Illawarra Coal - Carbon Steel Materials

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8 October 2012

Industry and Investment
P.O. Box 344
Hunter Regional Mail Centre NSW 2310
Attn: Paul Langley, Subsidence Executive Officer

Dear Paul

West Cliff Mine Area 5 Longwalls 34 – 6 SMP Variation Application to Reduce Longwall 36 Void

Pursuant to Condition 1 of the Subsidence Management Plan Approval for Longwalls 34-36 dated 6 August 2010, approval is sought to vary the area of extraction as shown on Approved Plan AS-2571.

Approval is sought to reduce the length of Longwall 36 (void) by 1008m at the western end as shown on attached Approved Plan AS-2571. The variation is required due to the operational issues associated with low seam section (less than 2m in height) and high insitu ash.

The proposed shortening of Longwall 36 equates to approximately 726,000 tonnes of in-situ coal which will not be mined.

The impact of the reduction in length of Longwall 36 has been assessed by Mine Subsidence Engineering Consultants (MSEC 573) as the same or less than the previous layout.

Pursuant to Condition 1 of the SMP Approval, Illawarra Coal seeks Approval of the new Approved Plan, AS-2571.

Should further information be required or if you would like to discuss this matter, please contact the undersigned.

Yours sincerely,

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West Cliff Colliery – Longwall 36

The Effects of the Proposed Modified Commencing End of Longwall 36 on Previous Subsidence Predictions and Impact Assessments

DOCUMENT REGISTER

Revision	Description	Author	Checker	Date
01	Draft Issue	JB	-	11th Jul 12
A	Final Issue	JB	PA	18th Jul 12

Report produced to:- Support the Application to Modify the Commencing End of West Cliff Longwall 36 to be assessed by the Department of Trade, Investment, Regional Infrastructure and Services (DTIRIS).

Previous reports:- MSEC326 (Revision C – December 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 34 to 36 in Area 5 at West Cliff Colliery (In Support of the SMP Application).

MSEC344 (Revision B – February 2008) - Predicted Subsidence Parameters at the Sydney Catchment Authority Infrastructure Resulting from Alternative Layouts of West Cliff Longwalls 34 to 36.

MSEC386 (Revision B – December 2008) - The Effects of Five Optional Modified Commencing Ends of Longwall 34 at West Cliff Colliery on the Previous Subsidence Predictions and Impact Assessments.

MSEC444 (Revision B – February 2010) - The Effects of the Proposed Modified Finishing End of Longwall 34 at West Cliff Colliery on Previous Subsidence Predictions and Impact Assessments.

MSEC463 (Revision B – July 2011) - The Effects of the Proposed Modified Commencing End of Longwall 35 at West Cliff Colliery on Previous 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

LIST OF TABLES, FIGURES AND DRAWINGS

Tables

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

Figures

Figures are prefixed by the number of the chapter or the letter of the appendix in which they are presented.

Drawings

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

1.1. Background

Mine Subsidence Engineering Consultants (MSEC) was previously commissioned by Illawarra Coal (IC) to prepare subsidence predictions and impact assessments for the proposed Longwalls 34 to 36 at West Cliff Colliery. Report No. MSEC326 (Revision C) was issued in December 2007, which supported the SMP Application for these longwalls. The Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS), then known as Industry and Investment NSW, granted IC approval under the SMP approval process for extraction of Longwalls 34 to 36 on the 13th May 2009.

IC modified Longwall 34 by shortening the commencing (western) end by 895 metres and by shortening the finishing (eastern) end by 125 metres from those indicated in the SMP Application. Report Nos. MSEC386 (Revision B, December 2008) and MSEC444 (Revision B, February 2010) were issued in support of the modifications of the commencing and finishing ends, respectively, of Longwall 34.

IC then modified Longwall 35 by shortening the commencing (western) end by 750 metres, from that indicated in the SMP Application, and Report No. MSEC463 (Revision B, July 2011) was issued in support of that modification.

IC now proposes to shorten the commencing (western) end of Longwall 36 by 1020 metres from that indicated in the SMP Application. This report provides information that will support a Variation to the Approved Subsidence Management Plan.

The longwall layout adopted in Report No. MSEC326, which supported the SMP Application for Longwalls 34 to 36, is referred to as the *SMP Layout* in this report. The longwall layout adopted in Report No. MSEC463, which includes the modified commencing and finishing ends of Longwalls 34 and 35, is referred to as the *Approved Layout* in this report. The longwall layout that includes the previous modifications and the proposed shortened commencing end of Longwall 36 is referred to as the *Modified Layout* in this report.

1.2. Mining Geometry

The Approved and Modified Layouts of the longwalls at West Cliff Colliery are overlaid in Drawing No. MSEC573-01, in Appendix B. A summary of the dimensions of Longwall 36 for both these layouts is provided in Table 1.1.

Table 1.1 Dimensions of the Proposed Longwall 36 Based on the Approved and Modified Layouts

Layout	Overall Void Length Including Installation Heading (m)	Overall Void Width Including First Workings (m)	Overall Tailgate Chain Pillar Width (m)
Approved Layout	2815	305	42
Modified Layout	1795	305	42

It can be seen from the above table, that the length of Longwall 36 is proposed to be shortened by 1020 metres, at the commencing (western) end, from the approved length which was adopted in the SMP Application.

The modified Longwall 36 is located within the *Extents of Longwall Mining* which was indicated in the Bulli Seam Operations Environmental Assessment (BSO EA). That is, the modified length of Longwall 36, of 1795 metres, is shorter than that adopted for the Base Case Layout in the BSO EA, as indicated in Report No. MSEC404 (Revision D), of 2885 metres.

The longwall is proposed to be extracted from the Bulli Seam. The depths of cover contours for this seam are shown in Drawing No. MSEC573-02. The depth of cover directly above the commencing end of Longwall 36 is around 480 metres, based on the Approved Layout, and is around 500 metres, based on the Modified Layout.

The thickness of the Bulli Seam within the extents of the proposed Longwall 36, based on the Modified Layout, varies between 2.2 metres at the commencing (western) end, and 2.4 metres in the eastern part of the longwall. IC proposed to extract a minimum seam thickness of 2.4 metres.

2.0 THE EFFECTS OF THE PROPOSED MODIFIED COMMENCING END OF LONGWALL 36 ON THE MAXIMUM PREDICTED SUBSIDENCE PARAMETERS

2.1. Maximum Predicted Conventional Subsidence Parameters

The Incremental Profile Method was previously used to predict the conventional subsidence parameters resulting from the extraction of Longwalls 29 to 36, based on the SMP Layout, and these predictions were provided in Report No. MSEC326. The Incremental Profile Method was also used to predict the conventional subsidence parameters resulting from the extraction of Longwalls 29 to 36, based on the Approved Layout, which were provided in Report No. MSEC463.

The Incremental Profile Method has now been used to predict the conventional subsidence parameters resulting from the extraction of Longwalls 29 to 36, based on the Modified Layout. The predicted incremental subsidence contours due to the extraction of Longwall 36, based on the Modified Layout, are shown in Drawing No. MSEC573-07. The predicted total subsidence contours resulting from the extraction of Longwalls 29 to 36, based on the Modified Layout, are shown in Drawing No. MSEC573-08. The predicted incremental and total 20 mm subsidence contours, based on the Approved Layout, are also shown in these drawings for comparison.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature due to the extraction of Longwall 36, based on the Approved and Modified Layouts, is provided in Table 2.1.

Table 2.1 Maximum Predicted Incremental Conventional Subsidence, Tilt and Curvature Resulting from the Extraction of Longwall 36 Based on the Approved and Modified Layouts

Layout	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Tilt (mm/m)	Maximum Predicted Incremental Hogging Curvature (km^{-1})	Maximum Predicted Incremental Sagging Curvature (km^{-1})
Approved Layout	775	5.5	0.05	0.12
Modified Layout	775	5.5	0.05	0.12

It can be seen from the above table, that the maximum predicted incremental conventional subsidence parameters, due to the extraction of Longwall 36, do not change as a result of the proposed modification to the longwall commencing end. Similarly, the maximum predicted total conventional subsidence parameters, resulting from the extraction of Longwalls 29 to 36, also do not change as a result of the proposed modification.

Although the predicted maxima do not change, the locations of the predicted maximum longitudinal tilt and curvatures change as a result of the proposed modification to the longwall commencing end. This is illustrated in Fig. A.01, in Appendix A, which shows the profiles of predicted incremental subsidence, tilt and curvature along Prediction Line 1, which has been taken through the centreline of Longwall 36, as shown in Drawings Nos. MSEC573-07 and MSEC573-08.

It can be seen from Fig. A.01, that the predicted longitudinal tilts and curvatures at the commencing end of Longwall 36 have moved around 1020 metres east as a result of the proposed modification. It can also be seen, that the magnitudes of the predicted longitudinal tilt and curvatures, based on the Modified Layout, are similar to those predicted based on the Approved Layout.

2.2. Predicted Strains

The prediction of strain is more difficult than the prediction of subsidence, tilt and curvature. The reason for this is that strain is affected by many factors, including ground curvature and horizontal movement, as well as local variations in the near surface geology, the locations of pre-existing natural joints at bedrock, and the depth of bedrock. Survey tolerance can also represent a substantial portion of the measured strain, in cases where the strains are of a low order of magnitude. The profiles of observed strain, therefore, can be irregular even when the profiles of observed subsidence, tilt and curvature are relatively smooth.

In previous MSEC subsidence reports, predictions of conventional strain were provided based on the best estimate of the relationship between curvature and strain. Similar relationships have been proposed by other authors. The reliability of the strain predictions was highlighted in these reports, where it was stated that measured strains can vary considerably from the predicted conventional values. Adopting a linear relationship between curvature and strain provides a reasonable prediction for the conventional tensile and compressive strains. The locations that are predicted to experience hogging or convex curvature are expected to be net tensile strain zones and locations that are predicted experience sagging or concave curvature are expected to be net compressive strain zones.

In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the maximum predicted curvatures and the maximum predicted conventional strains. The maximum predicted incremental conventional strains due to the extraction of Longwall 36, based on applying a factor of 15 to the maximum predicted incremental conventional curvatures, are 1 mm/m tensile and 2 mm/m compressive, for both the Approved and Modified Layouts.

At a point, however, there can be considerable variation from the linear relationship, resulting from non-conventional movements or from the normal scatters which are observed in strain profiles. When expressed as a percentage, observed strains can be many times greater than the predicted conventional strains for low magnitudes of curvature. In this report, therefore, we have provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of potential strains above Longwall 36 has been determined using monitoring data from the previously extracted longwalls in the Southern Coalfield. The monitoring data was used from West Cliff Colliery, as well as the nearby Appin, Tower and Tahmoor Collieries, where the overburden geology and mining geometry are reasonably similar to the proposed longwalls. The range of strains measured during the extraction of these longwalls should, therefore, provide a reasonable indication of the range of potential strains for the proposed longwall.

The data used in the analysis of observed strains included those resulting from both conventional and non-conventional anomalous movements, but did not include those resulting from valley related movements, which are addressed separately in this report. The strains resulting from damaged or disturbed survey marks have also been excluded.

The survey database has been analysed to extract the maximum total tensile and compressive strains that have been measured at any time during mining, for survey bays that were located directly above goaf or the chain pillars that are located between the extracted longwalls. A number of probability distribution functions were fitted to the empirical data. It was found that a Generalised Pareto Distribution (GPD) provided a reasonable fit to the raw strain data.

The histogram of the maximum observed total tensile and compressive strains measured in survey bays above goaf, for the previously extracted longwalls from the Southern Coalfield, is provided in Fig. 4.1. The probability distribution functions, based on the fitted GPDs, have also been shown in this figure.

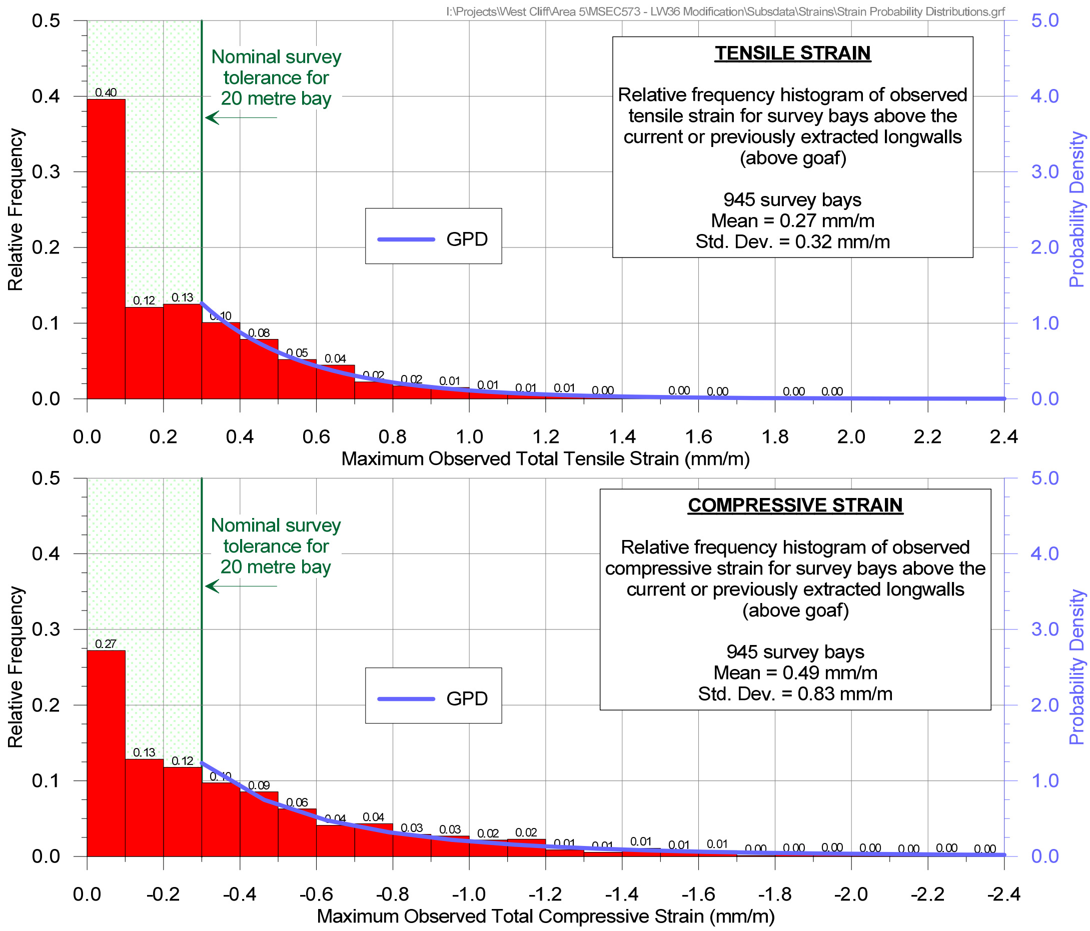


Fig. 2.1 Distributions of the Maximum Observed Total Tensile and Compressive Strains during the Extraction of Previous Longwalls for Survey Bays Located Above Goaf

Confidence levels have been determined from the empirical strain data using the fitted GPDs. In the cases where survey bays were measured multiple times during a longwall extraction, the maximum tensile strain and the maximum compressive strain were used in the analysis (i.e. single tensile strain and single compressive strain measurement per survey bay).

The 95 % confidence levels for the maximum strains that the individual survey bays experienced at any time during mining were 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence levels for the maximum strains that the individual survey bays experienced at any time during mining were 1.4 mm/m tensile and 3.2 mm/m compressive.

2.3. Maximum Predicted Valley Related Movements

The predicted valley related movements along the watercourses at West Cliff Colliery have been determined using the methods outlined in ACARP Research Project No. C9067, which were published in the handbook entitled "*Management Information Handbook on the Undermining of Cliffs, Gorges and River Systems*", issued in September 2002. Details on the ACARP Method are provided in the background report entitled "*General Discussion on Mine Subsidence Ground Movements*" which can be obtained from *www.minesubsidence.com*.

The predicted upsidence and closure movements along the watercourses have been determined from the empirical database based on their lateral and longitudinal distances from the extracted longwalls, the depths of the valleys and the maximum predicted incremental subsidence resulting from the extraction of each longwall. The predicted upsidence and closure movements for the watercourses near the commencing end of Longwall 36 are discussed further in Chapter 3.

For the watercourses which are located directly above Longwall 36, the predicted maximum upsidence and closure movements do not change as a result of the proposed modification to the commencing end of this longwall.

For the watercourses which are located outside the extents of Longwall 36, the predicted maximum upsidence and closure movement, based on the Modified Layout, are similar to or less than the maxima predicted based on the Approved Layout, depending on the relative location to the commencing end of this longwall.

3.0 THE EFFECTS OF THE PROPOSED MODIFIED COMMENCING END OF LONGWALL 36 ON THE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE NATURAL FEATURES AND ITEMS OF SURFACE INFRASTRUCTURE

3.1. The Study Area

The *Study Area* has been defined as the zone where the predicted mine subsidence parameters, based on the Modified Layout, are different to those predicted based on the Approved Layout. The Study Area has been based on the following:-

- 35 degree angle of draw line from the longwall commencing ends, based on both the original position (i.e. Approved Layout) and the modified position (i.e. Modified Layout), and
- The limit where the change in the predicted vertical subsidence, resulting from the proposed modification to the longwall commencing end, is greater than 20 mm.

The limit where the change in the predicted vertical subsidence is greater than 20 mm is located outside the 35 degree angle of draw line south of the tailgate of Longwall 36, above the previously extracted longwalls, but elsewhere this limit is located inside the 35 degree angle of draw line. The extent of the Study Area is shown in Drawing No. MSEC573-01.

There are a number of natural features and items of infrastructure located within the Study Area, which are shown in Drawings Nos. MSEC573-03 to MSEC573-06. There are also a number of features which are located outside this area, which could experience valley related or far-field movements, and could be sensitive to such movements, and these features have also been included as part of the assessments.

The natural features and items of surface infrastructure which have been included in the assessments provided in this report are:-

- Drainage Lines,
- The Upper Canal, Devines Tunnels and Associated Infrastructure,
- Water and Gas Pipelines,
- 330 kV Transmission Line,
- 66 kV and 11 kV Powerlines,
- Copper Telecommunications Cables,
- Fences,
- Farm Dams,
- Building Structures, and
- Survey Control Marks.

The predicted vertical subsidence at the natural features and items of infrastructure located within the Study Area, based on the Modified Layout, are similar to or less than those based on the Approved Layout. The predicted conventional tilts, curvatures and strains at these features, based on the Modified Layout, however, could be greater or less than those based on the Approved Layout, depending on their position relative to the longwall commencing end.

The effects of the proposed modification to the commencing end of Longwall 36 on the subsidence predictions and impact assessments for these features are provided in the following sections.

3.2. Drainage Lines

The locations of the drainage lines in the vicinity of Longwall 36 are shown in Drawing No.MSEC573-03. The drainage lines located within the Study Area include the Nepean Creek, which is partially located above Longwall 36, and Leafs Gully, which is partially located above Longwalls 34 and 35. Mallaty Creek is located just outside the Study Area and crosses directly above Longwalls 32 to 36.

The profiles of predicted incremental and total subsidence, upsidence and closure along the Nepean Creek are shown in Fig. A.02, in Appendix A. The predicted profiles based on the Approved Layout are shown as the cyan lines and the predicted profiles based on the Modified Layout are shown as the blue lines.

A summary of the maximum predicted incremental subsidence, upsidence and closure along the Nepean Creek, due to the extraction of Longwall 36, is provided in Table 3.1. A summary of the maximum predicted total subsidence, upsidence and closure along the creek, resulting from the extraction of Longwalls 29 to 36, is provided in Table 3.2. The results are provided for both the Approved and Modified Layouts.

Table 3.1 Maximum Predicted Incremental Subsidence, Upsidence and Closure along the Nepean Creek due to the Extraction of Longwall 36

Layout	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Upsidence (mm)	Maximum Predicted Incremental Closure (mm)
Approved Layout	500	60	35
Modified Layout	400	55	30

Table 3.2 Maximum Predicted Total Subsidence, Upsidence and Closure along the Nepean Creek Resulting from the Extraction of Longwalls 29 to 36

Layout	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Upsidence (mm)	Maximum Predicted Total Closure (mm)
Approved Layout	525	80	55
Modified Layout	425	75	45

It can be seen from the above tables, that the predicted subsidence, upsidence and closure along the Nepean Creek, based on the Modified Layout, are similar to, but, slightly less than those based on the Approved Layout. Similarly, the strains along the creek due to the extraction of Longwall 36 are expected to be similar, but, slightly less as a result of the proposed modification. It can also be seen from Fig. A.02, that the extent of creek affected by mine subsidence movements is reduced as a result of the proposed modification.

Leafs Gully and Mallaty Creek are located at minimum distances of 300 metres and 675 metres, respectively, from the commencing end of Longwall 36, based on the Modified Layout. As these drainage lines are located outside the extents of the modified Longwall 36, the predicted mine subsidence parameters at these features, based on the Modified Layout, are similar to or less than those predicted based on the Approved Layout.

In consequence, the assessed levels of impact for the drainage lines do not change or reduce as a result of the proposed modification of the longwall commencing end. The proposed management strategies for the drainage lines, therefore, are the same as those previously provided in Report No. MSEC326 and the SMP Application.

3.3. SCA Infrastructure

The locations of the Sydney Catchment Authority (SCA) infrastructure in the vicinity of Longwall 36 are shown in Drawing No.MSEC573-04. The infrastructure includes the Upper Canal, Devines Tunnels and associated infrastructure. A summary of the minimum distances of the SCA infrastructure from the commencing end of Longwall 36, based on both the Approved and Modified Layouts, is provided in Table 3.3.

Table 3.3 Minimum Distances between the SCA Infrastructure and the Commencing End of Longwall 36

SCA Infrastructure	Minimum Distance to Commencing End of Longwall 36 (m)	
	Approved Layout	Modified Layout
Upper Canal	600	1600
Devines Tunnel No. 1	1550	1950
Devines Tunnel No. 2	1100	1900
Mallaty Creek Aqueduct	1900	2075
Concrete Aqueduct C	1750	2050
Concrete Aqueduct D	1500	1950
Leafs Gully Aqueduct	1000	1925
Nepean Creek Aqueduct	600	1600

It can be seen from the above table, that the distances between the SCA infrastructure and the commencing end of Longwall 36 increase by between 175 metres and 1000 metres, as a result of the proposed modification. The SCA infrastructure are located at minimum distances of 1.6 kilometres from the commencing end of Longwall 36, based on the Modified Layout.

At these distances, the predicted incremental subsidence, upsidence and closure movements at the infrastructure, due to the extraction of the modified Longwall 36, are negligible (i.e. less than the order of survey tolerance). It is unlikely, therefore, that the SCA infrastructure would be impacted by the conventional or valley related movements resulting from the extraction of Longwall 36, based on the Modified Layout, even if the predicted movements were increased by a factor of 2 times.

The SCA infrastructure could be subjected to small far-field horizontal movements as a result of the extraction of the Longwall 36. Far-field horizontal movements have, in the past, been observed at similar distances as the SCA infrastructure is from the longwall, however, these movements tend to be bodily movements associated with very low levels of strain (i.e. in the order of survey tolerance). It is unlikely, therefore, that the SCA infrastructure would be impacted by the far-field horizontal movements resulting from the extraction of the Longwall 36, based on the Modified Layout, even if the predicted movements were increased by a factor of 2 times.

In consequence, the assessed levels of impact for the SCA infrastructure do not change or reduce as a result of the proposed modifications to Longwall 36. The proposed management strategies for the SCA infrastructure, therefore, are the same as those previously provided in Report No. MSEC326 and the SMP Application.

A summary of the maximum observed net subsidence, net uplift, horizontal movement and headwall closure at the SCA aqueducts, during the extraction of West Cliff Longwalls 34 and 35, is provided in Table 3.4. The results are based on the survey marks at the bases of the piers (i.e. closest to ground level) and the headwalls, between the surveys carried out in 19th January 2010 (i.e. prior to the commencement of Longwall 34) and 10th May 2012 (i.e. after 975 metres of extraction of Longwall 35). It is noted, that at this time, Appin Longwalls 703 and 704 were also being extracted, to the west of the Nepean River, which are located at minimum distances of 900 metres from the SCA Infrastructure.

Table 3.4 Maximum Observed Net Subsidence, Net Uplift, Horizontal Movement and Headwall Closure at the SCA Infrastructure during the Extraction of West Cliff Longwalls 34 and 35

SCA Infrastructure	Maximum Observed Net Subsidence (mm)	Maximum Observed Net Uplift (mm)	Maximum Observed Horizontal Movement (mm)	Maximum Observed Closure between the Headwalls (mm)
Mallaty Creek Aqueduct	1	1	2	1 (opening)
Concrete Aqueducts C and D	1	2	2 typ. (4 max)	N/A
Leafs Gully Aqueduct	1	1	2	0
Nepean Creek Aqueduct	1	0	1	2 (opening)

It can be seen from the above table, that the observed movements at the SCA infrastructure, resulting from the extraction of West Cliff Longwalls 34 and 35 and Appin Longwalls 703 and 704, were very small (i.e. similar to the order of survey tolerance).

Based on the monitoring results during the extraction of West Cliff Longwalls 34 and 35 and during Appin Longwalls 703 and 704, it is expected that the movements resulting from the extraction of West Cliff Longwall 36, based on the Modified Layout, and due to Appin Longwall 705 will not be measureable (i.e. in the order of survey tolerance).

3.4. Water and Natural Gas Pipelines

The location of the pipeline easement is shown in Drawing No.MSEC573-04. The easement crosses above the western ends of Longwalls 30 to 35 and above the approved western end of Longwall 36. The pipeline easement is located west of Longwall 36, based on the Modified Layout, at a minimum distance of 500 metres. There are four pipelines within the easement, being a 1200 mm diameter treated water gravity main and three natural gas pipelines.

A summary of the maximum predicted incremental subsidence, tilt and curvature along the alignment of the pipeline easement, due to the extraction of Longwall 36, is provided in Table 3.5. A summary of the maximum predicted total subsidence, tilt and curvature along the easement, resulting from the extraction of Longwalls 29 to 36, is provided in Table 3.6. The results are provided for both the Approved and Modified Layouts.

Table 3.5 Maximum Predicted Incremental Subsidence, Tilt and Curvature along the Alignment of the Pipeline Easement due to the Extraction of Longwall 36

Layout	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Tilt (mm/m)	Maximum Predicted Incremental Hogging Curvature (km^{-1})	Maximum Predicted Incremental Sagging Curvature (km^{-1})
Approved Layout	700	4.0	0.02	0.07
Modified Layout	< 20	< 0.5	< 0.01	< 0.01

Table 3.6 Maximum Predicted Total Subsidence, Tilt and Curvature along the Alignment of the Pipeline Easement Resulting from the Extraction of Longwalls 29 to 36

Layout	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
Approved Layout	1025	4.0	0.04	0.08
Modified Layout	1025	3.5	0.04	0.08

It can be seen from Table 3.5, that the pipeline easement is predicted to experience less than 20 mm subsidence due to the extraction of Longwall 36, based on the Modified Layout. Whilst the pipeline easement could experience some low level vertical subsidence, it is not expected to experience any significant conventional tilts, curvatures or strains.

It can also be seen from Table 3.6, that the predicted total subsidence, upsidence and closure along the pipeline easement, based on the Modified Layout, are similar to or slightly less than those based on the Approved Layout. It is noted, that the maxima total parameters are located above the previously extracted longwalls.

The pipelines could also experience valley related movements at the drainage line crossings. As Longwall 36 is proposed to be shortened, the predicted upsidence and closure movements at the drainage lines, based on the Modified Layout, are less than those predicted based on the Approved Layout.

A summary of the maximum observed incremental closure movements at the drainage line crossings, resulting from the extraction of Longwalls 32 to 35, is provided in Table 3.7. The results for Longwall 35 are based on the latest survey carried out on the 3rd July 2012.

Table 3.7 Maximum Observed Incremental Closure at the Drainage Line Crossings Resulting from the Extraction of Longwalls 32 to 35

Location	Total Observed Closure (mm)			
	LW32	LW33	LW34	LW35
Mallaty Creek	110	125	10	< 5
Leafs Gully	< 5	< 5	95	30
Tributary to Nepean Creek	-	-	< 5	< 5
Nepean Creek	-	-	-	< 5

It can be seen from the above table, that the observed incremental closure movements at Mallaty Creek, the Tributary to Nepean Creek and the Nepean Creek, due to the extraction of Longwall 35, to date, were all very small (i.e. in the order of survey tolerance).

The predicted incremental closure movements due to the extraction of Longwall 36, based on the Modified Layout, have been determined by analysing the observed closures from previous longwall mining, where the mining and valley geometries are similar to those within the Study Area. A summary of the maximum predicted incremental closure movements at the drainage line crossings, due to the extraction of the modified Longwall 36, is provided in Table 3.8.

Table 3.8 Maximum Predicted Incremental Upsidence and Closure at the Drainage Line Crossings due to the Extraction of the Modified Longwall 36

Location	Maximum Predicted Incremental Closure (mm)
Mallaty Creek	< 5
Leafs Gully	10
Tributary to Nepean Creek	< 5
Nepean Creek	< 5

It can be seen from the above table, that the predicted incremental closure movements at Mallaty Creek, the Tributary to Nepean Creek and the Nepean Creek, due to the extraction of the modified Longwall 36, are very small (i.e. in the order of survey tolerance). The predicted incremental closure at Leafs Gully, due to the extraction of the modified Longwall 36, is around 10 mm, which is less than that predicted based on the Approved Layout.

In consequence, the assessed levels of impact for the water and gas pipelines do not change or reduce as a result of the proposed modification of the longwall commencing end. The proposed management strategies for the pipelines, therefore, are the same as those previously provided in Report No. MSEC326 and the SMP Application.

3.5. 330 kV Transmission Line

The location of the Avon to Macarthur Substation 330 kV Transmission Line (No. 17) is shown in Drawing No. MSEC573-05. The transmission line crosses above the western ends of Longwalls 30 to 35 and above the approved western end of Longwall 36. The transmission line is located west of Longwall 36, based on the Modified Layout, at a minimum distance of 650 metres.

A summary of the minimum distances of the transmission towers from the commencing end of Longwall 36, based on both the Approved and Modified Layouts, is provided in Table 3.9.

Table 3.9 Minimum Distances between the Transmission Towers and the Commencing End of Longwall 36

Transmission Tower No.	Minimum Distance to Commencing End of Longwall 36 (m)	
	Approved Layout	Modified Layout
80	325	650
81	25	800
82	50	1050
83	525	1425

It can be seen from the above table, that the distances between the transmission towers and the commencing end of Longwall 36 increase by between 325 metres and 1000 metres, as a result of the proposed modification. The transmission towers are located at minimum distances of 650 metres from the commencing end of Longwall 36, based on the Modified Layout.

At these distances, the transmission towers are predicted to experience less than 20 mm incremental subsidence, due to the extraction of Longwall 36, based on the Modified Layout. Whilst the transmission towers could experience some low level vertical subsidence, they are not expected to experience any measureable conventional tilts, curvatures or strains.

The tower closest to the modified Longwall 36 is Tower No. 80, which is a tension tower, located around 650 metres west of the modified longwall commencing end. The strains at this tower have been assessed by statistically analysing the distribution of observed strains at similar distances from previously extracted longwalls in the Southern Coalfield.

The histogram of the maximum observed incremental strains (i.e. tensile or compressive) measured in survey bays, at distances between 500 metres and 800 metres from the ends of previously extracted longwalls from the Southern Coalfield, is provided in Fig. 3.1.

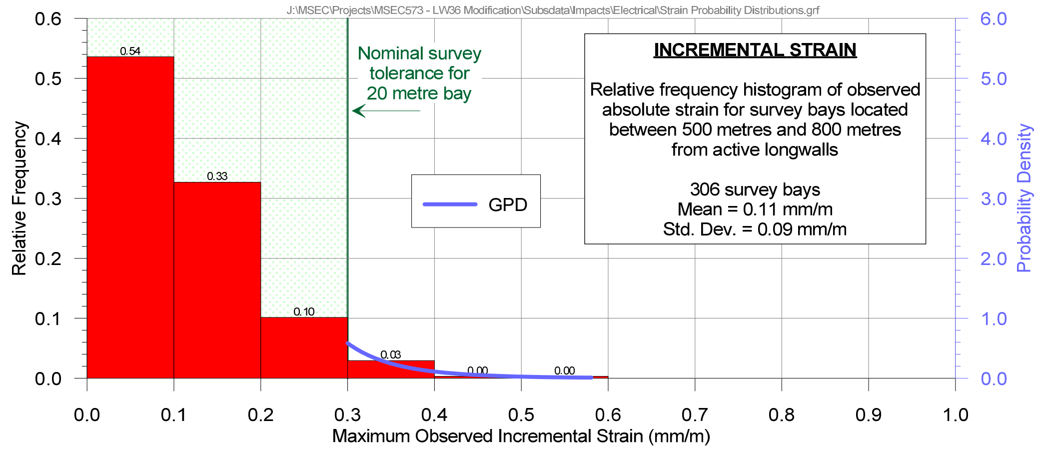


Fig. 3.1 Distribution of the Maximum Observed Incremental Strains for Survey Bays Located At Distances between 500 metres and 800 metres from the Ends of Previously Extracted Longwalls

Confidence levels have been determined from the empirical strain data using the fitted GPD. In the cases where survey bays were measured multiple times during a longwall extraction, the maximum strain (i.e. tensile or compressive) was used in the analysis (i.e. single strain per survey bay per longwall).

The 95 % and 99 % confidence levels for the maximum strains that the individual survey bays experienced at any time during mining were less than 0.3 mm/m and 0.4 mm/m, respectively. That is, the observed strains were similar to the order of survey tolerance of 0.3 mm/m. Based on this, it is expected that the changes in the K-Point distances for the transmission towers, due to the extraction of the modified Longwall 36, would not be measurable (i.e. less than the order of survey tolerance).

It is unlikely, therefore, that the 330 kV transmission line would be adversely impacted by the extraction of Longwall 36, based on the Modified Layout, even if the predicted movements were increased by a factor of 2 times. It is recommended, however, that these revised predictions should be provided to TransGrid, so that the transmission towers can be reviewed based on the latest movements.

3.6. 66 kV and 11 kV Powerlines

The locations of the 66 kV and 11 kV powerlines are shown in Drawing No. MSEC573-05. The powerlines comprise aerial cables and, therefore, are not adversely affected by curvature or ground strain.

The 66 kV powerline crosses above the western ends of Longwalls 30 to 35 and above the approved western end of Longwall 36. The powerline is located west of Longwall 36, based on the Modified Layout, at a minimum distance of 700 metres. At this distance, the 66 kV powerline is predicted to experience less than 20 mm incremental subsidence, due to the extraction of the Longwall 36, based on the Modified Layout. Whilst the powerline could experience some low level vertical subsidence, it is not expected to experience any measureable conventional tilts, curvatures or strains.

The 11 kV powerline crosses above Longwall 36, towards the middle of the longwall, east of the modified commencing end. The profiles of predicted incremental and total subsidence, tilt along and tilt across the alignment of the 11 kV powerline are shown in Fig. A.03, in Appendix A. The predicted profiles based on the Approved Layout are shown as the cyan lines and the predicted profiles based on the Modified Layout are shown as the blue lines.

A summary of the maximum predicted incremental subsidence, tilt along and tilt across the alignment of the 11 kV powerline within the Study Area, due to the extraction of Longwall 36, is provided in Table 3.10. A summary of the maximum predicted total subsidence, tilt along and tilt across the alignment of the powerline within the Study Area, resulting from the extraction of Longwalls 29 to 36, is provided in Table 3.11. The results are provided for both the Approved and Modified Layouts.

Table 3.10 Maximum Predicted Incremental Subsidence, Tilt Along and Tilt Across the Alignment of the 11 kV Powerline within the Study Area due to the Extraction of Longwall 36

Location	Layout	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Tilt Along Alignment (mm/m)	Maximum Predicted Incremental Tilt Across Alignment (mm/m)
11 kV Powerline	Approved Layout	725	2.5	4.5
	Modified Layout	725	2.5	4.5

Table 3.11 Maximum Predicted Total Subsidence, Tilt Along and Tilt Across the Alignment of the 11 kV Powerline within the Study Area Resulting from the Extraction of Longwalls 29 to 36

Location	Layout	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt Along Alignment (mm/m)	Maximum Predicted Total Tilt Across Alignment (mm/m)
11 kV Powerline	Approved Layout	1050	3.0	5.0
	Modified Layout	800	3.0	5.0

It can be seen from Table 3.10, that the predicted incremental subsidence, tilt along and tilt across the alignment of the 11 kV powerline, based on the Modified Layout, are similar to those based on the Approved Layout. It can be seen from Fig. A.03, however, that the extent of powerline affected by Longwall 36 is reduced as a result of the proposed modification.

It can be seen from Table 3.11, that the maximum predicted total subsidence parameters for the 11 kV powerline, based on the Modified Layout, are similar to or less than those predicted based on the Approved Layout. It is noted, that the predicted final tilt above Longwall 35, based on the Modified Layout, is slightly greater than that based on the Approved Layout, as the extraction of Longwall 36 reduces the tilt in this location. In any case, the predicted tilt in this location is less than the predicted maxima after the completion of Longwall 35 and, hence, the assessed impacts do not change.

In consequence, the assessed levels of impact for the 66 kV and 11 kV powerlines do not change or reduce as a result of the proposed modification of the longwall commencing end. The proposed management strategies for the powerlines, therefore, are the same as those previously provided in Report No. MSEC326 and the SMP Application.

3.7. Copper Telecommunications Cables

The locations of the copper telecommunications cables are shown in Drawing No. MSEC573-05. The copper cables cross directly above Longwall 36, towards the middle of the longwall, east of the modified commencing end. The copper cables are direct buried and, therefore, are not adversely affected by tilt.

The profiles of predicted subsidence along the alignment of the copper telecommunications cables are similar to the adjacent 11 kV powerline, which are shown in Fig. A.03, in Appendix A. The predicted profiles based on the Approved Layout are shown as the cyan lines and the predicted profiles based on the Modified Layout are shown as the blue lines.

A summary of the maximum predicted incremental subsidence and curvatures for the copper telecommunications cables within the Study Area, due to the extraction of Longwall 36, is provided in Table 3.12. A summary of the maximum predicted total subsidence and curvatures for the cables within the Study Area, resulting from the extraction of Longwalls 29 to 36, is provided in Table 3.13. The results are provided for both the Approved and Modified Layouts.

Table 3.12 Maximum Predicted Incremental Subsidence and Curvatures for the Copper Telecommunications Cables within the Study Area due to the Extraction of Longwall 36

Location	Layout	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Hogging Curvature (km^{-1})	Maximum Predicted Incremental Sagging Curvature (km^{-1})
Copper Cables	Approved Layout	725	0.02	0.03
	Modified Layout	725	0.02	0.03

Table 3.13 Maximum Predicted Total Subsidence and Curvatures for the Copper Telecommunications Cables within the Study Area Resulting from the Extraction of LWs 29 to 36

Location	Layout	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
Copper Cables	Approved Layout	1025	0.07	0.10
	Modified Layout	800	0.05	0.10

It can be seen from the above tables, that the that the maximum predicted subsidence parameters for the copper telecommunications cables within the Study Area, based on the Modified Layout, are similar to or less than those predicted based on the Approved Layout. Similarly, the strains along the copper cables due to the extraction of Longwall 36 are not expected to change as a result of the proposed modification.

In consequence, the assessed levels of impact for the copper telecommunications cables do not change or reduce as a result of the proposed modification of the longwall commencing end. The proposed management strategies for the copper cables, therefore, are the same as those previously provided in Report No. MSEC326 and the SMP Application.

3.8. Fences

The fences are located across the Study Area and, therefore, are expected to experience the full range of predicted subsidence movements. A summary of the maximum predicted incremental subsidence parameters, due to the extraction of Longwall 36, is provided in Table 2.1. It can be seen from this table, that the maximum predicted subsidence parameters do not change, as a result of the proposed modification. The overall levels of the mine subsidence movement across the Study Area have reduced, however, as the length of Longwall 36 has been shortened.

In consequence, the assessed levels of impact for the fences do not change as a result of the proposed modification of the longwall commencing end. The proposed management strategies for the fences, therefore, are the same as those previously provided in Report No. MSEC326 and the SMP Application.

3.9. Farm Dams

The locations of the farm dams in the vicinity of Longwall 36 are shown in Drawing No. MSEC573-06. There are 17 farms dams which have been identified within the Study Area. The farm dams have maximum lengths varying between 15 metres and 100 metres and surface areas varying between 100 m^2 and 4000 m^2.

A summary of the maximum predicted incremental subsidence, tilt and curvatures for the farm dams within the Study Area, due to the extraction of Longwall 36, is provided in Table 3.14. A summary of the maximum predicted total subsidence parameters the farm dams within the Study Area, resulting from the extraction of Longwalls 29 to 36, is provided in Table 3.15. The predicted parameters are the maxima within a 20 metre radius of the farm dams.

Table 3.14 Maximum Predicted Incremental Subsidence, Tilt and Curvature for the Farm Dams within the Study Area Resulting from the Extraction of Longwall 36

Location	Layout	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Tilt (mm/m)	Maximum Predicted Incremental Hogging Curvature (km^{-1})	Maximum Predicted Incremental Sagging Curvature (km^{-1})
Farm Dams	Approved Layout	750	5.5	0.05	0.12
	Modified Layout	475	5.0	0.04	0.02

Table 3.15 Maximum Predicted Total Subsidence, Tilt and Curvature for the Farm Dams within the Study Area Resulting from the Extraction of Longwalls 29 to 36

Location	Layout	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
Farm Dams	Approved Layout	1000	6.0	0.05	0.12
	Modified Layout	875	5.5	0.05	0.09

It can be seen from the above tables, that the that the maximum predicted subsidence, tilt and curvatures at the farm dams within the Study Area, based on the Modified Layout, are similar to or less than those predicted based on the Approved Layout. Similarly, the strains at the farm dams, based on the Modified Layout, are expected to be similar to or slightly less than those based on the Approved Layout. Also, the number of farm dams directly mined beneath by Longwall 36 reduces from four to one as a result of the proposed modification.

In consequence, the assessed levels of impact for the farm dams do not change or reduce as a result of the proposed modification of the longwall commencing end. The proposed management strategies for the farm dams, therefore, are the same as those previously provided in Report No. MSEC326 and the SMP Application.

3.10. Building Structures

The locations of the building structures in the vicinity of Longwall 36 are shown in Drawing No. MSEC573-06. There are no houses identified within the Study Area. There are 15 rural building structures located within the Study Area, which include sheds, garages and other non-residential building structures.

A summary of the maximum predicted incremental subsidence, tilt and curvatures for the rural building structures within the Study Area, due to the extraction of Longwall 36, is provided in Table 3.16. A summary of the maximum predicted total subsidence parameters for the rural building structures within the Study Area, resulting from the extraction of Longwalls 29 to 36, is provided in Table 3.17. The predicted parameters are the maxima within a 20 metre radius of the structures.

Table 3.16 Maximum Predicted Incremental Subsidence, Tilt and Curvature for the Rural Building Structures within the Study Area Resulting from the Extraction of Longwall 36

Location	Layout	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Tilt (mm/m)	Maximum Predicted Incremental Hogging Curvature (km^{-1})	Maximum Predicted Incremental Sagging Curvature (km^{-1})
Rural Structures	Approved Layout	< 20	< 0.5	< 0.01	< 0.01
	Modified Layout	< 20	< 0.5	< 0.01	< 0.01

Table 3.17 Maximum Predicted Total Subsidence, Tilt and Curvature for the Rural Structures within the Study Area Resulting from the Extraction of Longwalls 29 to 36

Location	Layout	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt (mm/m)	Maximum Predicted Total Hogging Curvature (km^{-1})	Maximum Predicted Total Sagging Curvature (km^{-1})
Rural Structures	Approved Layout	75	1.0	0.01	< 0.01
	Modified Layout	60	1.0	0.01	< 0.01

It can be seen from table Table 3.16, that the predicted incremental subsidence at the rural building structures, based on the Approved and Modified Layouts, are both less than 20 mm. Whilst these structures could experience some low level vertical subsidence, they are not expected to experience any significant conventional tilts, curvatures or strains.

It can also be seen from Table 3.17, that the that the maximum predicted total subsidence, tilt and curvatures at the rural building structures within the Study Area, based on the Modified Layout, are similar to or slightly less than those predicted based on the Approved Layout. Similarly, the total strains at the rural building structures, based on the Modified Layout, are expected to be similar to or slightly less than those based on the Approved Layout.

In consequence, the assessed levels of impact for the rural building structures reduce as a result of the proposed modification of the longwall commencing end. The proposed management strategies for the building structures, therefore, are the same as those previously provided in Report No. MSEC326 and the SMP Application.

3.11. Archaeological Sites

There are no archaeological sites identified within the Study Area. The closest site is Ref. 52-2-2265 (stone artefact scatters) which is located east of the commencing end of Longwall 34, and is 500 metres south of Longwall 36, based on the Approved Layout, and 800 metres south-west of the longwall, based on the Modified Layout. At these distances, it is unlikely that this site would experience adverse impacts resulting from the extraction of Longwall 36.

3.12. Survey Control Marks

The locations of the state survey control marks are shown in Drawing No. MSEC573-06. There is one mark located within the Study Area, being PM 82965, which is located above the tailgate of Longwall 35. There are also additional marks located in the vicinity of the Study Area. The predicted mine subsidence parameters at these survey control marks, based on the Modified Layout, are similar to or slightly less than those predicted based the Approved Layout.

In consequence, the assessed levels of impact for the survey control marks do not change or reduce as a result of the proposed modification of the longwall commencing end. The proposed management strategies for the state survey control marks, therefore, are the same as those previously provided in Report No. MSEC326 and the SMP Application.

3.13. Summary

The maximum predicted incremental conventional subsidence parameters, due to the extraction of Longwall 36, do not change as a result of the proposed modification to the longwall commencing end. Similarly, the maximum predicted total conventional subsidence parameters, resulting from the extraction of Longwalls 29 to 36, also do not change as a result of the proposed modification.

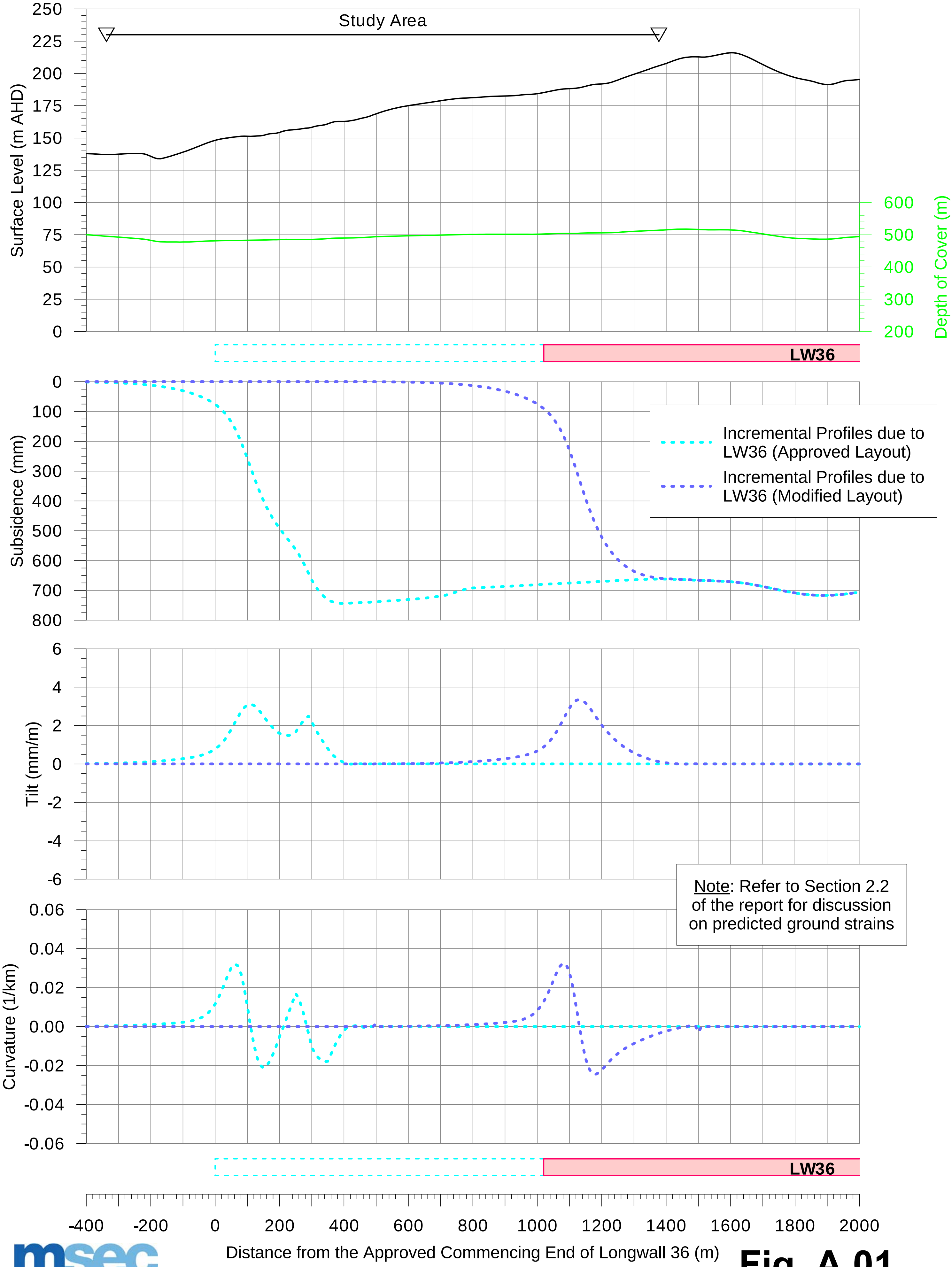
Although the predicted maxima do not change, the locations of the maximum predicted longitudinal tilt and curvatures change as a result of the proposed modification to the longwall commencing end. As shown in Fig. A.01, the predicted longitudinal tilts and curvatures at the commencing end of Longwall 36 have moved around 1020 metres east as a result of the proposed modification.

The maximum predicted mine subsidence parameters for the natural features and surface infrastructure, based on the Modified Layout are, in all cases, similar to or less than those predicted based on the Approved Layout.

In consequence, the assessed levels of impact for the natural features and surface infrastructure do not change or reduce as a result of the proposed modification of the longwall commencing end. The proposed management strategies for all features, therefore, are the same as those previously provided in Report No. MSEC326 and the SMP Application.

APPENDIX A. FIGURES

Predicted Profiles of Incremental Subsidence, Tilt and Curvature along Prediction Line 1 Resulting from the Extraction of Longwall 36



msec

Fig. A.01

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Predicted Profiles of Subsidence, Upsidence and Closure along the Nepean Creek Resulting from the Extraction of Longwalls 29 to 36

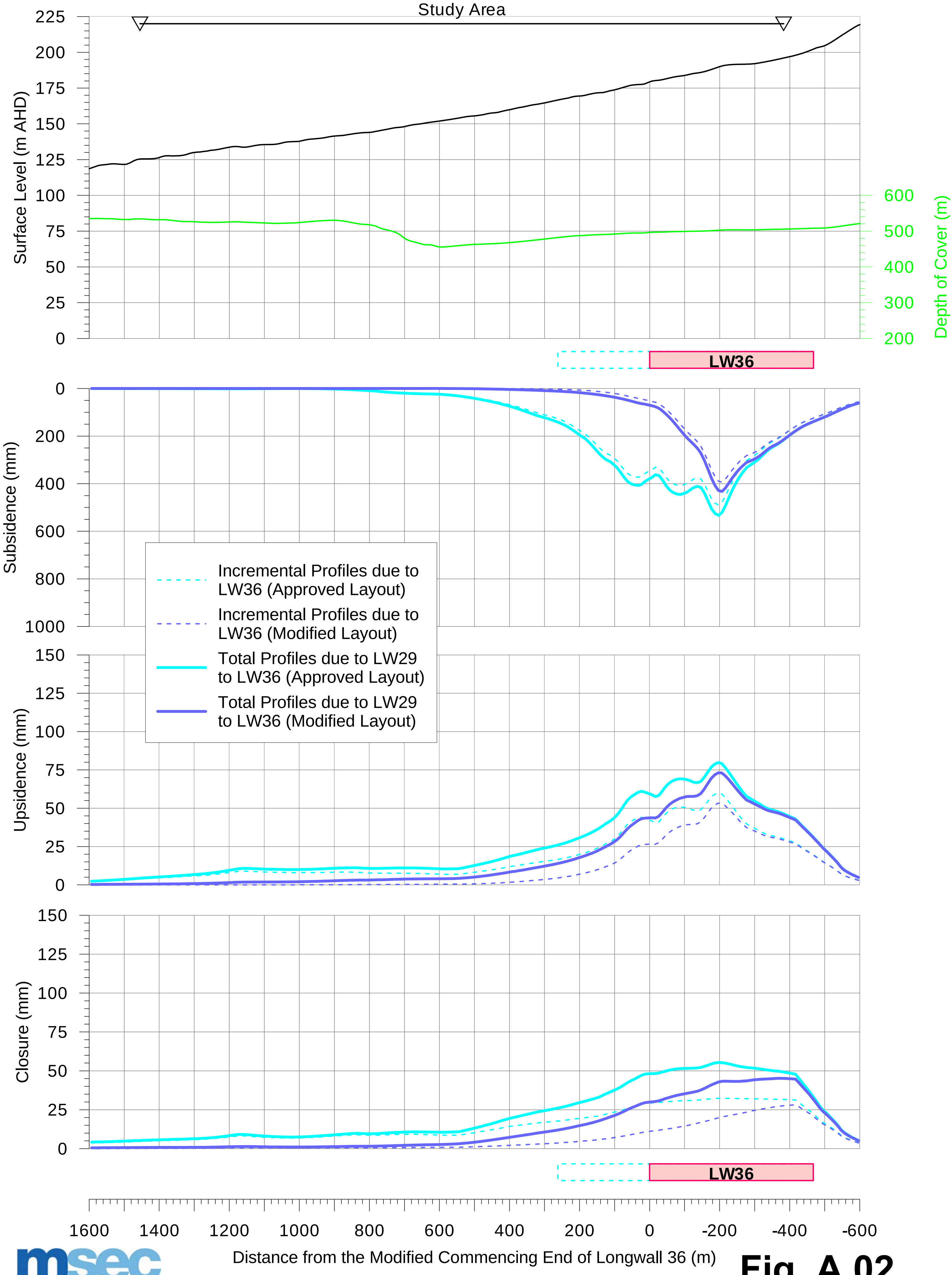

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Fig. A.02

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Predicted Profiles of Subsidence, Tilt Along and Tilt Across the 11 kV Powerline Resulting from the Extraction of Longwalls 29 to 36

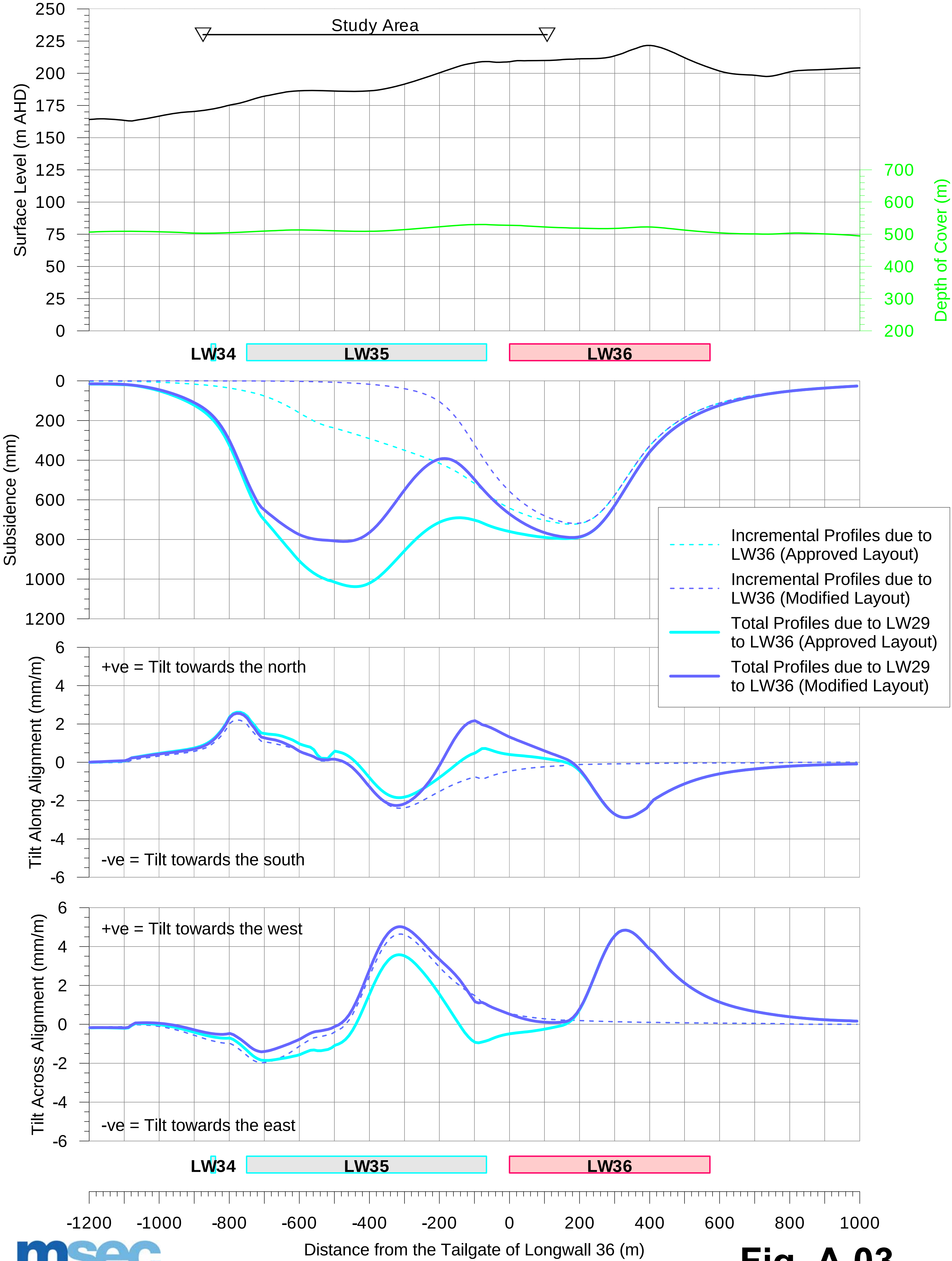

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Fig. A.03

APPENDIX B. DRAWINGS

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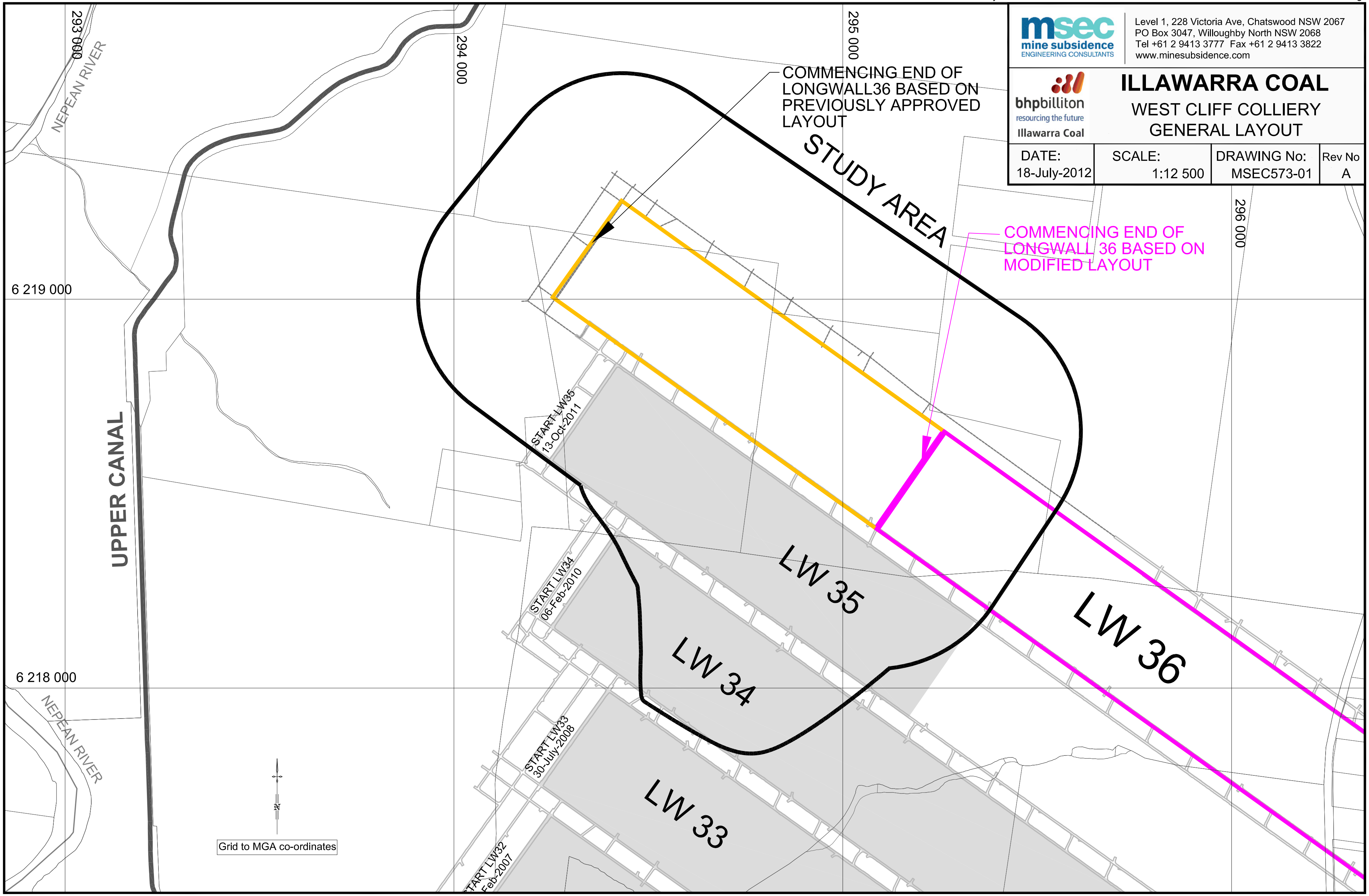

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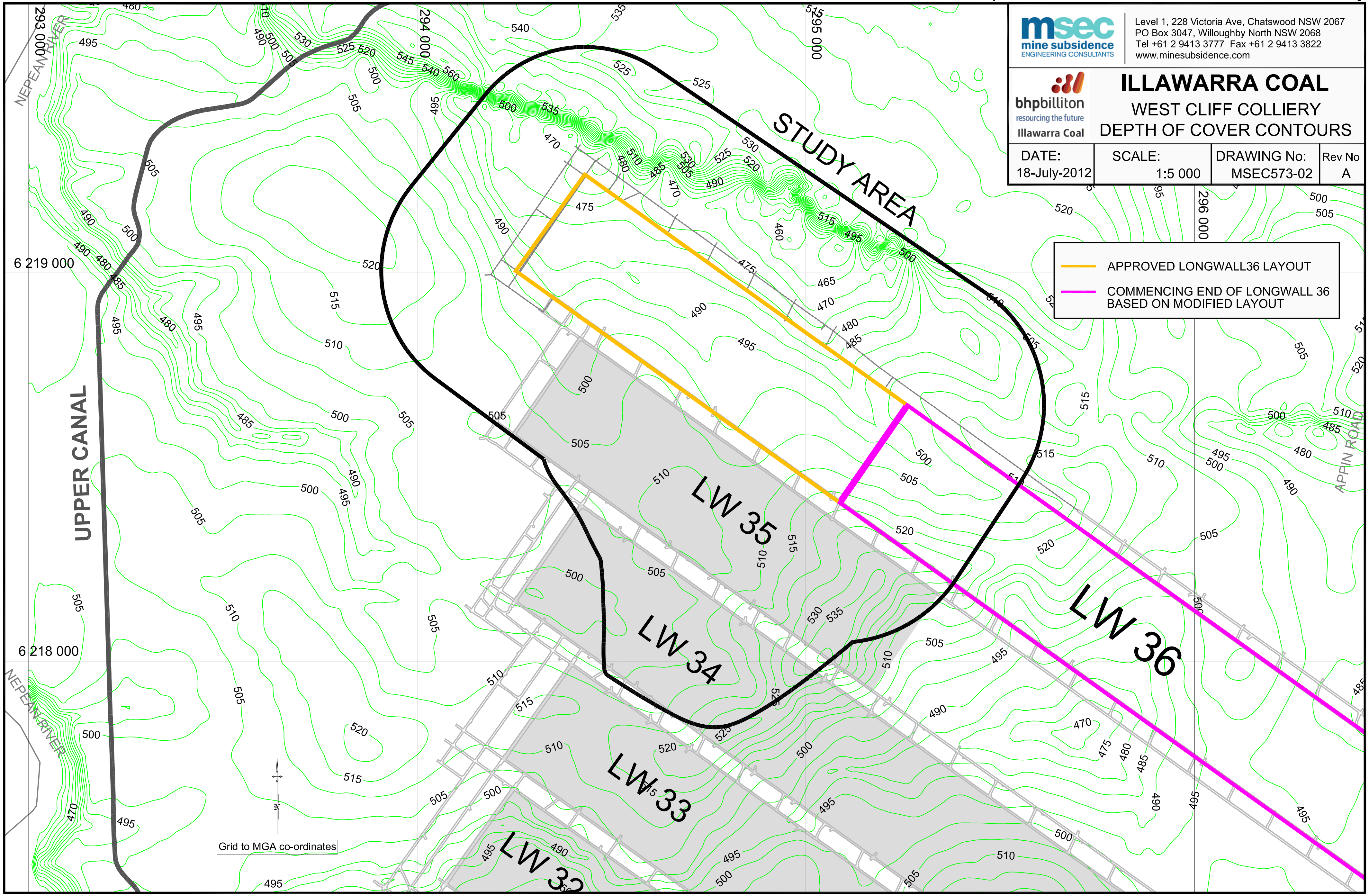

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Rev No
A
APPROVED LONGWALL36 LAYOUT
COMMENCING END OF LONGWALL 36
BASED ON MODIFIED LAYOUT
STUDY AREA
LW 36
LW 35
LW 34
LW 33
LW 32
UPPER CANAL
NEPEAN RIVER
APPIN ROAD
293 000
294 000
295 000
296 000
6 219 000
6 218 000
Grid to MGA co-ordinates

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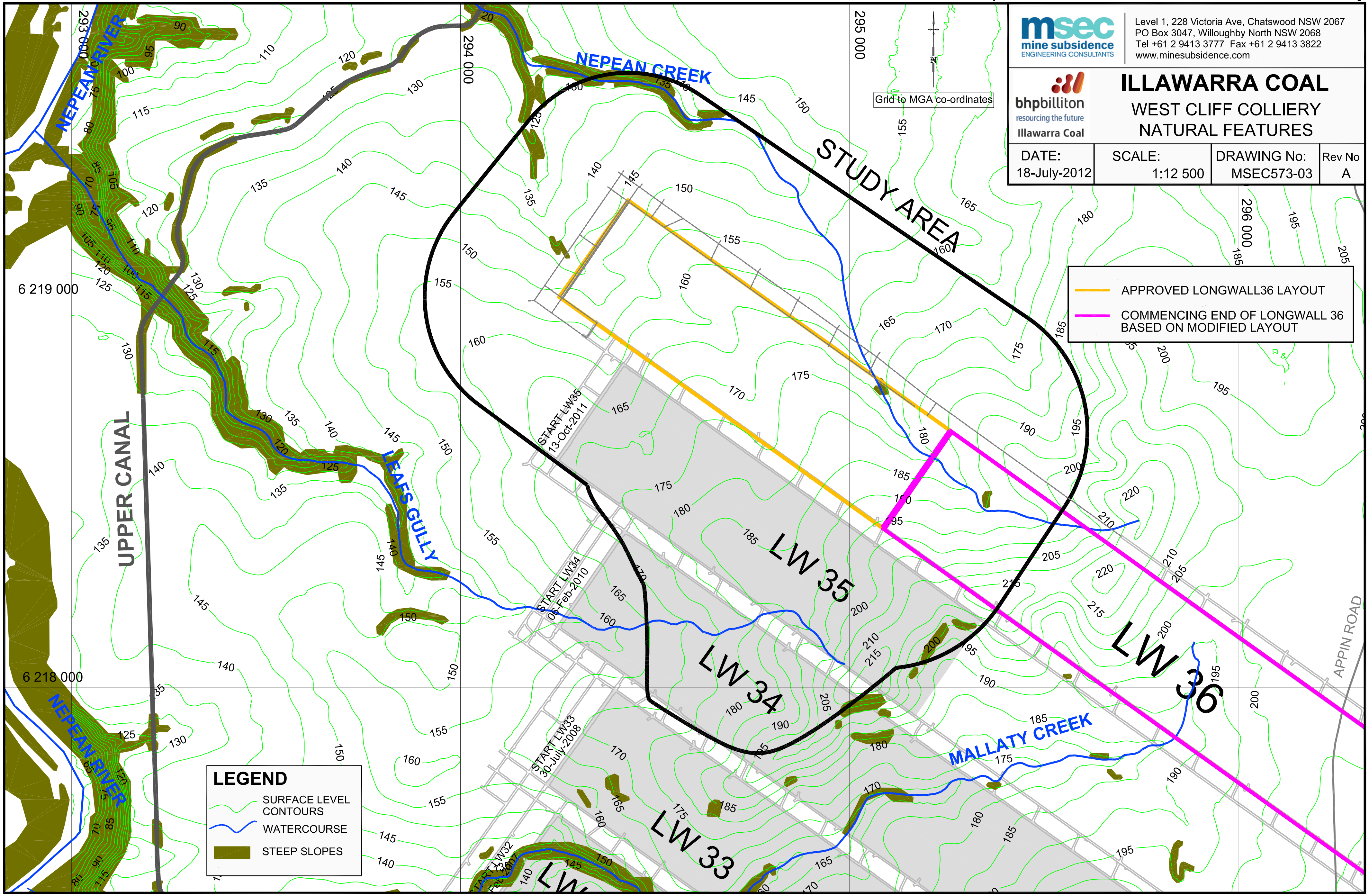

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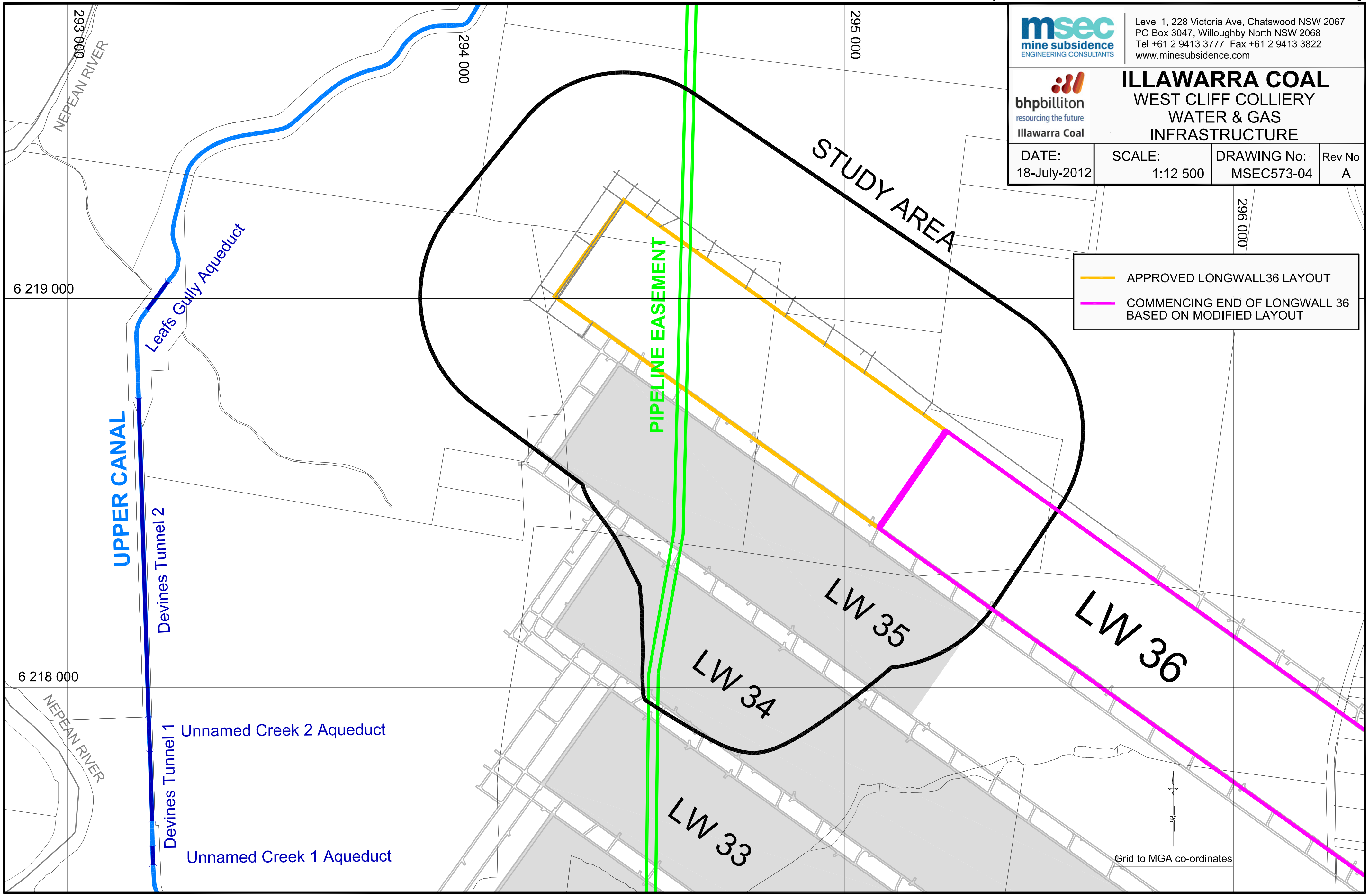

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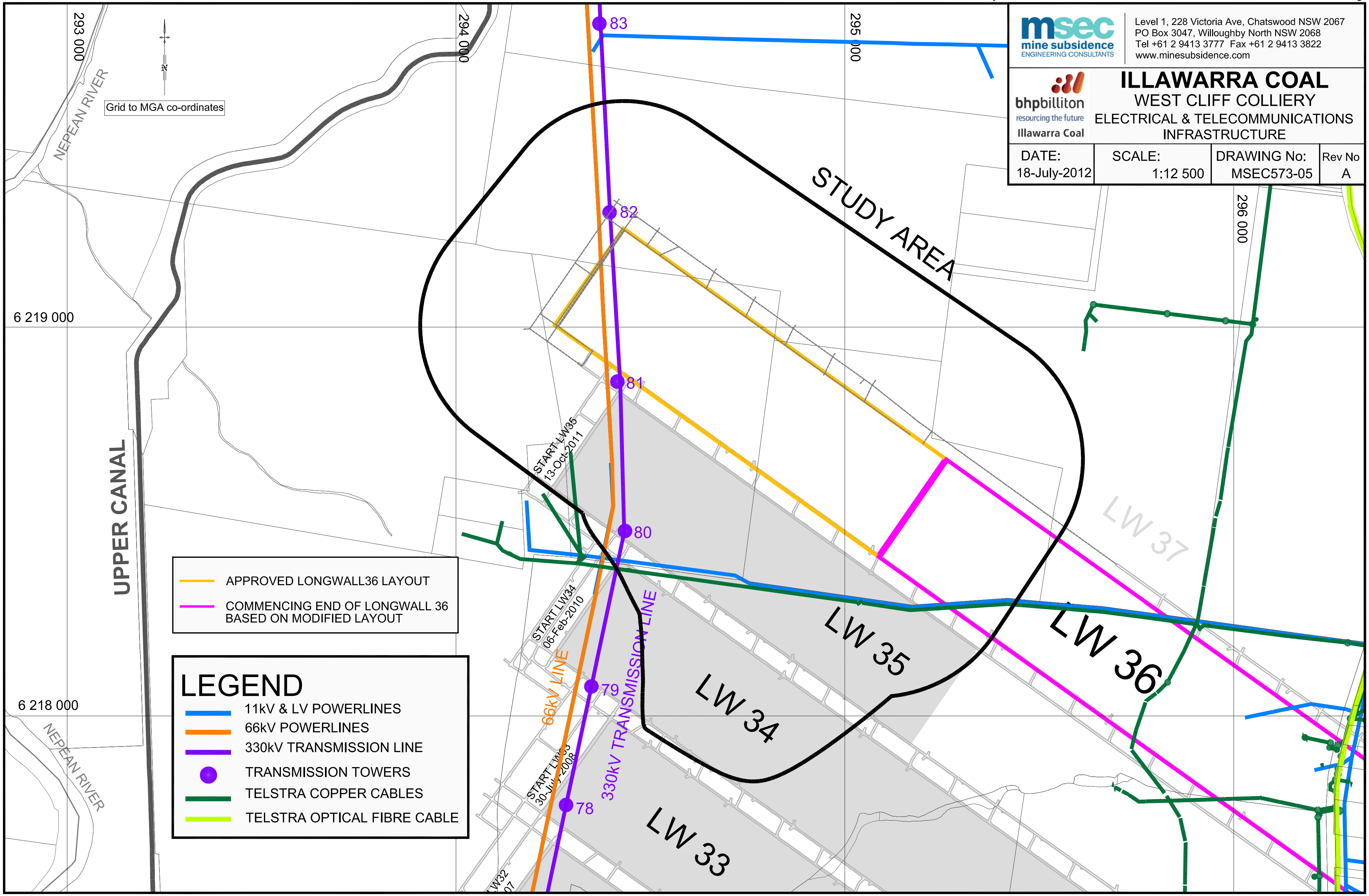
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SCALE: 1:12 500
DRAWING No: MSEC573-05
Rev No A
STUDY AREA
LW 37
LW 36
LW 35
LW 34
LW 33
START LW35 13-Oct-2011
START LW34 06-Feb-2010
330kV TRANSMISSION LINE
66kV LINE
83
82
81
80
79
78
UPPER CANAL
NEPEAN RIVER
NEPEAN RIVER
Grid to MGA co-ordinates
293 000
294 000
295 000
296 000
6 219 000
6 218 000
APPROVED LONGWALL36 LAYOUT
COMMENCING END OF LONGWALL 36 BASED ON MODIFIED LAYOUT
LEGEND
11kV & LV POWERLINES
66kV POWERLINES
330kV TRANSMISSION LINE
TRANSMISSION TOWERS
TELSTRA COPPER CABLES
TELSTRA OPTICAL FIBRE CABLE

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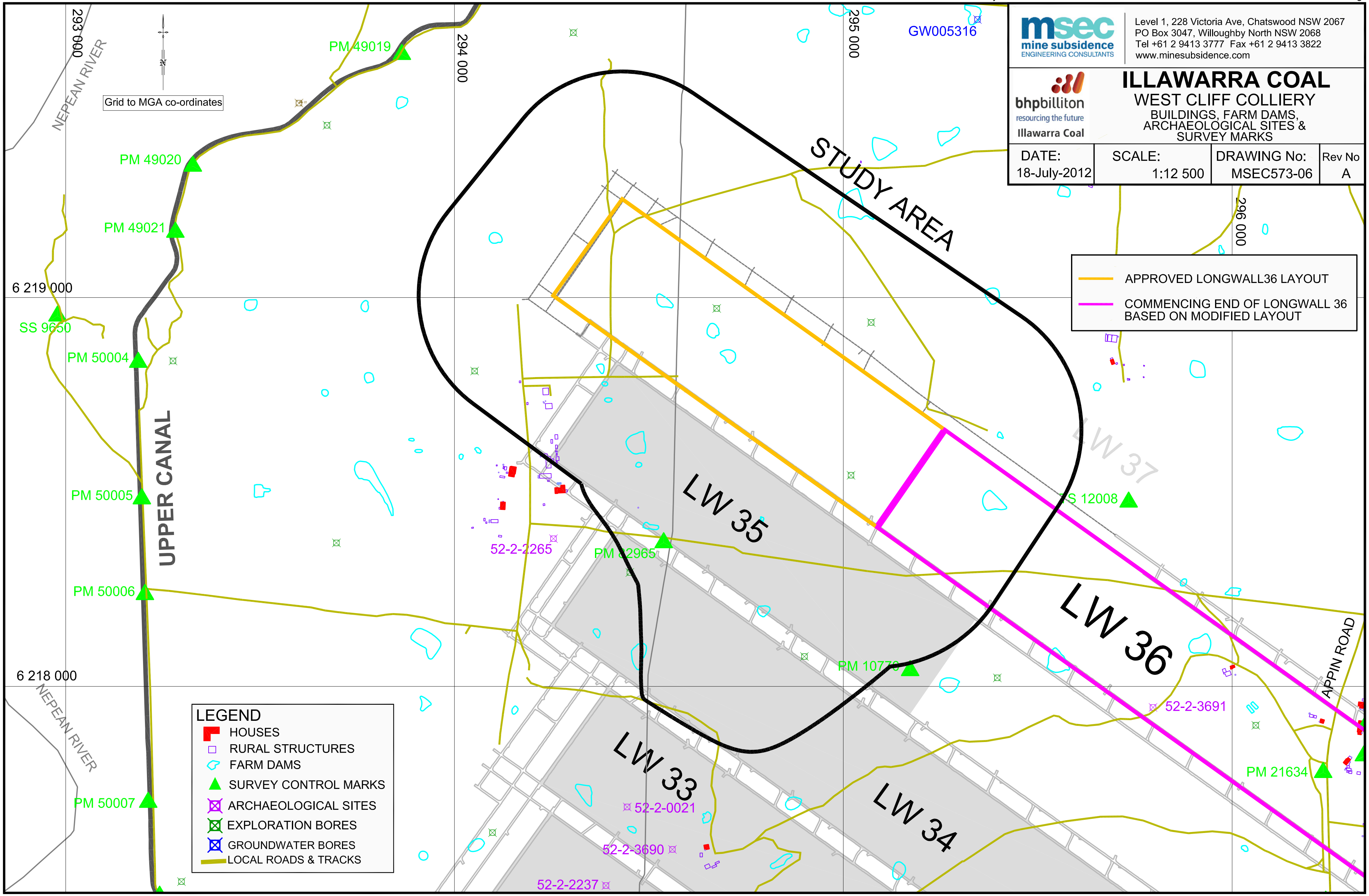

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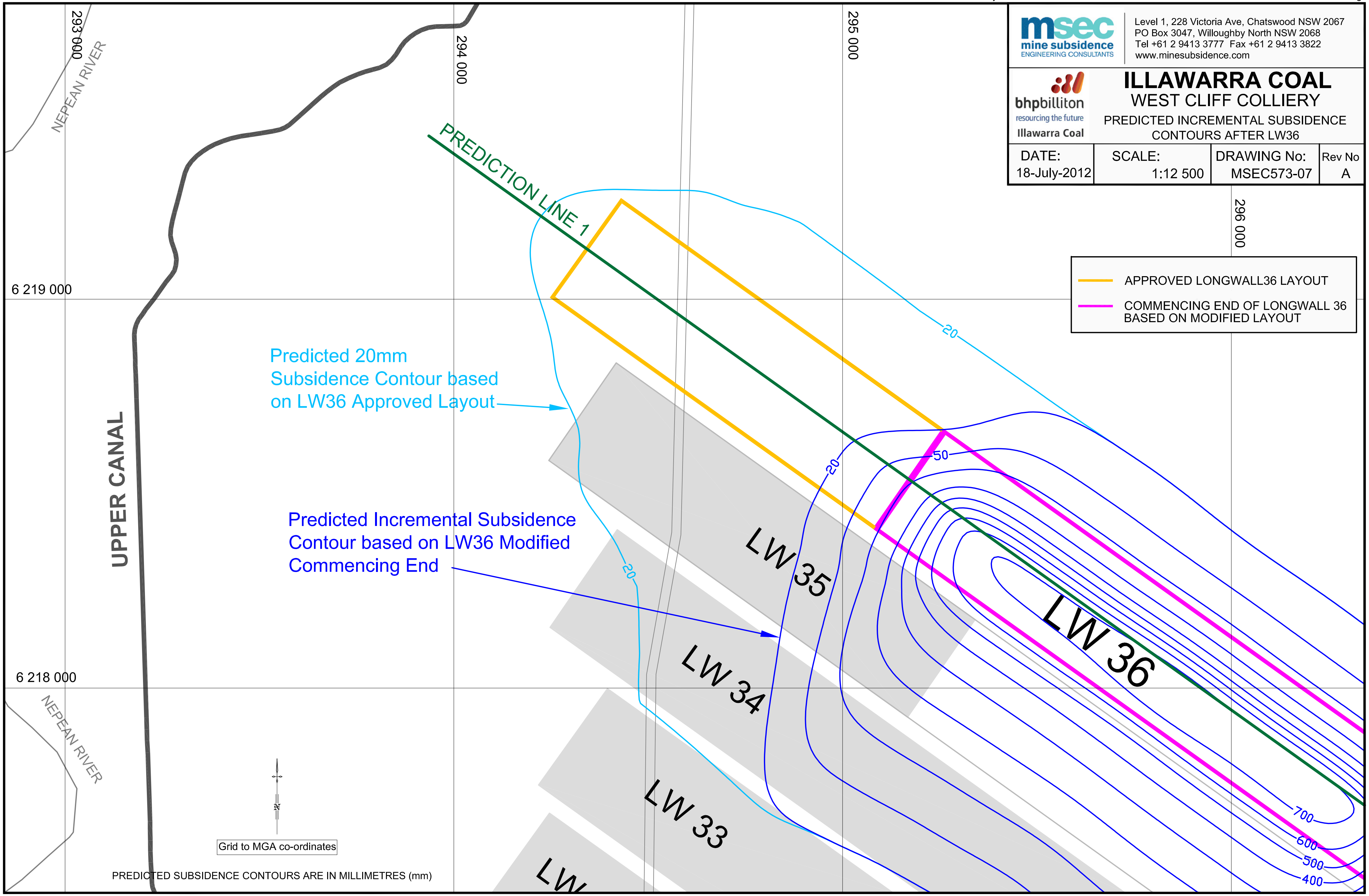

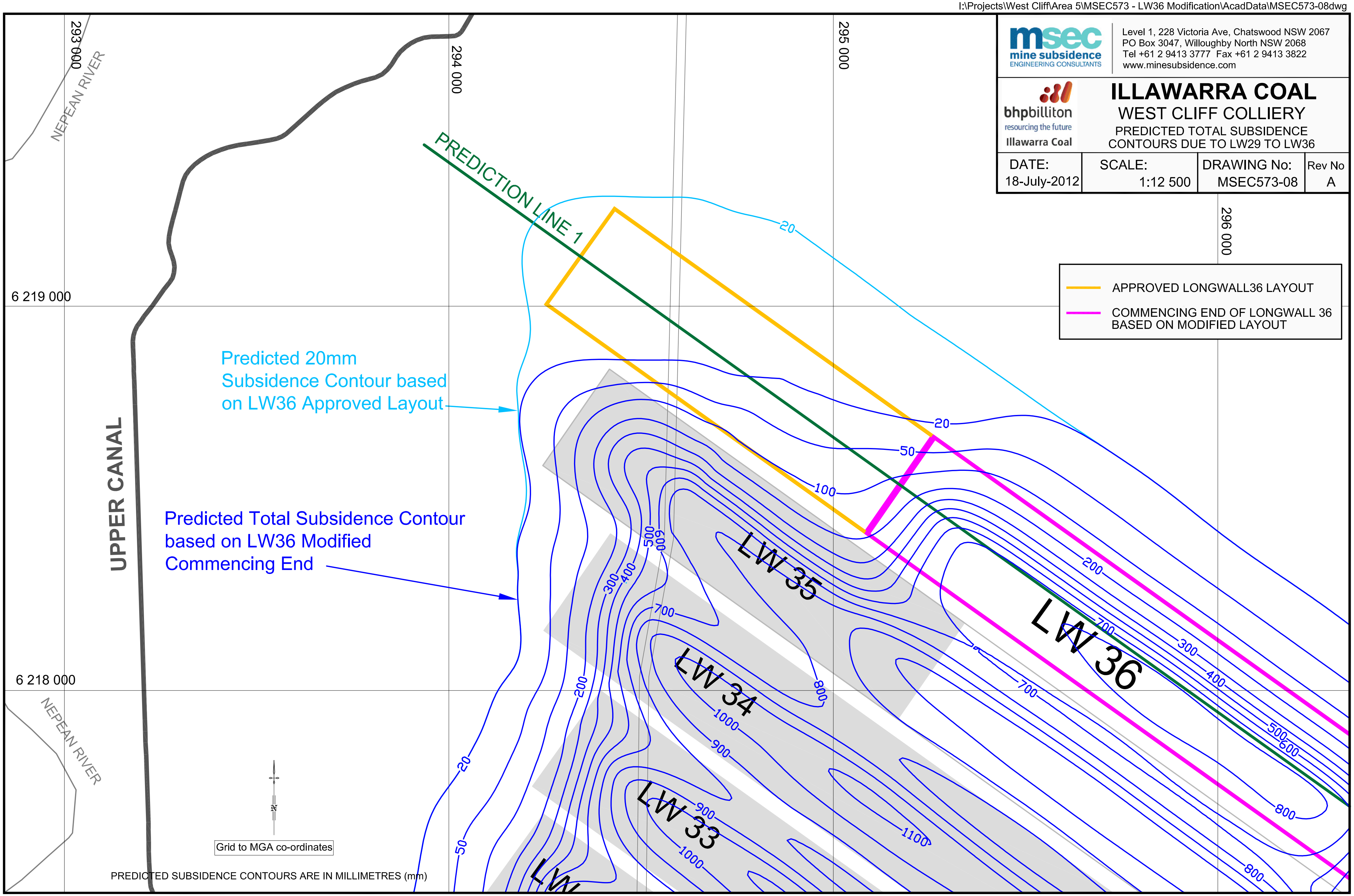
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PREDICTED TOTAL SUBSIDENCE CONTOURS DUE TO LW29 TO LW36
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SCALE: 1:12 500
DRAWING No: MSEC573-08
Rev No A
APPROVED LONGWALL36 LAYOUT
COMMENCING END OF LONGWALL 36 BASED ON MODIFIED LAYOUT
PREDICTION LINE 1
Predicted 20mm Subsidence Contour based on LW36 Approved Layout
Predicted Total Subsidence Contour based on LW36 Modified Commencing End
UPPER CANAL
NEPEAN RIVER
NEPEAN RIVER
LW 36
LW 35
LW 34
LW 33
6 219 000
6 218 000
293 000
294 000
295 000
296 000
Grid to MGA co-ordinates
PREDICTED SUBSIDENCE CONTOURS ARE IN MILLIMETRES (mm)