mine subsidence ENGINEERING CONSULTANTS

DONALDSONCOAL
Part of the Yancoal Australia Group

ABEL UNDERGROUND MINE:

SMP Area 3 – Modified Panel 26

The Effects of the Proposed Modification to Panel 26 on the Subsidence Predictions and Impact Assessments

DOCUMENT REGISTER

Revision	Description	Author	Checker	Date
01	Draft Issue	JB	-	15th May 14
A	Final Issue	JB	PD	6th Jun 14

Report produced for:- Support the Application for the Proposed Modification to Panel 26 which will be issued to the Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS).

Previous reports:- MSEC596 (Rev. A) – Abel Underground Mine SMP Area 3 – Proposed Panels 23 to 26 – Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the SMP Application.

MSEC653 (Rev. A) – Abel Underground Mine SMP Area 3 – The Effects of the Proposed Modification to Panel 24 on the Subsidence Predictions and Impact Assessments.

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

Introduction to Longwall Mining and Subsidence (Revision A)

General Discussion of Mine Subsidence Ground Movements (Revision A)

Mine Subsidence Damage to Building Structures (Revision A)

CONTENTS

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 A at the end of this report.

1.1. Background

Donaldson Coal Pty Limited (Donaldson Coal) operates the Abel Underground Mine (ML1618, the mine), which is located in the Newcastle Coalfield of New South Wales. The mine was approved under Part 3A of the *Environmental Planning and Assessment Act 1979* in June 2007 (Project Approval 05-0136). Donaldson Coal has extracted panels using bord and pillar total and partial extraction methods within the Upper Donaldson Seam in SMP Areas 1 and 2 and is currently mining in SMP Area 3.

The Subsidence Management Plan (SMP) Application for the extraction of Panels 23 to 26 in SMP Area 3 was submitted in November 2012. Mine Subsidence Engineering Consultants (MSEC) prepared Report No. MSEC596 (Revision A) which provided the subsidence predictions and impact assessments for these panels in support of this application. The Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS) approved the SMP on the 16th July 2013.

Donaldson Coal subsequently modified Panel 24 by forming up and extracting nine additional pillars on the eastern side of this panel and, therefore, increasing the overall void width at the northern end. Report No. MSEC653 (Rev. A) was issued in November 2013, which supported this modification application.

Donaldson Coal now proposes to modify Panel 26 by narrowing its width by 40 metres, on the western edge, so that the overall void width is 180 metres.

MSEC has been commissioned by Donaldson Coal to assess the effects of the proposed modification to Panel 26 on the subsidence predictions and impact assessments that were previously provided in Report No. MSEC596. This report provides information that will support an application for a Modification to the Approved Subsidence Management Plan.

1.2. Mining Geometry

The mining layout adopted in the SMP Application and in Report No. MSEC596 is referred to as the *SMP Layout* in this report. The mining layout adopted in Report No. MSEC653, which included the previous modification to Panel 24, is referred to as the *Approved Layout* in this report. The mining layout that includes the previous modification to Panel 24 and the currently proposed modification to Panel 26 is referred to as the *Modified Layout* in this report.

The Approved and Modified Layouts of the panels in SMP Area 3 are overlaid in Drawing No. MSEC695-01. A summary of the dimensions of Panel 26 for both these layouts is provided in Table 1.1. The Panels 23 to 26 are being extracted using bord and pillar total extraction methods.

Table 1.1 Dimensions of the Panel 26 Based on the Approved and Modified Layouts

Layout	Overall Void Length Including First Workings (m)	Overall Void Width Including First Workings (m)	Solid Barrier Pillar Width (m)
Approved Layout	1,320	220	25
Modified Layout	1,320	180	25

The panels in SMP Area 3 are being extracted from the Upper Donaldson Seam. The depths of cover contours for this seam are shown in Drawing No. MSEC695-02. The depth of cover directly above Panel 26 varies between a minimum of 60 metres at the northern end and a maximum of 170 metres at the southern end of the panel.

The seam floor falls from the northern end towards the southern end of the proposed mining area. The grade of the seam within the extents of Panel 26 is approximately 5 % (i.e. 1 in 20). The thickness of the Upper Donaldson Seam within the extents of the panel varies between approximately 1.5 metres and 2.8 metres. There is minor faulting at the northern end of Panel 26, as shown in Drawing No. MSEC695-03, however, this is unlikely to have any significant affect on the predicted subsidence contours as the panel is supercritical in this location.

2.0 THE EFFECTS OF THE PROPOSED MODIFICATION TO PANEL 26 ON THE MAXIMUM PREDICTED SUBSIDENCE PARAMETERS

2.1. Introduction

The Incremental Profile Method was previously used to predict the conventional subsidence parameters resulting from the extraction of Panels 23 to 26, based on the SMP Layout, and these predictions were provided in Report No. MSEC596. This method was also used to predict the parameters based on the Approved Layout, which included the modified Panel 24, and these were provided in Report No. MSEC653.

The prediction model was calibrated to local conditions using the available monitoring data from SMP Areas 1 and 2, which is described in Section 3.7 of Report No. MSEC596.

Donaldson Coal has completed the extraction of Panel 23 and is currently extracting Panel 24 in SMP Area 3. The profiles of observed subsidence along the Panel 23 Centreline, Panel 24 Centreline and Black Hill Road monitoring lines are illustrated in Fig. 2.1, Fig. 2.2 and Fig. 2.3, respectively. The profiles of the final predicted subsidence (i.e. at the completion of mining) are also shown for comparison. The locations of these monitoring lines are shown in Drawing No. MSEC695-01.

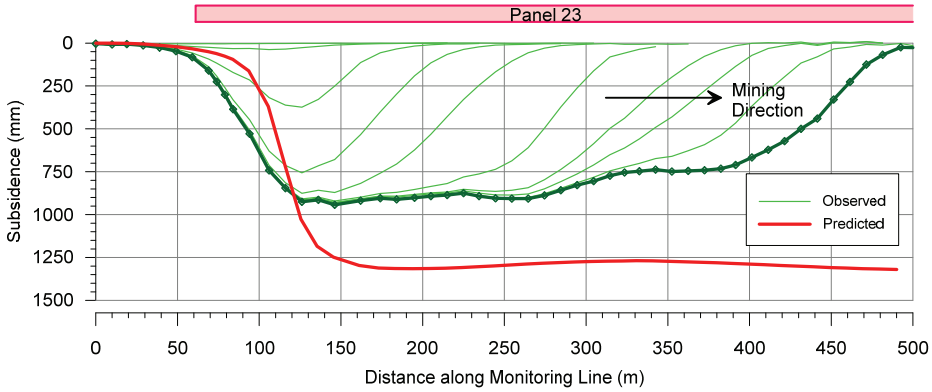

Fig. 2.1 Observed and Predicted Profiles along the Panel 23 Centreline

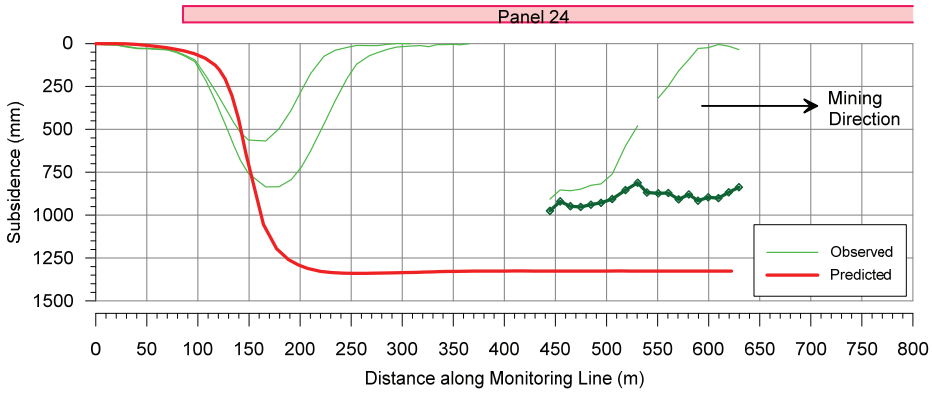

Fig. 2.2 Observed and Predicted Profiles along the Panel 24 Centreline

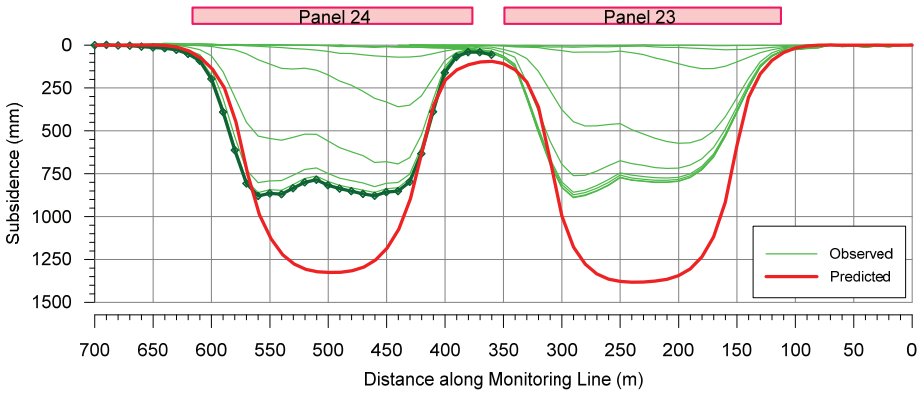

Fig. 2.3 Observed and Predicted Profiles along Black Hill Road

In the latest surveys, that the maximum observed subsidence along these monitoring lines were less than the maximum predicted. The maximum observed subsidence of approximately 1,000 mm represents around 38 % of the seam thickness of 2.6 metres. The maximum predicted subsidence, based on supercritical mining conditions, is 51 % of the extraction height.

The magnitudes of the maximum observed subsidence are less than what would normally be expected for supercritical mining conditions. Whilst, the prediction model could be calibrated to reduce the magnitudes of the predicted subsidence, it was considered appropriate to maintain the current levels of conservatism, since the observed subsidence were much closer to those predicted in SMP Area 1.

The profiles of observed subsidence reasonably match those predicted inside of panel edges, i.e. on the steep parts of the subsidence profiles away from the maximum observed subsidence. In some cases, there are lateral shifts between the observed and predicted profiles, which could be the result of surface dip, seam dip, or variations in the overburden geology.

Based on these comparisons, it would appear that the standard Incremental Profile Method provides reasonable predictions along these monitoring lines. It has not been considered necessary, therefore, to provide any site specific calibration of the standard IPM subsidence prediction curves in SMP Area 3.

2.2. Maximum Predicted Conventional Subsidence Parameters

The Incremental Profile Method has been used to predict the conventional subsidence parameters resulting from the extraction of Panels 23 to 26, based on the Modified Layout. The predicted total subsidence contours due to the extraction of Panels 23 to 26, based on the Modified Layout, are shown in Drawing No. MSEC695-06.

A summary of the maximum predicted values of incremental conventional subsidence, tilt and curvature due to the extraction of Panel 26, based on both 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 Panel 26 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	1,450	70	> 3.0	> 3.0
Modified Layout	1,450	70	> 3.0	> 3.0

It can be seen from the above table, that the maximum predicted incremental conventional subsidence parameters due to the extraction of Panel 26 do not change as a result of the proposed modification. The reason for this is that the modified panel is still supercritical and, therefore, the decreased overall void width does not result in decreased predicted subsidence parameters.

The maximum predicted subsidence parameters occur at the northern end of Panel 26, where the depths of cover are the shallowest. Away from the northern end, the panel is subcritical and the modified width results in a slight reduction of the predicted subsidence parameters. This is illustrated in Fig. A.01, in Appendix A, which shows the profiles of the predicted total subsidence, tilt and curvature along Prediction Line 1, which is located near the middle of Panel 26, as shown in Drawing No. MSEC695-06.

It can be seen from Fig. A.01, that the magnitudes of the predicted tilts and curvatures, based on the Modified Layout, are slightly less than those predicted based on the Approved Layout. Also, the locations of the maxima move around 40 metres towards the east as a result of the proposed modification.

2.3. Predicted Strains

The prediction of strain is more difficult than the predictions 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.

Donaldson Coal has extracted panels in SMP Areas 1, 2 and 3 using bord and pillar total and partial extraction. These panels were typically supercritical in width and, therefore, should provide a reasonable indication of the range of strains above Panel 26. The frequency distribution of the maximum observed tensile and compressive strains measured in survey bays located directly above the previously extracted panels at the mine is provided in Fig. 2.4. The probability distribution functions, based on fitted Generalised Pareto Distributions (GPDs), are also shown in this figure.

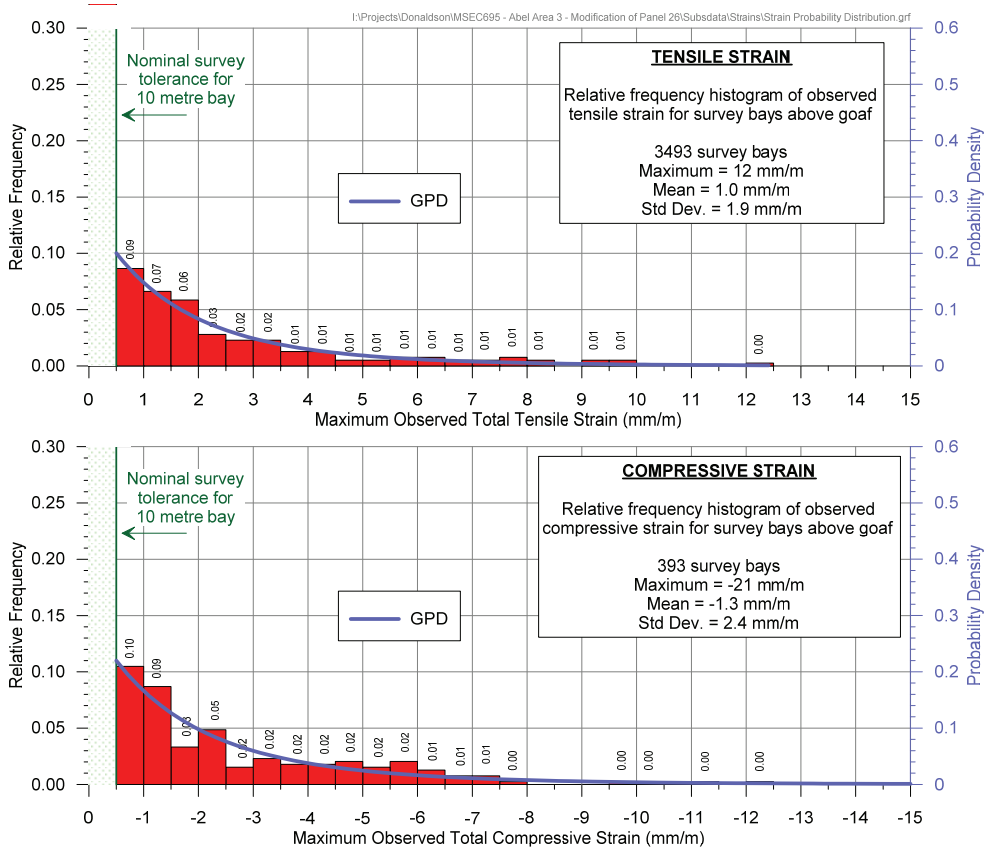

Fig. 2.4 Distributions of the Measured Maximum Tensile and Compressive Strains in Areas 1, 2 and 3 at the Abel Underground Mine

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 panel 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 total strains that the individual survey bays experienced at any time during mining were 5 mm/m tensile and 6 mm/m compressive. The 99 % confidence levels for the maximum total strains that the individual survey bays experienced at any time during mining were 9 mm/m tensile and 11 mm/m compressive.

3.0 THE EFFECTS OF THE PROPOSED MODIFICATION TO PANEL 26 ON THE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE NATURAL AND BUILT FEATURES

3.1. The Study Area

The *Study Area* has been defined as the zone where the predicted conventional 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:-

- 26.5 degree angle of draw line around Panel 26, based on both the original width (i.e. Approved Layout) and the proposed narrow width (i.e. Modified Layout), and
- The limit where the change in the predicted vertical subsidence, resulting from the proposed modification, is greater than 20 mm. In all locations, this limit is located within the 26.5 degree angle of draw line.

The extent of the Study Area is shown in Drawing No. MSEC695-01, in Appendix A. The natural and built features located within the Study Area are shown in Drawing Nos. MSEC695-04 and MSEC695-05, respectively, and are summarised below:-

- Four Mile Creek and associated tributaries,
- Steep slopes,
- Black Hill Road,
- 11 kV and low voltage powerlines,
- Copper telecommunications cables,
- Farm dams,
- Building structures on two properties (owned by the mine), and
- Archaeological sites.

The effects of the proposed modification of Panel 26 on the subsidence predictions and impact assessments for these features are provided in the following sections.

3.2. Four Mile Creek and Associated Tributaries

Four Mile Creek is a Schedule 1 (i.e. second order) ephemeral stream which crosses the northern part of Panel 26. The total length of creek located directly above the approved extents of the panel is around 0.8 kilometres.

The predicted profiles of subsidence, tilt and curvature along Four Mile Creek are illustrated in Fig. A.02, in Appendix A. The predicted total profiles based on the Approved Layout are shown by the cyan lines and the predicted total profiles based on the Modified Layout are shown by the blue lines.

A summary of the maximum predicted values of total conventional subsidence, tilt and curvature for Four Mile Creek, based on both the *Approved* and *Modified Layouts*, is provided in Table 3.1. The values are the maxima resulting from the extraction of Panels 23 to 26.

Table 3.1 Maximum Predicted Total Conventional Subsidence, Tilt and Curvature for Four Mile Creek Resulting from the Extraction of Panels 23 to 26

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Approved Layout	1,400	70	> 3.0	> 3.0
Modified Layout	1,400	70	> 3.0	> 3.0

It can be seen from the above table, that the maximum predicted subsidence parameters for Four Mile Creek, based on the Modified Layout, are the same as those based on the Approved Layout. The maxima occur at the northern end of Panel 26, where the depths of cover are the shallowest.

The magnitudes of the predicted tilt and curvatures adjacent to the western edge of Panel 26 decrease slightly as a result of the proposed modification. These local maxima also move around 40 metres to the east, which is illustrated in Fig. A.02. The total length of creek which is directly mined beneath also reduces by around 40 metres as a result of the proposed modification.

The impact assessments and proposed management strategies for Four Mile Creek and the associated tributaries within the Study Area, based on the *Modified Layout* are, therefore, the same as those provided in Report No. MSEC596 and the SMP Application. With these management strategies in place, it is unlikely that there would be any long term impacts on these streams.

3.3. Steep Slopes

For the purposes of this report, steep slopes have been defined as areas of land having natural gradients greater than 1 in 3 (i.e. 33 %, or an angle to the horizontal of 18°). There are steep slopes located to the south of Panel 26, which are associated with an east-west orientated ridgeline. There are some isolated areas with steep slopes located directly above the panel, which are associated with the banks of the streams.

The predicted subsidence parameters for these steep slopes, based on the Modified Layout, are similar to or slightly less than those predicted based on the Approved Layout.

The impact assessments and proposed management strategies for the steep slopes within the Study Area, based on the *Modified Layout* are, therefore, the same as those provided in Report No. MSEC596 and the SMP Application. With these management strategies in place, it is unlikely that there would be any long term impacts on these steep slopes.

3.4. Black Hill Road

Black Hill Road crosses directly above Panel 26 around mid-length of this panel. This public road provides a connection between the township of Black Hill, to the east of SMP Area 3, through to John Renshaw Drive, to the north-west of this area. The total length of road located directly above the approved extents of the panel is around 0.8 kilometres.

The predicted profiles of subsidence, tilt and curvature along Black Hill Road are illustrated in Fig. A.03, in Appendix A. The predicted total profiles based on the Approved Layout are shown by the cyan lines and the predicted total profiles based on the Modified Layout are shown by the blue lines.

A summary of the maximum predicted values of total conventional subsidence, tilt and curvature for Black Hill Road, based on both the *Approved* and *Modified Layouts*, is provided in Table 3.2. The values are the maxima for the section of road within the Study Area resulting from the extraction of Panels 23 to 26.

Table 3.2 Maximum Predicted Total Conventional Subsidence, Tilt and Curvature for the Section of Black Hill Road within the Study Area Resulting from the Extraction of Panels 23 to 26

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Approved Layout	1,400	40	2.5	2.0
Modified Layout	1,400	40	2.0	2.0

It can be seen from the above table, that the maximum predicted subsidence parameters for the section of Black Hill Road located within the Study Area, based on the Modified Layout, are the same or less than those based on the Approved Layout. The total length of road which is directly mined beneath reduces by around 40 metres as a result of the proposed modification.

The impact assessments and proposed management strategies for Black Hill Road, based on the *Modified Layout* are, therefore, the same as those provided in Report No. MSEC596 and the SMP Application. With these management strategies in place, it is unlikely that there would be any long term impacts on the road.

3.5. 11 kV and Low Voltage Powerlines

11 kV and low voltage powerlines are located above the Panel 26, to the south of Black Hill Road. These powerlines comprise aerial copper cables supported on timber poles. The electrical infrastructure within the SMP Area is owned by *Ausgrid*.

The predicted profiles of subsidence, tilt along and tilt across the alignment of the 11 kV Powerline are illustrated in Fig. A.04, in Appendix A. The predicted total profiles based on the Approved Layout are shown by the cyan lines and the predicted total profiles based on the Modified Layout are shown by the blue lines.

A summary of the maximum predicted values of total conventional subsidence and tilts for the powerline, based on both the *Approved* and *Modified Layouts*, is provided in Table 3.3. The values are the maxima anywhere along the section of powerline within the Study Area resulting from the extraction of Panels 23 to 26.

Table 3.3 Maximum Predicted Total Conventional Subsidence, Tilt and Curvature for the Section of 11 kV Powerline within the Study Area Resulting from the Extraction of Panels 23 to 26

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt Along Alignment (mm/m)	Maximum Predicted Total Conventional Tilt Across Alignment (mm/m)	Maximum Predicted Total Conventional Tilt in Any Direction (mm/m)
Approved Layout	1,400	35	20	40
Modified Layout	1,400	35	20	40

It can be seen from the above table, that the maximum predicted subsidence parameters for the section of the 11 kV powerline located within the Study Area, based on the Modified Layout, are the same as those based on the Approved Layout. The total length of powerline which is directly mined beneath reduces by around 40 metres as a result of the proposed modification.

There are powerpoles located near the western edge of Panel 26. A summary of the predicted tilts for these powerpoles, based on both the *Approved* and *Modified Layouts*, is provided in Table 3.4.

Table 3.4 Maximum Predicted Total Conventional Subsidence, Tilt and Curvature for the Powerpoles Located Near the Western Edge of Panel 26

Location	Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt Along Alignment (mm/m)	Maximum Predicted Total Conventional Tilt Across Alignment (mm/m)	Maximum Predicted Total Conventional Tilt in Any Direction (mm/m)
IS-73121	Approved Layout	550	35	20	40
	Modified Layout	50	5	< 5	5
IS-73113	Approved Layout	1,400	< 5	< 5	< 5
	Modified Layout	1,100	20	5	20
IS-73112	Approved Layout	1,150	20	< 5	20
	Modified Layout	1,150	20	< 5	20

The predicted maximum tilt at Pole IS-73113 increases as a result of the proposed modification. There are also other powerpoles associated with the consumer powerlines near this location which also could experience similar increased tilts. It is recommended that the predictions based on the Modified Layout are provided to *Ausgrid* so that any necessary preventive measures can be developed.

The impact assessments and proposed management strategies for the powerlines, based on the *Modified Layout* are the same as those provided in Report No. MSEC596 and the SMP Application. With these management strategies in place, it is unlikely that there would be any long term impacts on the powerlines.

3.6. Copper Telecommunications Cables

There are direct buried copper telecommunications cables within the Study Area which follow the alignment of Black Hill Road. The predicted profiles of subsidence, tilt and curvature along the road and, hence, along the alignment of the copper telecommunications cables are illustrated in Fig. A.03, in Appendix A. The predicted total profiles based on the Approved Layout are shown by the cyan lines and the predicted total profiles based on the Modified Layout are shown by the blue lines.

The maximum predicted subsidence parameters for the copper telecommunications cables within the Study Area are the same as Black Hill Road, which are summarised in Table 3.2. It can be seen from this table, that the maximum predicted subsidence parameters, based on the Modified Layout, are the same or less than those based on the Approved Layout. The total length of the cables which are directly mined beneath reduces by around 40 metres as a result of the proposed modification.

The impact assessments and proposed management strategies for copper telecommunications cables, based on the *Modified Layout* are, therefore, the same as those provided in Report No. MSEC596 and the SMP Application. With these management strategies in place, it is unlikely that there would be any long term impacts on the cables.

3.7. Farm Dams

There are five dams located within the Study Area, being Refs. A02d01 to A02d05, which have been constructed along the tributaries to Four Mile Creek. These dams are associated with Property A02 which has been purchased by the mine.

A summary of the maximum predicted values of total conventional subsidence, tilt and curvature for the farm dams located within the Study Area, based on both the *Approved* and *Modified Layouts*, is provided in Table 3.5.

Table 3.5 Maximum Predicted Total Conventional Subsidence, Tilt and Curvature for the Farm Dams within the Study Area Resulting from the Extraction of Panels 23 to 26

Location	Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt Along Alignment (mm/m)	Maximum Predicted Total Conventional Tilt Across Alignment (mm/m)	Maximum Predicted Total Conventional Tilt in Any Direction (mm/m)
A02d01	Approved Layout	950	35	2.0	1.5
	Modified Layout	950	35	2.0	1.5
A02d02	Approved Layout	1,350	45	3.0	2.0
	Modified Layout	1,350	45	3.0	2.0
A02d03	Approved Layout	1,400	35	1.5	1.5
	Modified Layout	1,400	30	1.5	1.0
A02d04	Approved Layout	1,350	25	1.0	1.0
	Modified Layout	1,300	25	1.0	1.0
A02d05	Approved Layout	1,050	25	1.0	1.0
	Modified Layout	850	20	0.5	1.0

It can be seen from the above table, that the predicted subsidence parameters for the farm dams located within the Study Area, based on the Modified Layout, are the same or less than those based on the Approved Layout.

The impact assessments and proposed management strategies for the farm dams, based on the *Modified Layout* are, therefore, the same as those provided in Report No. MSEC596 and the SMP Application. With these management strategies in place, it is unlikely that there would be any long term impacts on the dams.

3.8. Building Structures

There are two houses, being Refs A01h01 and A02h01, which are located within the Study Area. Both these houses have been purchased by the mine and, therefore, there are no Subsidence Control Zones around them. There are also two rural building structures within the Study Area, being Refs. A01r01 and A02r01, which are also owned by the mine.

A summary of the maximum predicted values of total conventional subsidence, tilt and curvature for the building structures located within the Study Area, based on both the *Approved* and *Modified Layouts*, is provided in Table 3.6. The values are the maxima within 20 metres of the perimeters of each structure.

Table 3.6 Maximum Predicted Total Conventional Subsidence, Tilt and Curvature for the Building Structures within the Study Area Resulting from the Extraction of Panels 23 to 26

Location	Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt Along Alignment (mm/m)	Maximum Predicted Total Conventional Tilt Across Alignment (mm/m)	Maximum Predicted Total Conventional Tilt in Any Direction (mm/m)
A01h01 (House)	Approved Layout	1,400	35	1.0	1.5
	Modified Layout	1,300	35	1.5	1.0
A01r01 (Rural structure)	Approved Layout	550	30	1.5	0.5
	Modified Layout	50	5	0.5	0.5
A01h02 (House)	Approved Layout	1,300	35	1.5	1.5
	Modified Layout	1,300	35	1.5	1.5
A01r02 (Rural structure)	Approved Layout	1,000	35	2.0	1.5
	Modified Layout	1,000	35	2.0	1.5

The predicted hogging curvature at House A01h01 increases from 1.0 km^{-1} to 1.5 km^{-1} as a result of the proposed modification, however, the predicted sagging curvature at this house also reduces from 1.5 km^{-1} to 1.0 km^{-1}. The predicted parameters at the remaining structures, based on the Modified Layout, are similar to or less than those based on the Approved Layout.

The two houses within the Study Area could experience moderate to severe impacts, including cracking to brickwork, external claddings and internal plasterboard. Substantial repairs are likely to be required, which could include relevelling of these structures. The rural structures could experience slight impacts which are expected could be remediated using normal building maintenance techniques.

The houses will be vacated prior to the panels mining directly beneath them. It is recommended that these houses are inspected by a structural engineer and that the necessary repairs are undertaken prior to them being retenanted.

3.9. Archaeological Sites

There are two archaeological sites located in the north-eastern corner of the Study Area, being Sites CA6 and 38-4-0980, which are both artefact scatters. Both these sites are located adjacent to but outside the eastern edge of Panel 26. The predicted subsidence parameters at these sites, based on the Modified Layout, are the same as those based on the Approved Layout.

The impact assessments and proposed management strategies for the archaeological sites, based on the *Modified Layout* are, therefore, the same as those provided in Report No. MSEC596 and the SMP Application. With these management strategies in place, it is unlikely that there would be any long term impacts on the archaeological sites.

3.10. Summary

The maximum predicted conventional subsidence parameters for Panel 26, based on the Modified Layout, are the same as the maxima for the Approved Layout. The surface area affected by subsidence reduces, however, as a result of the proposed modification.

The maximum predicted subsidence parameters for the natural and built features, based on the Modified Layout, are typically similar to or less than those predicted based on the Approved Layout. The predicted tilts at the powerpoles located near the western edge of Panel 26 increase, as a result of the proposed modification, and it is recommended that the updated predictions are provided to *Ausgrid* so that any necessary preventive measures can be developed.

The impact assessments and proposed management strategies for the natural and built features, based on the *Modified Layout* are, therefore, the same as those provided in Report No. MSEC596 and the SMP Application. With these management strategies in place, it is unlikely that there would be any long term impacts on these features.

APPENDIX A. FIGURES AND DRAWINGS

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Prediction Line 1 Resulting from the Extraction of Panels 23 to 26

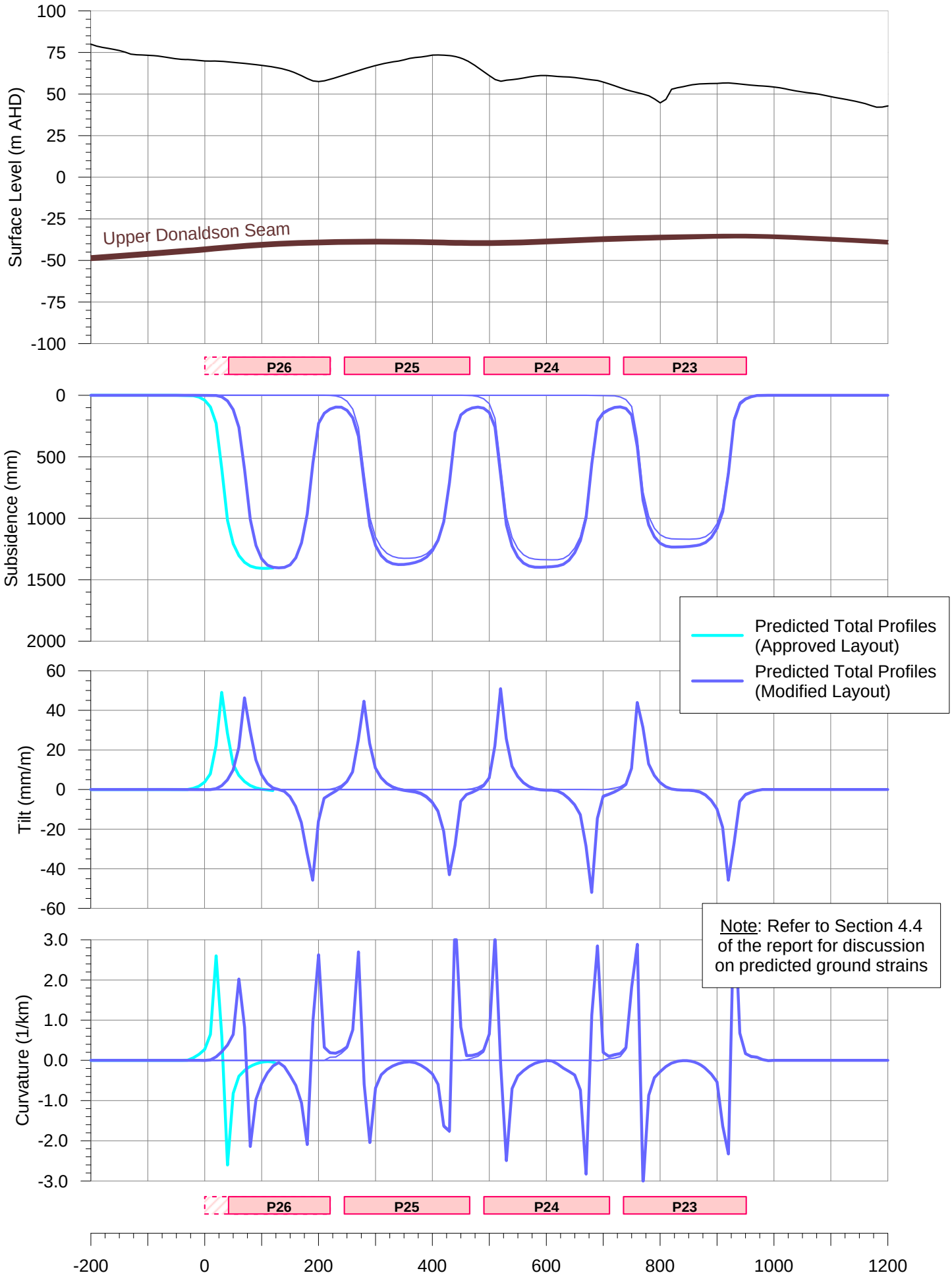

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Fig. A.01

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Four Mile Creek Resulting from the Extraction of Panels 23 to 26

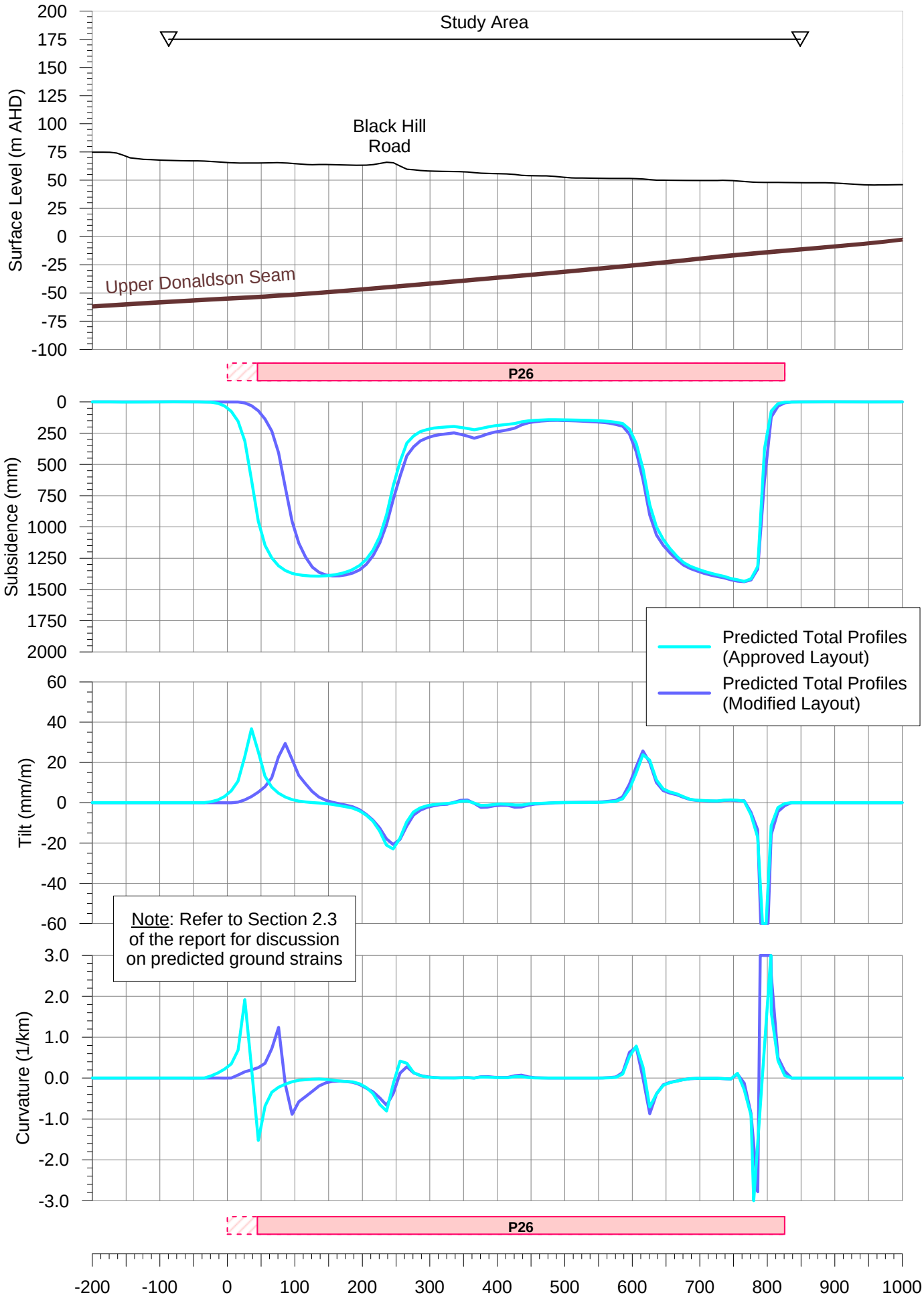

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Fig. A.02

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Black Hill Road Resulting from the Extraction of Panels 23 to 26

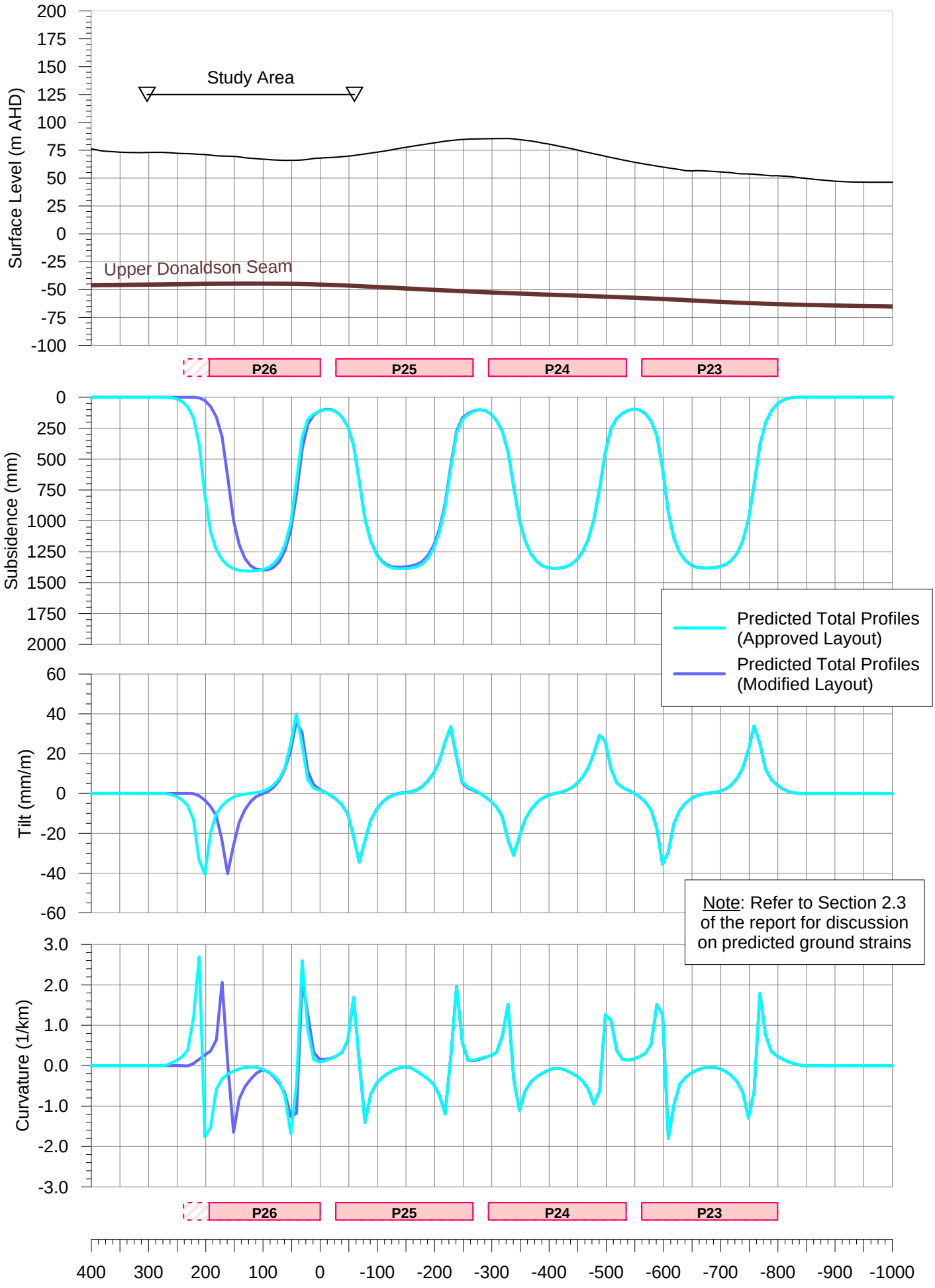

Fig. A.03

Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the 11 kV Powerline Resulting from the Extraction of Panels 23 to 26

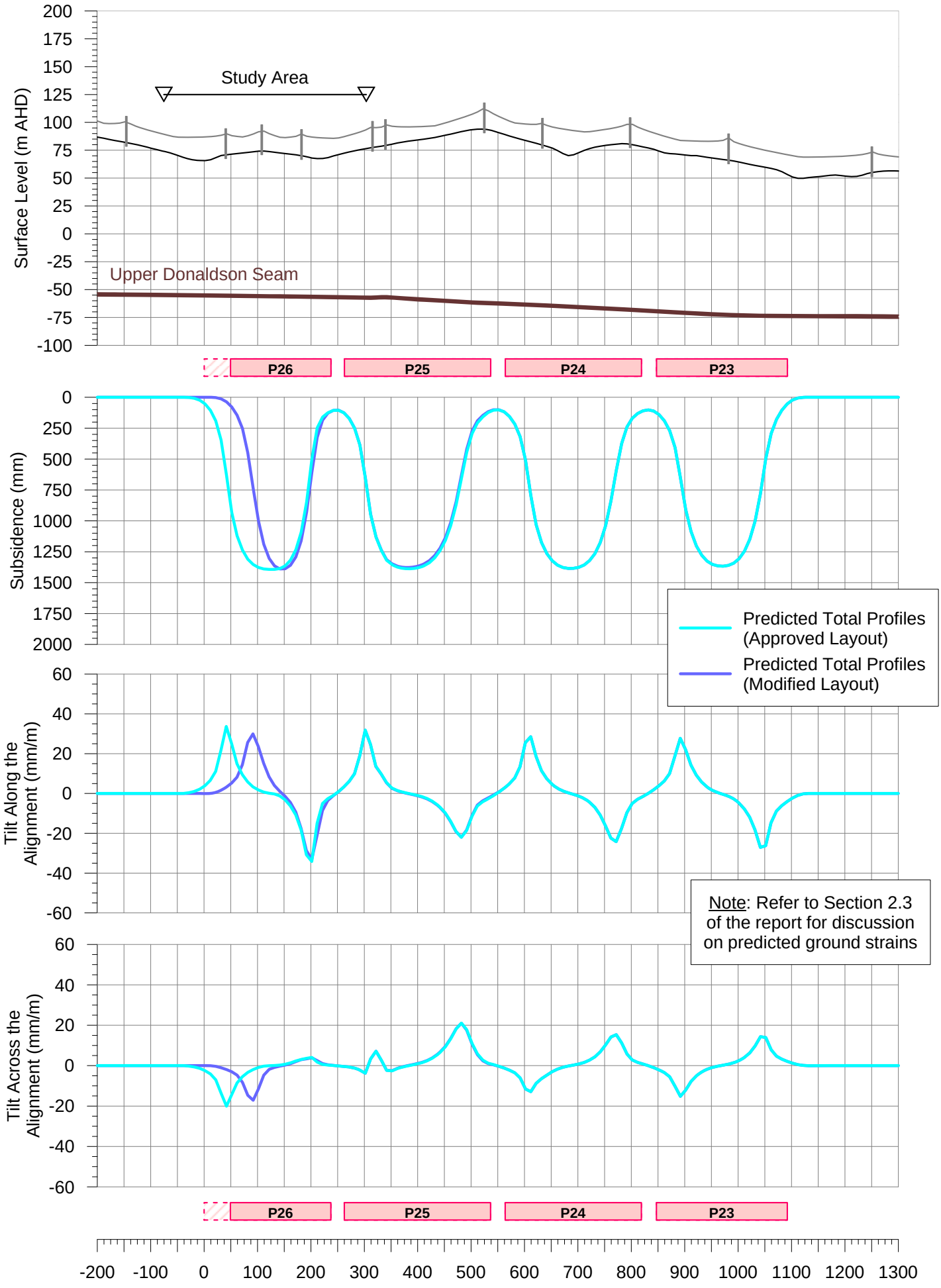

Fig. A.04

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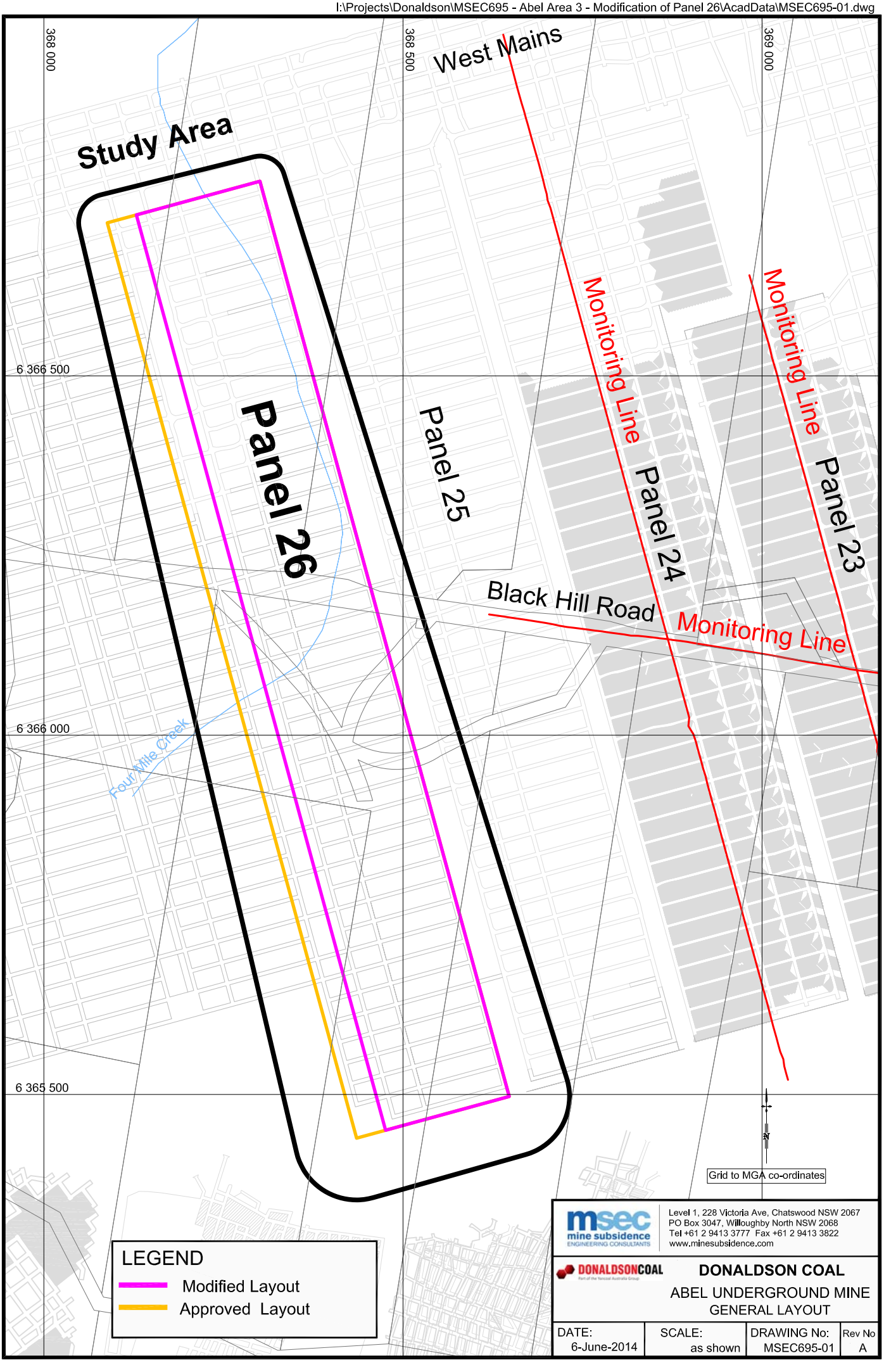

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ABEL UNDERGROUND MINE
GENERAL LAYOUT

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DEPTH OF COVER CONTOURS

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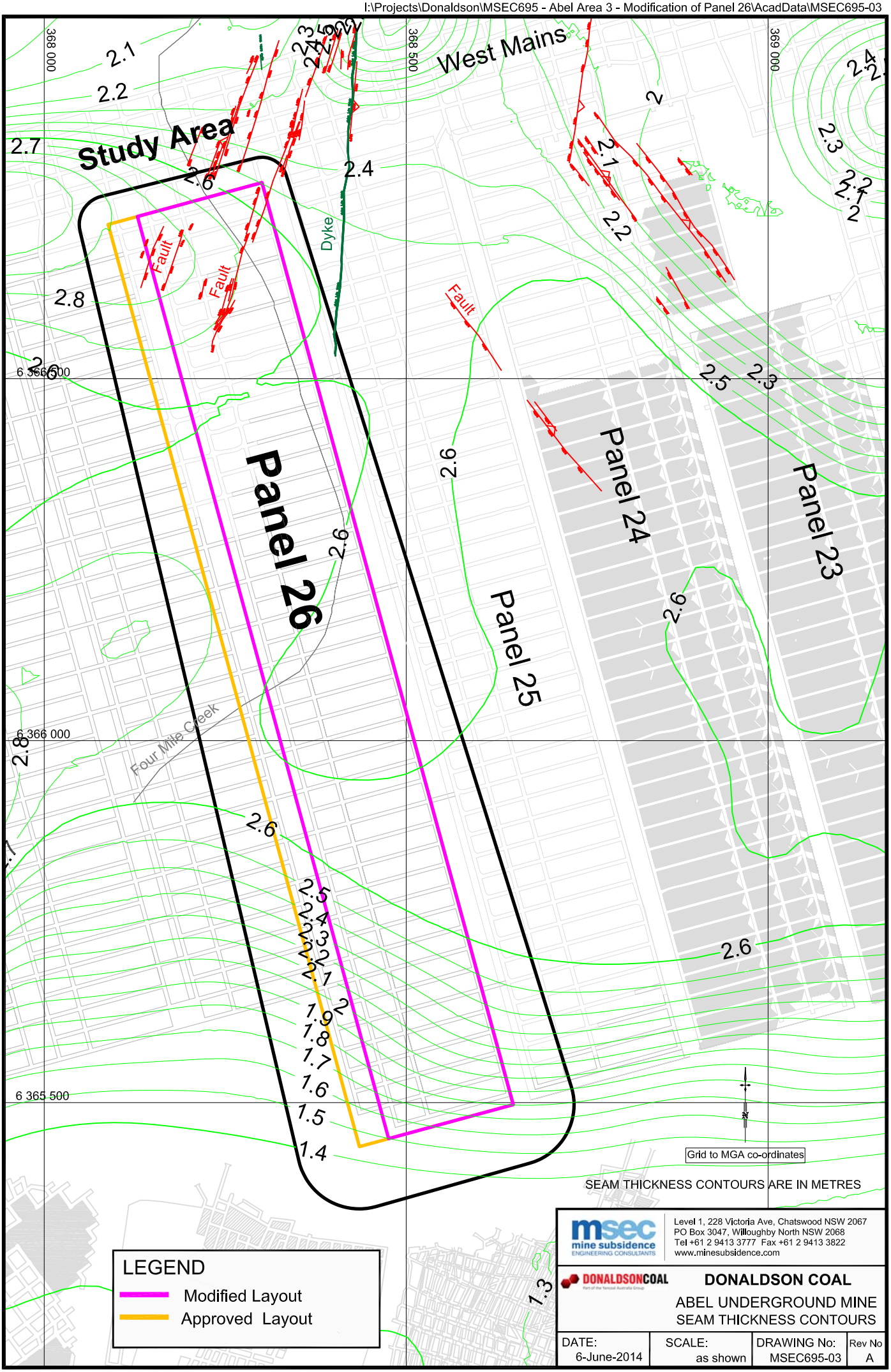

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SEAM THICKNESS CONTOURS

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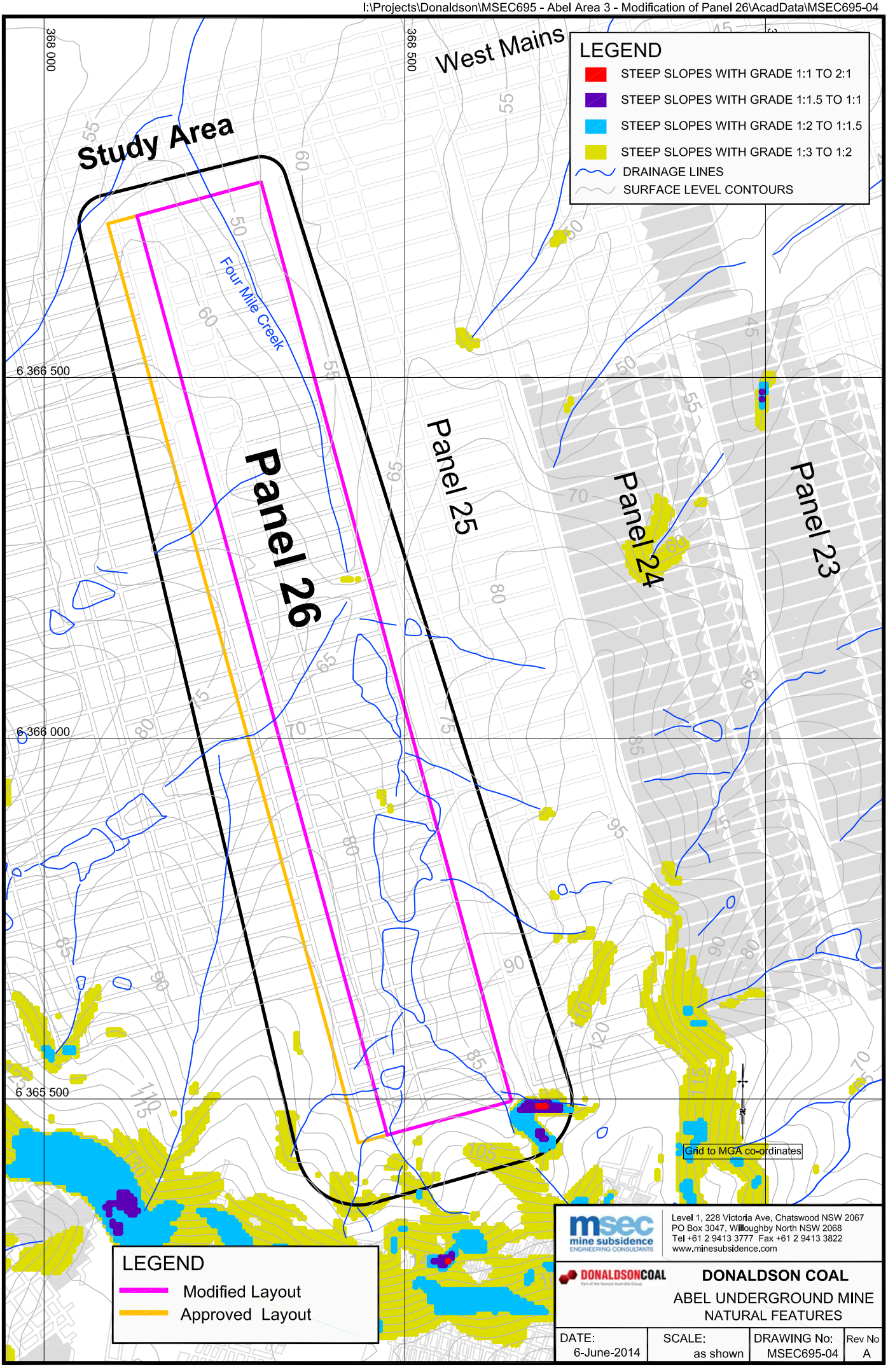

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NATURAL FEATURES

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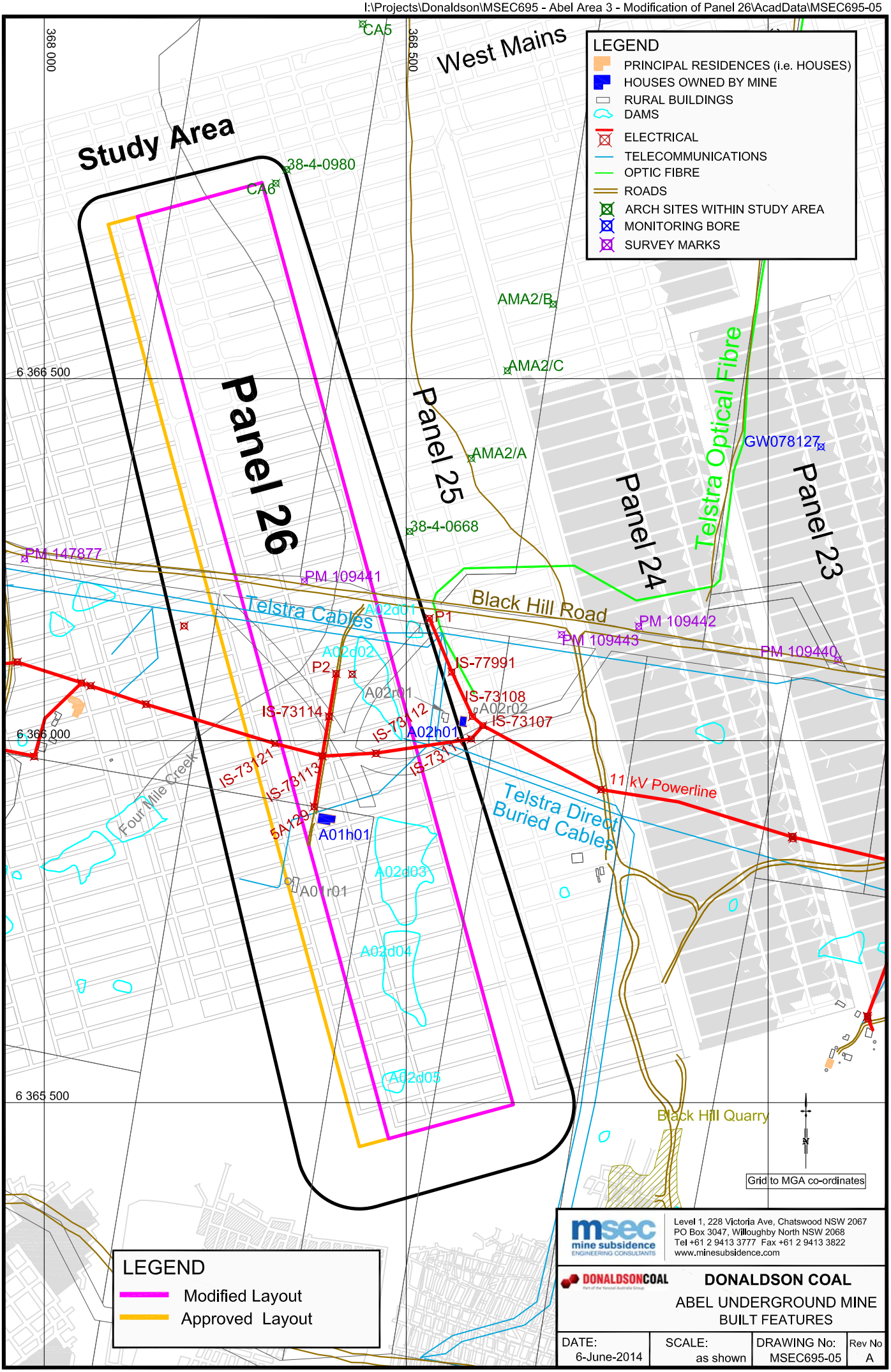

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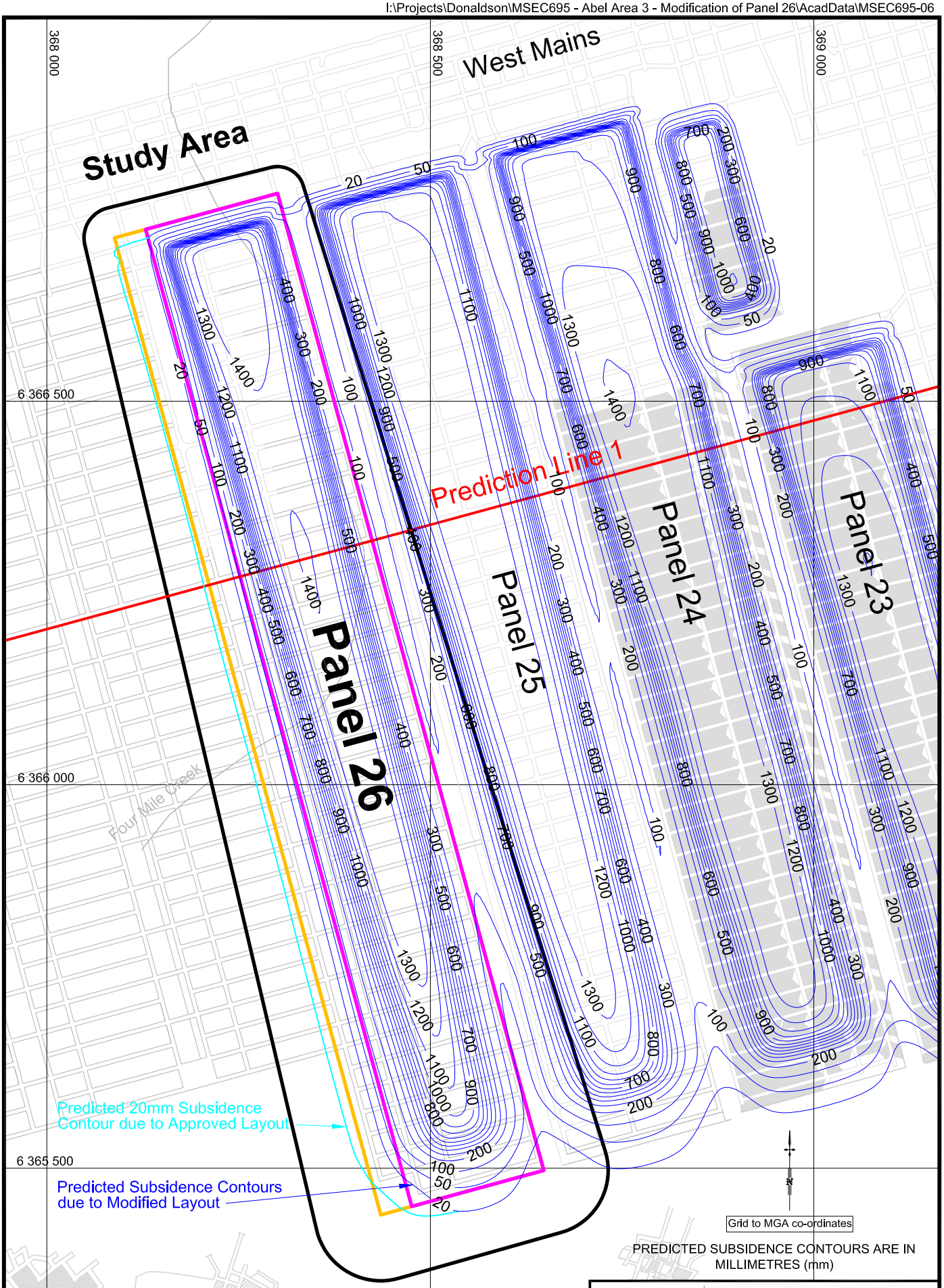

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PREDICTED TOTAL SUBSIDENCE CONTOURS

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