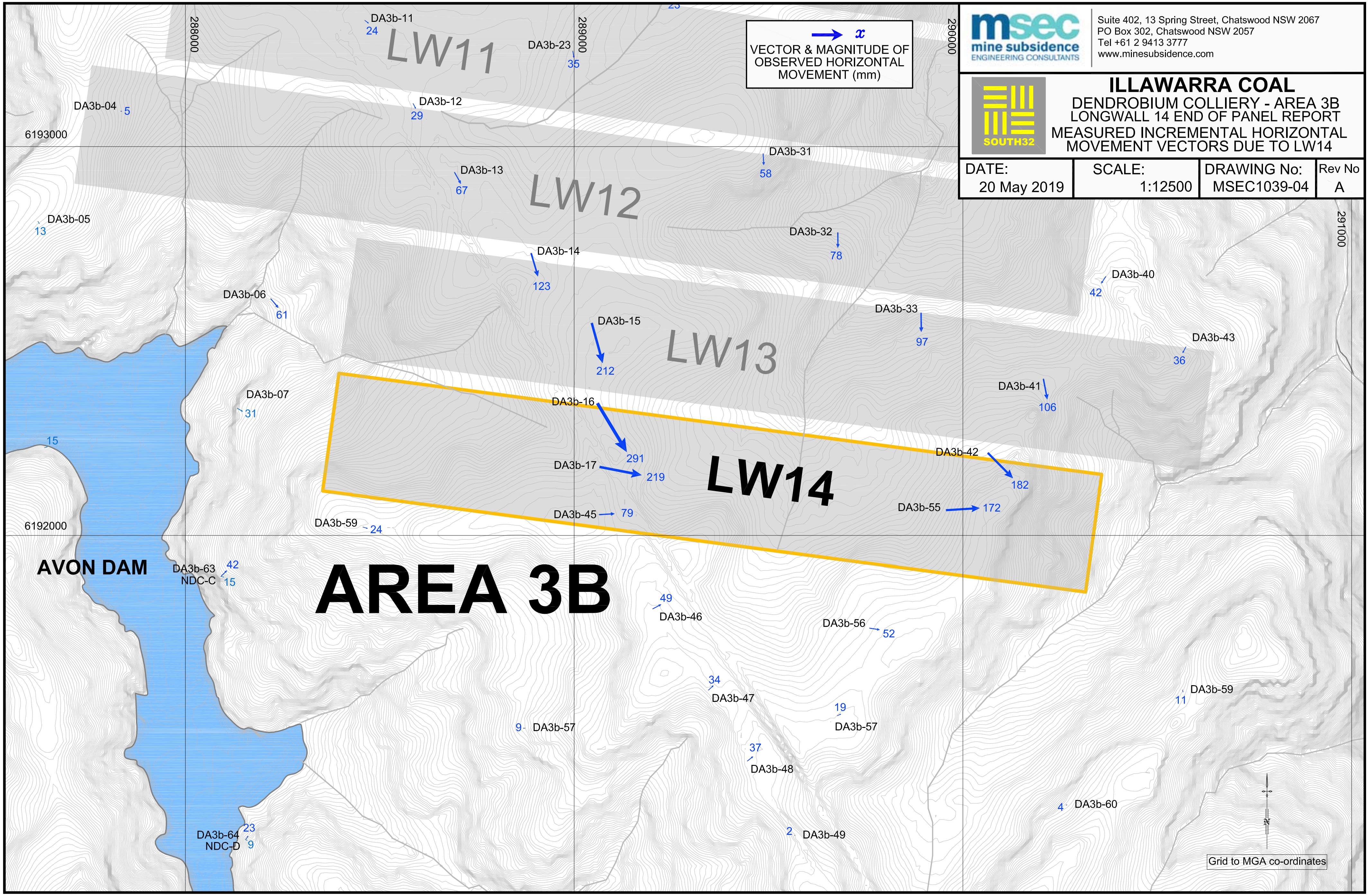

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DENDROBIUM COLLIERY - AREA 3B
LONGWALL 14 END OF PANEL REPORT
MEASURED INCREMENTAL HORIZONTAL MOVEMENT VECTORS DUE TO LW14

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