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BUILT FEATURES MANAGEMENT PLAN
GARRAWARRA CENTRE COMPLEX

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&E Approval Date
All	LW301-303 BFMP_GAR-R01-A	Original – Draft for Consultation	NSW Health, DRG and DP&E	-
Figure 4	LW301-303 BFMP_GAR-R01-B	Minor amendments to Figure 4	NSW Health, DRG and DP&E	11 May 2017*
Tables 2, 4, 6, 8 & 9 and Appendix 3	LW301-303 BFMP_GAR-R01-C	Revised – Addressing DP&E and DRG requirements	NSW Health, DRG and DP&E	-
Sections 4.2.1, 4.2.2 and 7, and Table 6	LW301-303 BFMP_GAR-R01-D	Revised to include updates regarding the Memorandum of Understanding and monitoring program	NSW Health	-
-	LW301-303 BFMP_GAR-R01-D	No changes, distribution to DRG and DP&E only	DRG and DP&E	-
All	LW301-303 BFMP_GAR-R01-E	Revised to include LW303	NSW Health and DRG	8 November 2018#
All	BFMP GAR-R01-F	Inclusion of Longwall 304 into BFMP	NSW Health	-

* The approval allows for the extraction of Longwalls 301 and 302 only.
# Approval for the extraction of Longwall 303.

April 2019

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1 INTRODUCTION

Metropolitan Coal is a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under section 75J of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com).

The Project comprises the continuation, upgrade and extension of underground coal mining operations (Longwalls 20-27 and Longwalls 301-317) and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1. Following the completion of Longwall 27 in 2017, Longwalls 301, 302, 303 and 304 define the next mining sub-domains within the Project underground mining area (Figures 1 to 3).

1.1 PURPOSE AND SCOPE

In accordance with Condition 6(f), Schedule 3 of the Project Approval, this Built Features Management Plan – Garrawarra Centre Complex (BFMP-GAR) has been developed to manage the potential consequences of longwall extraction on the Garrawarra Centre Complex.

The relationship of this BFMP-GAR to the Metropolitan Coal Environmental Management Structure is shown on Figure 4.

In accordance with Condition 6, Schedule 3 of the Project Approval, the suitably qualified and experienced experts that have prepared this BFMP-GAR, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and Metropolitan Coal were endorsed by the Director-General (now Secretary) of the NSW Department of Planning and Environment (DP&E).

This BFMP-GAR has been prepared in consultation with NSW Health.

1.2 STRUCTURE OF THE BFMP-GAR

The remainder of the BFMP-GAR is structured as follows:

Section 2: Describes the review and update of the BFMP-GAR.

Section 3: Outlines the statutory requirements applicable to the Plan.

Section 4: Provides a revised assessment of the potential subsidence impacts and environmental consequences for Longwalls 301-304.

Section 5: Details the performance measures and indicators that will be used to assess the Project.

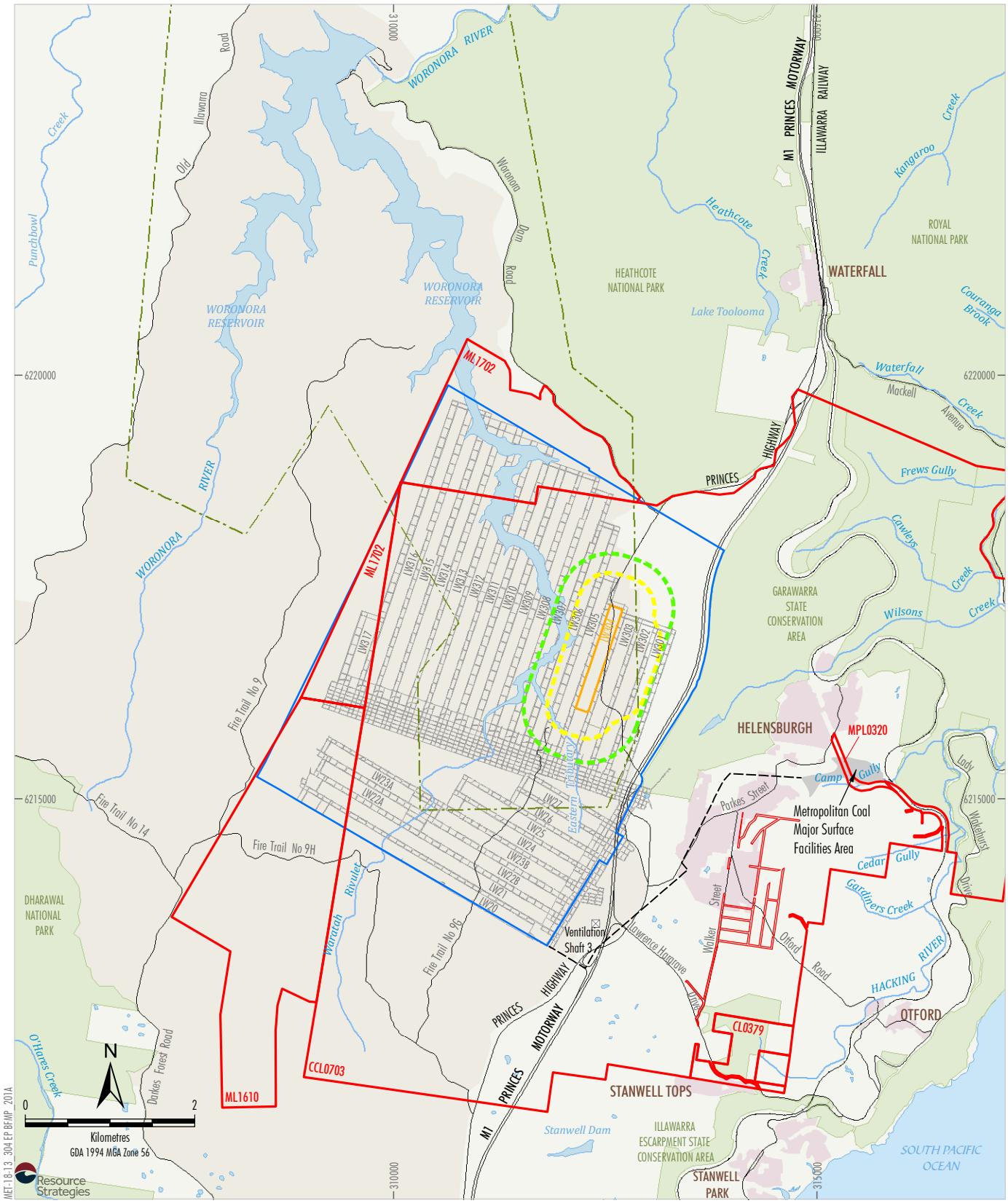
Section 6: Provides the detailed baseline data.

Section 7: Describes the monitoring program.

Section 8: Describes the management measures that will be implemented.

Section 9: Provides a contingency plan to manage any unpredicted impacts and their consequences.

Section 10: Describes the Trigger Action Response Plan (TARP) management tool.



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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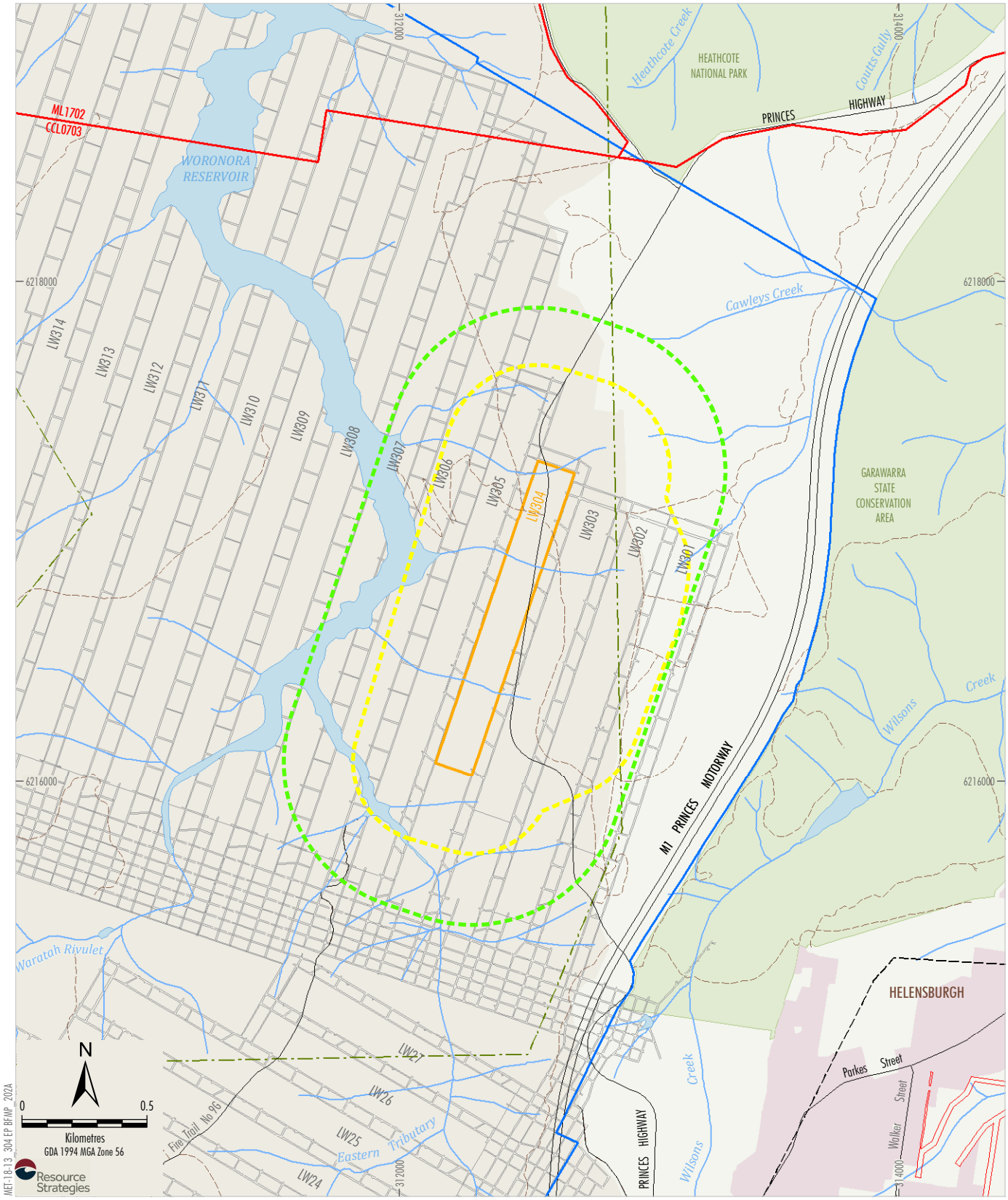
Longwalls 20-27 and Longwalls 301-317 Layout

Figure 1



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)
- Vehicular Track

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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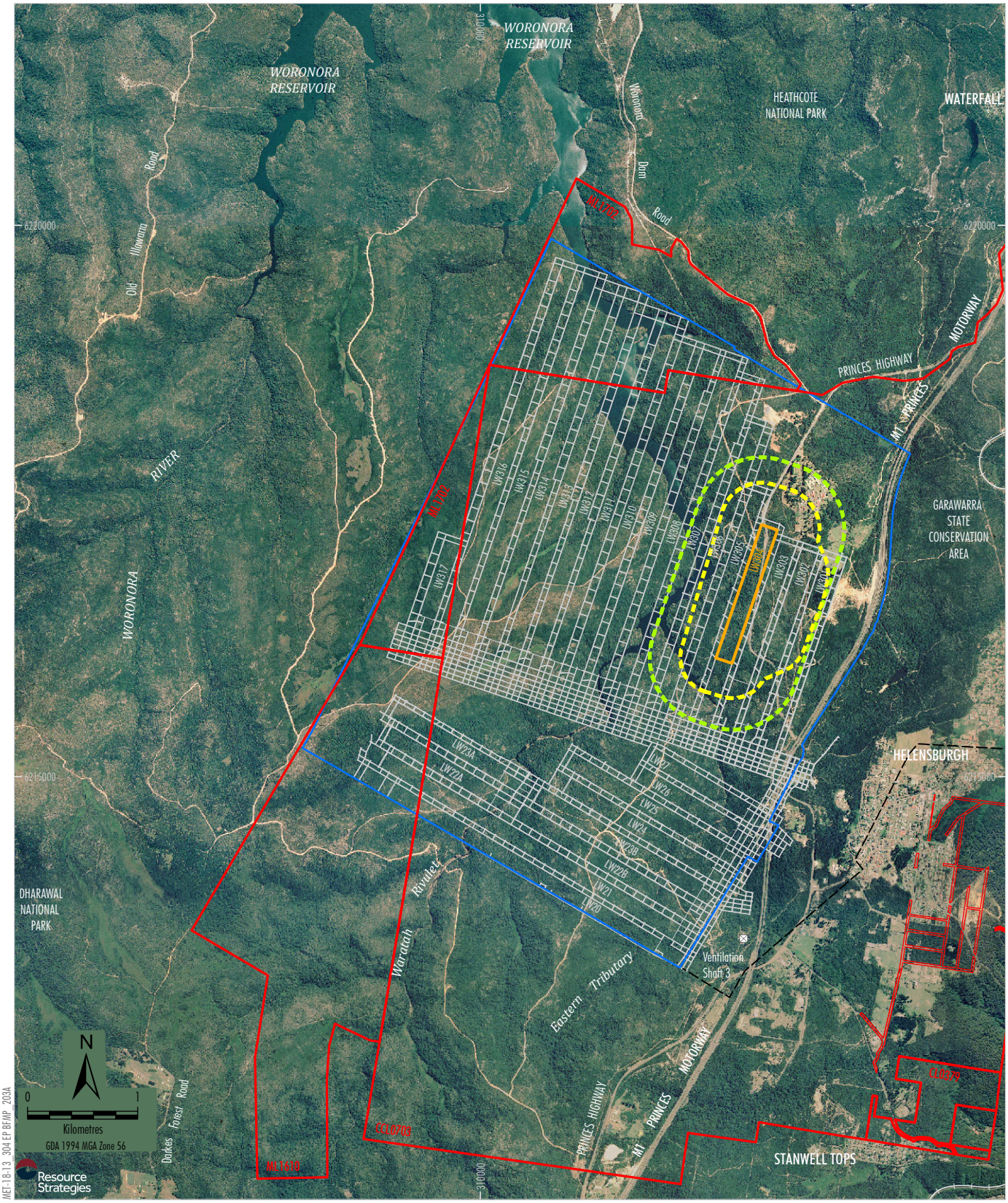
Longwalls 301-304 Layout

Figure 2



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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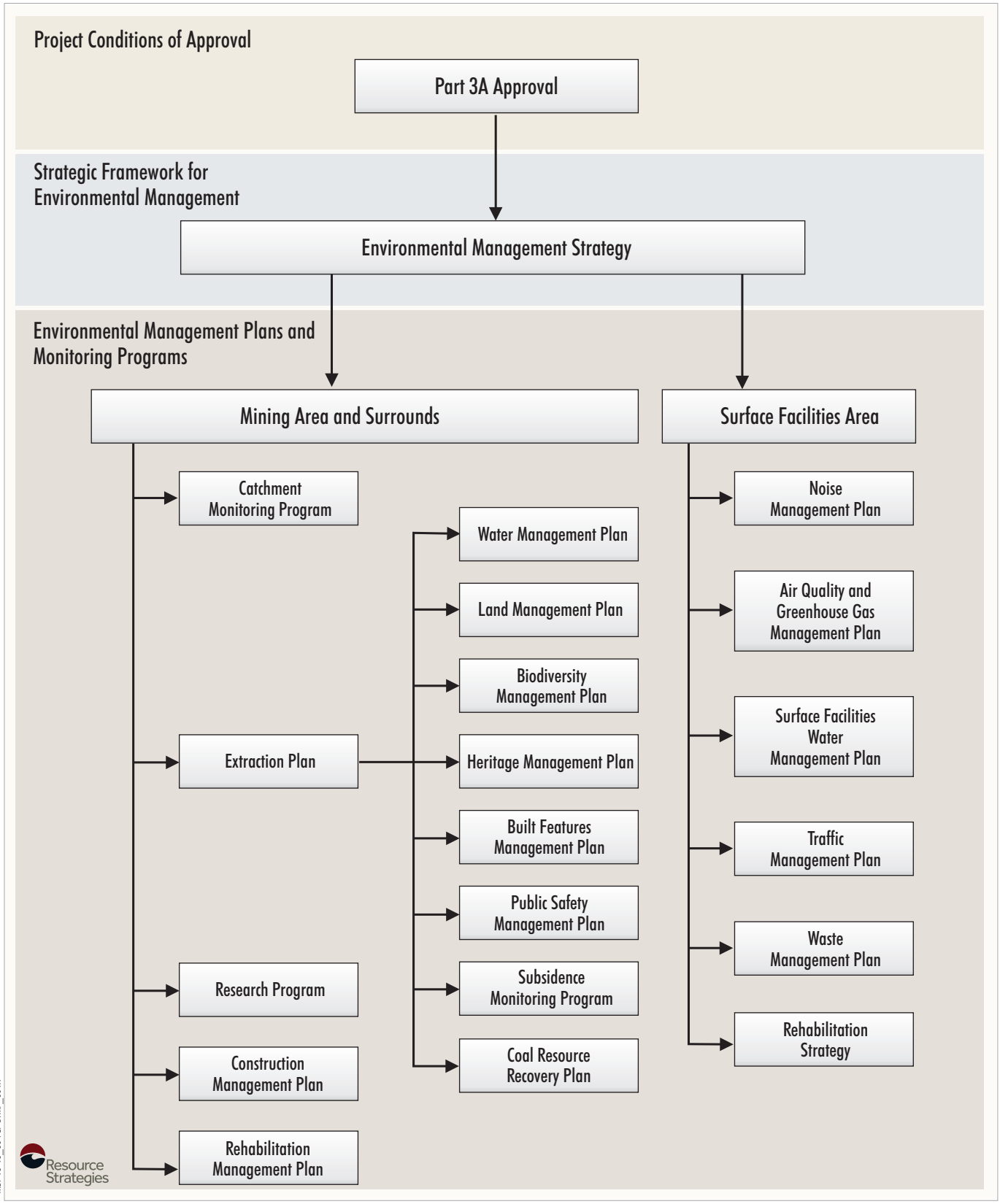
Longwalls 20-27 and Longwalls 301-317 Layout - Aerial Photograph

Figure 3



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Environmental Management Structure

Figure 4

Section 11: Describes the program to collect sufficient baseline data for future Extraction Plans.

Section 12: Describes the annual review and improvement of environmental performance.

Section 13: Outlines the management and reporting of incidents.

Section 14: Outlines the management and reporting of complaints.

Section 15: Outlines the management and reporting of non-compliances with statutory requirements.

Section 16: Lists the references cited in this BFMP-GAR.

2 BFMP-GAR REVIEW AND UPDATE

In accordance with Condition 4, Schedule 7 of the Project Approval, this BFMP-GAR will be reviewed within three months of the submission of:

- an audit under Condition 8 of Schedule 7;
- an incident report under Condition 6 of Schedule 7;
- an annual review under Condition 3 of Schedule 7; and

if necessary, revised to the satisfaction of the Director-General (now Secretary) of DP&E, to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

This BFMP will also be reviewed within three months of approval of any Project modification and if necessary, revised to the satisfaction of the DP&E.

The revision status of this plan is indicated on the title page of each copy of the BFMP-GAR. The distribution register for controlled copies of the BFMP-GAR is described in Section 2.1.

Revisions to any documents listed within this BFMP-GAR will not necessarily constitute a revision of this document.

2.1 DISTRIBUTION REGISTER

In accordance with Condition 10, Schedule 7 ‘Access to Information’, Metropolitan Coal will make the BFMP-GAR publicly available on the Peabody website. A hard copy of the BFMP-GAR will also be maintained at the Metropolitan Coal site.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format. An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom the Metropolitan Coal plans and programs, such as the BFMP-GAR, will be distributed;
- the format (i.e. electronic or hard copy) of distribution; and
- the format of revision notification.

Metropolitan Coal will make the Distribution Register publicly available on the Peabody website.

Metropolitan Coal will be responsible for maintaining the Distribution Register and for ensuring that the notification of revisions is sent by email or post as appropriate.

In addition, Metropolitan Coal employees with local computer network access will be able to view the controlled electronic version of this BFMP-GAR on the Metropolitan Coal local area network. Metropolitan Coal will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on Metropolitan Coal's computer system and the Peabody website.

3 STATUTORY REQUIREMENTS

Metropolitan Coal's statutory obligations are contained in:

(i) the conditions of the Project Approval;

(ii) relevant licences and permits, including conditions attached to mining leases; and

(iii) other relevant legislation.

These are described below.

3.1 EP&A ACT APPROVAL

Condition 6(f), Schedule 3 of the Project Approval requires the preparation of a BFMP as a component of Extraction Plan(s) for second workings. Project Approval Condition 6(f), Schedule 3 states:

> ***SECOND WORKINGS***
>
> ***Extraction Plan***
>
> *6. The Proponent shall prepare and implement an Extraction Plan for all second workings in the mining area to the satisfaction of the Director-General. This plan must:*
>
> *…*
>
> *(f) include a:*
>
> *…*
>
> - *Built Features Management Plan, which has been prepared in consultation with the owner of the relevant feature, to manage the potential environmental consequences of the Extraction Plan on any built features;*
>
> *…*

In addition, Condition 2, Schedule 7 and Condition 7, Schedule 3 of the Project Approval outline management plan requirements that are applicable to the preparation of the BFMP-GAR. Table 1 indicates where each component of the conditions is addressed within this BFMP-GAR.

Table 1
Management Plan Requirements

Project Approval Condition	BFMP-GAR Section
Condition 2 of Schedule 7	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Section 6
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 3
• any relevant limits or performance measures/criteria;	Section 5
• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 5
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Sections 7, 8, 9 and 10
d) a program to monitor and report on the:	Sections 7, 8 and 12
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 9 and Appendix 4
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Sections 7 and 12
g) a protocol for managing and reporting any;	
• incidents;	Section 13
• complaints;	Section 14
• non-compliances with statutory requirements; and	Section 15
• exceedances of the impact assessment criteria and/or performance criteria; and	Section 9 and Appendix 4
h) a protocol for periodic review of the plan.	Section 2
Condition 7 of Schedule 3	
7. In addition to the standard requirements for management plans (see condition 2 of schedule 7), the Proponent shall ensure that the management plans required under condition 6(f) above include:	
a) a program to collect sufficient baseline data for future Extraction Plans;	Section 11
b) a revised assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval;	Section 4
c) a detailed description of the measures that would be implemented to remediate predicted impacts; and	Section 8
d) a contingency plan that expressly provides for adaptive management.	Section 9 and Appendix 4

3.2 LICENCES, PERMITS AND LEASES

In addition to the Project Approval, all activities at or in association with the Metropolitan Coal Mine will be undertaken in accordance with the following licences, permits and leases which have been issued or are pending issue.

- The conditions of mining leases issued by the NSW Division of Resources and Geoscience (DRG), under the NSW *Mining Act, 1992* (e.g. Consolidated Coal Lease [CCL] 703, Mining Lease [ML] 1610, ML 1702, Coal Lease [CL] 379 and Mining Purpose Lease [MPL] 320).
- The *Metropolitan Coal Mining Operations Plan 1 October 2012 to 30 September 2019* approved by NSW Department of Industry.
- The conditions of Environment Protection Licence (EPL) No. 767 issued by the NSW Environment Protection Authority (EPA) under the NSW *Protection of the Environment Operations Act, 1997*. Revision of the EPL will be required prior to the commencement of Metropolitan Coal activities that differ from those currently licensed.
- The prescribed conditions of specific surface access leases within CCL 703 for the installation of surface facilities as required.
- Water Access Licences (WALs) issued by the Department of Primary Industries – Water (now the Department of Industry – Water) under the NSW *Water Management Act, 2000*, including WAL 36475 under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* and WAL 25410 under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011.*
- Mining and workplace health and safety related approvals granted by NSW Department of Industry and WorkCover NSW.
- Supplementary approvals obtained from WaterNSW for surface activities within the Woronora Special Area (e.g. fire road maintenance activities).

3.3 OTHER LEGISLATION

Metropolitan Coal will conduct the Project consistent with the Project Approval and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to the conduct of the Project (Helensburgh Coal Pty Ltd [HCPL], 2008)[1]:

- *Biodiversity Conservation Act, 2016;*
- *Biosecurity Act, 2015;*
- *Contaminated Land Management Act, 1997;*
- *Crown Land Management Act, 2016;*
- *Dams Safety Act, 2015;*
- *Dangerous Goods (Road and Rail Transport) Act, 2008;*
- *Energy and Utilities Administration Act, 1987;*
- *Fisheries Management Act, 1994;*

[1] The list of potentially applicable Acts has been updated to reflect changes to the Acts that were in force at the time of submission of the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008).

- *Mining Act, 1992;*
- *Protection of the Environment Operations Act, 1997;*
- *Rail Safety (Adoption of National Law) Act, 2012;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Water NSW Act, 2014;*
- *Work Health and Safety Act, 2011; and*
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

Relevant licences or approvals required under these Acts will be obtained as required.

4 REVISED ASSESSMENT OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

4.1 EXTRACTION LAYOUT

Longwalls 301-304 and the area of land within 600 metres (m) of Longwall 304 secondary extraction are shown on Figures 2 and 3. Longwall extraction occurs from north to south. The longwall layouts include 163 m panel widths (void) with 45 m pillars (solid).

The provisional extraction schedule for Longwalls 301-304 is provided in Table 2.

Table 2
Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
301	June 2017	6 months	February 2018
302	March 2018	7 months	October 2018
303	November 2018	7 months	May 2019
304	July 2019	6 months	December 2019

The future Extraction Plans will consider the cumulative subsidence effects, subsidence impacts and/or environmental consequences. Note that the total cumulative predicted subsidence effects, subsidence impacts and/or environmental consequences at the completion of the Project are considered in the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008) and the Preferred Project Report (HCPL, 2009).

4.1.1 NSW Health Assets - Garrawarra Centre Complex

Figures 5, 6 and 7 illustrate the NSW Health assets at the Garrawarra Centre Complex within and in proximity to the Study area for Longwall 304. The assets comprise approximately 85 building structures, including:

- abandoned (and fenced) hospital buildings (A01a-A01k and B03a-B03l) and lodge (A01l);
- aged care building structures (B01a-B01j and B02a-B02h) and other associated structures (B01k-B01q and B02i-B02j);
- houses (A01m, A02a-A09a and B04a-B09a) and other associated structures (A02b, A03b-A03d, A06b, A08b-A08f and A09b);
- water storage tanks (B01t01, B01t02, B14t01, B14t02, B16t01-B16t03, B17t01 and B18t01) and a trickle filter tank (B15t01);
- gas storage tank (B01t03);
- kiln (F01b); and
- telecommunications towers and associated compounds (B06b and B10a-B12a).[2]

Other built features and services at the Garrawarra Centre Complex include private access roads/tracks, potable water and sewer pipelines[3], powerlines[4] and telecommunications cables[5].

4.2 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

4.2.1 Revised Subsidence Predictions

Subsidence predictions for Longwalls 20-44 in relation to the Garrawarra Centre Complex was conducted by MSEC (2008) as part of the Metropolitan Coal Project EA. MSEC (2008) includes a table summarising the incremental systematic subsidence parameters for the extraction of each longwall from Longwalls 20-44. These include:

- maximum predicted incremental subsidence (vertical movement);
- maximum predicted incremental tilt along alignment;
- maximum predicted incremental tilt across alignment;
- maximum predicted incremental tensile strain; and
- maximum predicted incremental compressive strain.

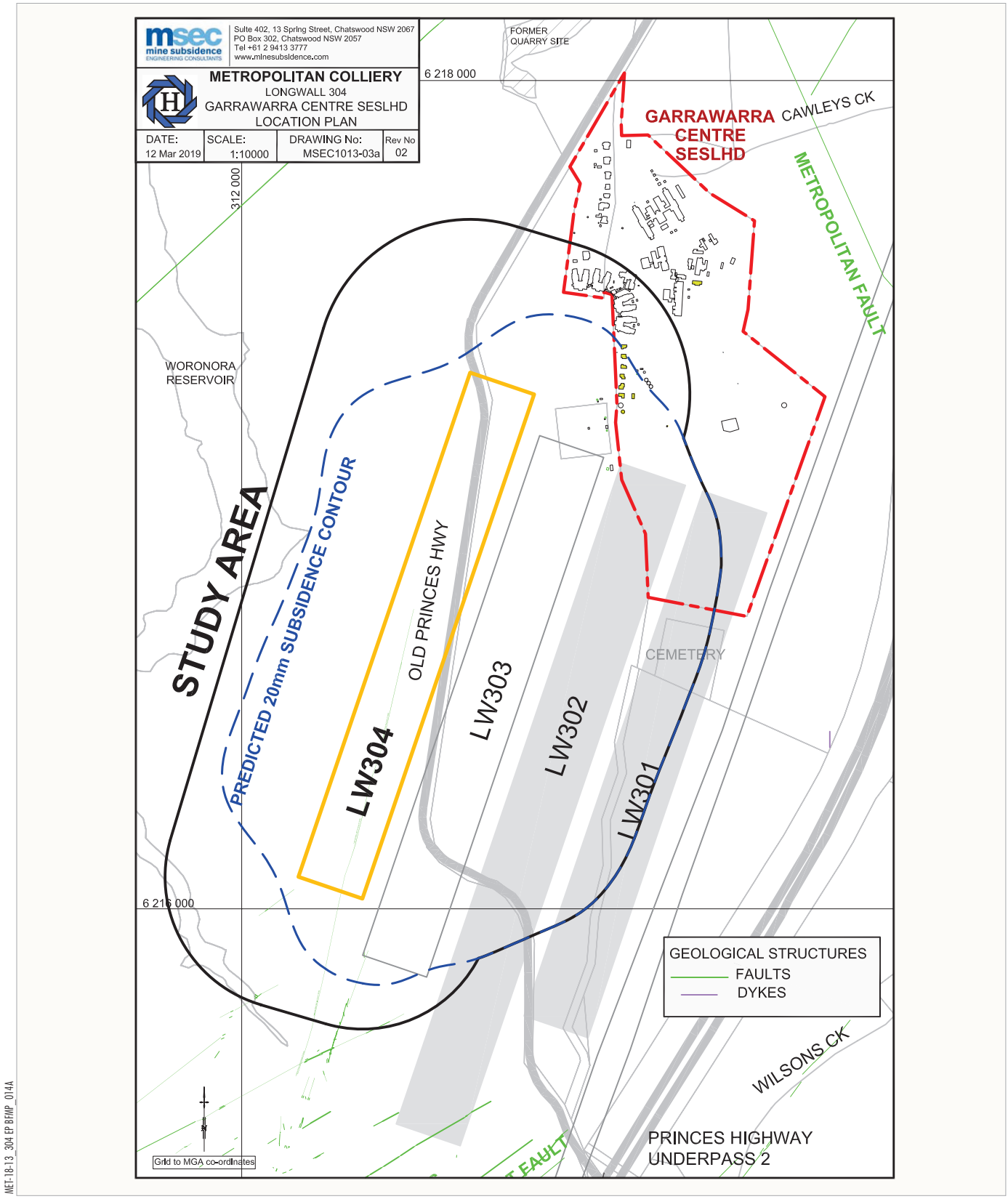
Revised subsidence and impact predictions for the extraction of Longwalls 301-303 and Longwall 304 on the Garrawarra Centre Complex were conducted by MSEC and reported in MSEC (2016) and MSEC (2019) (Appendices 1 and 2), respectively.

[2] Separate BFMPs for the telecommunication towers and compounds were developed in consultation with the relevant asset owners (i.e. Axicom, Telstra and Sydney Trains).

[3] A separate BFMP was developed in consultation with Sydney Water for relevant water infrastructure / services owned by Sydney Water.

[4] A separate BFMP was developed in consultation with Endeavour Energy for relevant electricity infrastructure / services owned by Endeavour Energy.

[5] A separate BFMP was developed in consultation with Telstra for relevant telecommunication services owned by Telstra.



Source: MSEC (2019)

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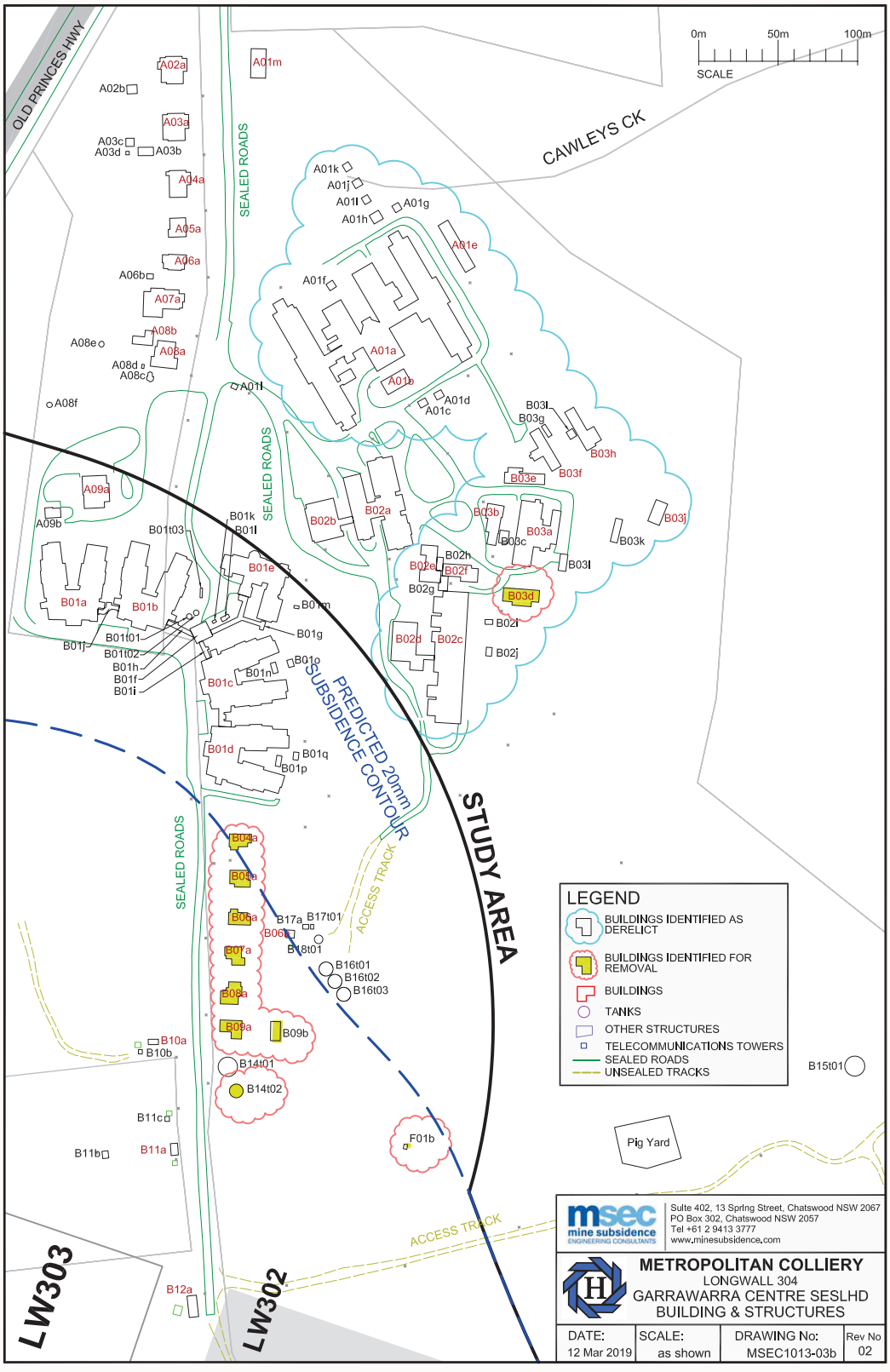
Garrawarra Centre Complex
Location Plan

Figure 5



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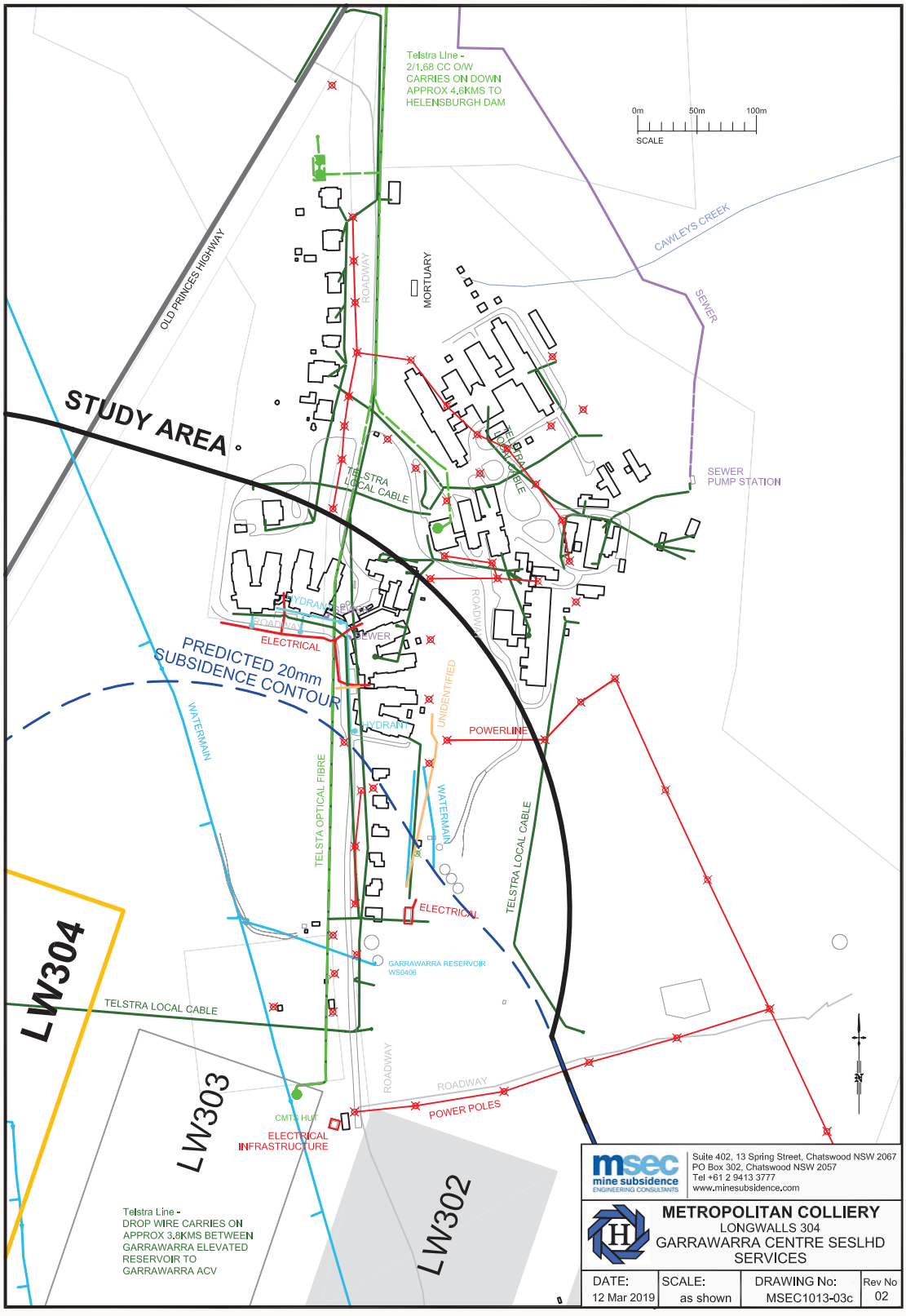
Source: MSEC (2019)



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Source: MSEC (2019)

It is noted that longwall layouts have been modified in order to minimise predicted subsidence movements at the Garrawarra Centre Complex building structures which house aged care patients and administrative support (e.g. B01a-B01e) by limiting the predicted conventional curvature to less than 0.01 km^{-1}.

In relation to subsidence predictions, John Matheson and Associates (JMA) (2016) and MSEC (2016) make the following conclusions and are summarised for each building / structure in Table 3.

Table 3
Summary of Revised Predictions for Buildings / Structures

Building (MSEC, 2016, JMA, 2016 and Howard Tanner & Associates, 1993)		**Predictions and Exceedance Probabilities (MSEC, 2016 and JMA, 2016)**			
		Probability of Exceedance			**Commentary**
		Nil – Category 0 [Hairline Crack <0.1 mm]	**< Category 1 [Fine Crack <1 mm not requiring repair]**	**Category 2 or greater [e.g. 2 mm Crack]**	
Hospital Buildings (Abandoned)					
A01a	Former Male Wards* (Wards 1-8)	Refer below	Refer below	Refer below	Refer below
	• Building A01a-i*	20%	1%	Unlikely	Possible (up to 3 mm cracks) if strain concentrates at pre-existing rock joints
	• Building A01a-ii*	7%	Unlikely	Remote	-
	• Building A01a-iii*	2%	Remote	Remote	-
	• Building A01a-iv*	<1%	Remote	Remote	-
	• Building A01a-v*	20%	0.01%	Remote	Possible (up to 3 mm cracks) if strain concentrates at pre-existing rock joints
	• Building A01a-vi*	2%	Remote	Remote	-
	• Building A01a-vii (Pharmacy – A01b)	0.1%	Remote	Remote	Pharmacy A01b as described in MSEC (2016)
	• Small Adjoining Buildings	0.01%	Remote	Remote	-
A01b	Pharmacy	0.1%	Remote	Remote	-
A01c	Chalet^	0.1%	Remote	Remote	-
A01d	Chalet^	0.1%	Remote	Remote	-
A01e	PWD Workshop	4%	Unlikely	Remote	-
A01f	Chalet^	0.1%	Remote	Remote	-
A01g	Chalet^	0.1%	Remote	Remote	-
A01h	Chalet^	0.1%	Remote	Remote	-
A01i	Chalet^	0.1%	Remote	Remote	-
A01j	Chalet^	0.1%	Remote	Remote	-
A01k	Chalet^	0.1%	Remote	Remote	-
A01l	Gatehouse / Lodge*	0.1%	Remote	Remote	-
B03a	Laundry / Boilerhouse^	45%	10%	1%	-

Table 3 (Continued)
Summary of Revised Predictions for Buildings / Structures

Building (MSEC, 2016, JMA, 2016 and Howard Tanner & Associates, 1993)		Predictions and Exceedance Probabilities (MSEC, 2016 and JMA, 2016)			
		Probability of Exceedance			Commentary
		Nil – Category 0 [Hairline Crack <0.1 mm]	< Category 1 [Fine Crack <1 mm not requiring repair]	Category 2 or greater [e.g. 2 mm Crack]	
Hospital Buildings (Abandoned) (Continued)					
B03b	Outdoor Staff	5%	Unlikely	Remote	-
B03c	Substation	0.1%	Remote	Remote	-
B03d	Seamstress	15%	Unlikely	Remote	Pre-existing pier tilt monitoring recommended
B03e	Transport Services	15%	Unlikely	Remote	-
B03f	Workshops	5%	Remote	Remote	-
B03g	Workshops	0.1%	Remote	Remote	-
B03h	Workshops	5%	Remote	Remote	-
B03i	Workshops	0.1%	Remote	Remote	-
B03j	Painters Workshop[#]	5%	Remote	Remote	-
B03k	Shed	5%	Remote	Remote	-
B03l	Shed	5%	Remote	Remote	-
Aged Care Buildings					
B01a	Administration	20%	1%	Remote	20% (higher if plasterboard does not have a matching joint)
B01b	Administration	20%	1%	Remote	20% (higher if plasterboard does not have a matching joint)
B01c	Administration	20%	1%	Remote	20% (higher if plasterboard does not have a matching joint)
B01d	Administration	20%	1%	Remote	20% (higher if plasterboard does not have a matching joint)
B01e	Nurses Quarters / Administration*,^	Refer below	Refer below	Refer below	Refer below
	• Original Building*	25%	1%	Unlikely	-
	• Stage 2^ & 3 Additions	15%	1%	Unlikely	-
B01f	Link Building	10%	1%	Unlikely	-
B01g	Link Building	10%	1%	Unlikely	-
B01h	Link Building	10%	1%	Unlikely	-
B01i	Link Building	10%	1%	Unlikely	-
B01j	Link Building	10%	1%	Unlikely	-
B01k	Shed	Unlikely	Unlikely	Unlikely	-
B01l	Shed	Unlikely	Unlikely	Unlikely	-
B01m	Shed	Unlikely	Unlikely	Unlikely	-

Table 3 (Continued)
Summary of Revised Predictions for Buildings / Structures

Building (MSEC, 2016, JMA, 2016 and Howard Tanner & Associates, 1993)		Predictions and Exceedance Probabilities (MSEC, 2016 and JMA, 2016)			
		Probability of Exceedance			Commentary
		Nil – Category 0 [Hairline Crack <0.1 mm]	< Category 1 [Fine Crack <1 mm not requiring repair]	Category 2 or greater [e.g. 2 mm Crack]	
Aged Care Buildings (Continued)					
B01n	Shed	Unlikely	Unlikely	Unlikely	-
B01o	Shed	Unlikely	Unlikely	Unlikely	-
B01p	Shed	Unlikely	Unlikely	Unlikely	-
B01q	Shed	Unlikely	Unlikely	Unlikely	-
B02a	Administration / Kitchen Group*	35%	1%	Unlikely	Possible (1 mm opening and closure) between buildings [Further investigation recommended]
	Dining and Recreation (Activities 1)*,^	15%	Unlikely	Remote	Possible (1 mm opening and closure) between buildings
B02b	Administration / Kitchen Group*	15%	Unlikely	Remote	Possible (2 mm opening and closure) between buildings [More detailed analysis of brick arches recommended]
B02c	Former Female Wards (Wards 9-12)*	45%	10%	1%	Possible (up to 3 mm cracks) if strain concentrates at pre-existing rock joints
B02d	Library / Canteen / Female Dining Room*	15%	0.01%	Unlikely	-
B02e	X-Ray Block	15%	0.01%	Unlikely	-
B02f	Activities 2 / Open Air Ward	15%	0.01%	Unlikely	-
B02g	Shed	5%	Unlikely	Unlikely	-
B02h	Shed	5%	Unlikely	Unlikely	-
B02i	Amenities	1%	Unlikely	Remote	-
B02j	Amenities	1%	Unlikely	Remote	-
Houses					
A01m	Staff Cottage	5%	Unlikely	Remote	-
A02a	Doctor's Residence*	5%	Unlikely	Remote	-
A02b	Shed	Remote	Remote	Remote	-
A03a	Doctor's Residence*	5%	Unlikely	Remote	-
A03b	Shed	Remote	Remote	Remote	-
A03c	Shed	Remote	Remote	Remote	-
A03d	Shed	Remote	Remote	Remote	-
A04a	Doctor's Residence*	5%	Unlikely	Remote	-

Table 3 (Continued)
Summary of Revised Predictions for Buildings / Structures

Building (MSEC, 2016, JMA, 2016 and Howard Tanner & Associates, 1993)		Predictions and Exceedance Probabilities (MSEC, 2016 and JMA, 2016)			
		Probability of Exceedance			Commentary
		Nil – Category 0 [Hairline Crack <0.1 mm]	< Category 1 [Fine Crack <1 mm not requiring repair]	Category 2 or greater [e.g. 2 mm Crack]	
Houses (Continued)					
A05a	Staff Cottage	5%	Unlikely	Remote	-
A06a	Staff Cottage#	5%	Unlikely	Remote	-
A06b	Shed	Remote	Remote	Remote	-
A07a	Staff Cottage#	5%	Unlikely	Remote	-
A08a	Medical Officer's Residence#	5%	Unlikely	Remote	-
A08b	Shed	5%	Unlikely	Remote	-
A08c	Shed	Remote	Remote	Remote	-
A08d	Shed	Remote	Remote	Remote	-
A08e	Shed	Remote	Remote	Remote	-
A08f	Shed	Remote	Remote	Remote	-
A09a	Palmer House*	25%	0.1%	Unlikely	-
A09b	Palmer House - Garage / Stable*	5%	Unlikely	Remote	-
B04a	Staff Cottage	1%	Unlikely	Remote	-
B05a	Staff Cottage	1%	Unlikely	Remote	-
B06a	Staff Cottage	1%	Unlikely	Remote	-
B06b	Shed	Remote	Remote	Remote	-
B07a	Staff Cottage	1%	Unlikely	Remote	-
B08a	Staff Cottage	1%	Unlikely	Remote	-
B09a	Staff Cottage	1%	Unlikely	Remote	-
B09b	Shed	1%	Unlikely	Remote	-
B14t01	Reservoir	50%	20%	5%	-
B14t02	Reservoir (no water)#	50%	20%	5%	-
B15t01	Trickle Filter Tank	50%	20%	5%	-
B16t01	Below Ground Tank	50%	20%	5%	-
B16t02	Below Ground Tank	50%	20%	5%	-
B16t03	Below Ground Tank	50%	20%	5%	-
B17a	Pump House	Unlikely to be affected			
B17t01	Fire Water Tank	Unlikely to be affected			
B18t01	Tank	Unlikely to be affected			
B01t01	Rainwater Tank	Unlikely to be affected			
B01t02	Rainwater Tank	Unlikely to be affected			
Gas Storage Tank					
B01t03	Gas Storage Tank	Unlikely to be affected			
Other					
F01b	Kiln	Tilt may add to pre-existing tilt – barrier fence recommended			

After: JMA (2016) and Howard Tanner & Associates (1993)
* Items of Exceptional Cultural Significance (Howard Tanner & Associates, 1993)
^ Items of High Cultural Significance (Howard Tanner & Associates, 1993)
# Items of Some Cultural Significance (Howard Tanner & Associates, 1993)

The predicted subsidence parameters for the structures after Longwall 304 are generally unchanged or similar to those assessed in the report by JMA (2016) and the resulting assessments for the structures do not change (MSEC, 2019). The buildings are expected to remain safe and serviceable and potential impacts could be repaired using normal building maintenance techniques (MSEC, 2019). A detailed assessment of the structural assessments is provided in JMA (2016).

Hospital Buildings (Abandoned)

- The buildings are fenced and therefore access is restricted.
- The structures are located outside the extents of Longwalls 301 to 304.
- The building structures are expected to remain safe and serviceable (or as otherwise identified during the pre-mining inspection, noting that some buildings have deteriorated).
- Negligible damage (i.e. hairline [<0.1 mm] or fine cracks which do not need repair [<1 mm]) is expected.
- It is noted that for Buildings A01a-i and A01a-v at the Former Male Wards, category 2 impacts or greater are possible (up to 3mm cracks) if strain concentrates at pre-existing rock joints due to length of structure however is considered unlikely and remote respectively.
- It is also noted for Buildings B03a (Laundry / Boilerhouse), category 2 impacts or greater has a 1% probability.
- As a contingency, should greater cracking occur, these could be repaired using normal building maintenance techniques in consultation with the relevant authorities.

Aged Care Buildings

- The aged care buildings are located outside the extents of Longwalls 301 to 304.
- The building structures are expected to remain safe and serviceable.
- Negligible damage (i.e. hairline [<0.1 mm] or fine cracks which do not need repair [<1 mm]) is expected.
- It is noted that for Building B02a at the Administration / Kitchen Group and Dining / Recreation, category 2 impacts or greater are possible (1mm opening and closure) between buildings however is considered unlikely and remote respectively.
- It is noted that for Building B02b at the Administration / Kitchen Group, category 2 impacts or greater are possible (2mm opening and closure) between buildings however is considered remote.
- It is noted that for Buildings B02c at the Former Female Wards, category 2 impacts or greater are possible (up to 3mm cracks) if strain concentrates at pre-existing rock joints due to length of structure with a 1% probability.
- As a contingency, should greater cracking or opening and closing of joints occur, these could be repaired using normal building maintenance techniques in consultation with the relevant authorities.

Houses

- The houses are located outside the extents of Longwalls 301 to 304.
- The houses are expected to remain safe and serviceable (or as otherwise identified during the pre-mining inspection, noting that some buildings have deteriorated).

- Negligible damage (i.e. hairline [<0.1 mm] or fine cracks which do not need repair [<1 mm]) is expected for all houses with a confidence level greater than 99%.
- As a contingency, should greater cracking occur, these could be repaired using normal building maintenance techniques in consultation with the relevant authorities.

Water Storage Tanks

- The water storage tanks (including the trickle filter tank) are located outside the extents of Longwalls 301 to 304.
- Given the low magnitude of predicted subsidence parameters, it is not expected that preventative measures would be required.
- It is expected that these tanks can be maintained in a safe and serviceable condition (or as otherwise identified during the pre-mining inspection, noting that some structures have deteriorated).
- As a management measure, if the tank base or lower sections of the tank walls were to develop leakage or if pre-existing leakage were to increase, the tank could be temporarily drained and lined with HDPE to establish a watertight envelope.
- As a management measure, should cracking occur (i.e. more than negligible damage) in the columns, elevated ring beam or central access shaft, these could be repaired using normal building maintenance techniques in consultation with the relevant authorities.

Gas Storage Tank

- The gas storage tank is located outside the extents of Longwalls 301 to 304, by more than 310 m.
- The maximum predicted subsidence parameters are negligible and therefore unlikely to adversely impact on the tank.
- The gas storage tank is supported on a concrete slab above the ground and therefore is unlikely to experience the mining induced curvatures and strains.

Kiln

- The kiln is located outside the extents of Longwalls 301 to 304 (north of Longwall 302).
- As described in Section 6.6, an agreement was previously reached between South Eastern Sydney Local Health District and Metropolitan Coal to remove the kiln as part of risk mitigation process. The kiln has been securely fenced whilst mining is nearby awaiting development approval to remove.

Telecommunication Towers Compounds and Cables

- The optical fibre cable is direct buried in conduit and, therefore, will not be impacted by the tilts resulting from the extraction of Longwalls 301-304.
- The buried optical fibre cable is likely to experience curvatures and ground strains resulting from the extraction of Longwalls 301-304.
- The predicted curvatures and strains for the optical fibre cable are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar cables.
- Based on the predicted curvatures and strains, it is unlikely the copper telecommunications cables would experience adverse impacts.

- The magnitude of tilt predicted at the telecommunications towers (and compounds) is very small (less than 1%) and is unlikely to be adversely impacted.
- It is expected that the building enclosure would remain in safe and serviceable conditions during and after mining.

Private Access Road/Tracks

- The private roads at the Garrawarra Centre Complex with bitumen seals are located outside the proposed longwall extents. Experience from the Southern Coalfield indicates that the impacts on these roads are not expected.
- Short lengths of road comprising chip seal or gravel surface are located near or above the proposed longwalls. Potential impacts to these roads may include minor and isolated cracks. Any impacts can be remediated using normal road maintenance techniques.
- It is expected that the private roads can be maintained in safe and serviceable conditions.

Powerlines

- The aerial conductors are supported by timber poles above the ground and therefore are not expected to experience adverse impacts due to curvature or strain.
- The buried cables could experience the mining induced curvatures and strains.
- Extensive experience of mining beneath aerial and buried powerlines in the Southern Coalfield indicates that the potential mining impacts are rare and generally of a minor nature.

Water Pipelines

- The distribution network at the Garrawarra Centre Complex comprises Cast Iron Cement Lined (CICL) pipelines with diameters ranging between 150 mm and 300 mm.
- Experience from the Southern Coalfield indicates that the potential impacts on these types of pipelines are rare and generally of a minor nature.
- It is possible that some minor leaks could develop as a result of the extraction of Longwalls 301 to 304. It is expected that any impacts could be remediated by locally exposing the pipeline and repairing or replacing the affected section.
- It is expected that the water services can be maintained in safe and serviceable conditions.

4.2.2 Risk Assessment Meeting

In accordance with the *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) a risk assessment meeting for Longwalls 301-303 was held on 20 October 2016. Attendees at the risk assessment meeting included representatives from Metropolitan Coal, NSW Health, MSEC, John Matheson and Associates, Resource Strategies and Axys Consulting (risk assessment facilitator).

The investigation and analysis methods used during the risk assessment included:

- preliminary identification of NSW Health assets;
- review of the revised subsidence predictions and potential impacts on NSW Health assets (including consideration of past experience in the Southern Coalfield); and
- development of a preliminary monitoring plan.

A number of risk control measures and procedures were identified during the risk assessment which considered the extraction of coal beneath the land within the Study area and in proximity to the NSW Health assets, and are summarised as follows:

Baseline Data / Validation

1. Provide a copy of the JMA (2016) report to NSW Health.
2. Carry out a visual / baseline audit of the NSW Health assets (i.e. occupied buildings, water storage tanks, gas storage tank and private roads) within the Study area.

Management / Monitoring / Response Measures

3. Establish a key contacts list between Peabody and NSW Health to provide a regular update of status of mining activities, and for ongoing liaison.
4. Install security fencing and signage (complete with entry gate) around the perimeter of both large water tanks during active mining of Longwall 301 to 303 that may result in impacts on the water towers.
5. Conduct visual inspections of the private roads within the Garrawarra Centre Complex during active mining to document the condition and serviceability.

Contingency Planning

6. Include in the BFMP a table of key contacts of water suppliers that could assist to provide additional water for Garrawarra Centre Complex (if required).

Metropolitan Coal considers all risk control measures and procedures to be feasible to manage all identified risks.

The proposed risk control measures and procedures have been incorporated where relevant in this BFMP and the program for implementation is summarised in Table 4.

Table 4
Program for Implementation of Proposed Risk Control Measures and Procedures

	Risk Control Measure / Procedure	BFMP Section	Proposed Timing
Baseline Data / Validation			
1	Provide a copy of the JMA (2016) report to NSW Health	Section 6	Complete
2	Carry out a visual / baseline audit of the NSW Health assets (i.e. occupied buildings, water storage tanks, gas storage tank and private roads) in the Study area	Sections 6, 6.4, 6.5 and 7.2.1	Complete
Management / Monitoring / Response Measures			
3	Establish key contacts list in the BFMP	Section 6.9	Complete
4	Install security fencing and signage (complete with entry gate) around the perimeter of large water storage tanks during active mining of Longwall 301 to 303 that may result in impacts on the water towers	Section 6.4	Complete
5	Conduct visual inspections of the private roads within the Garrawarra Centre Complex during active subsidence	Section 7.2.1	As prescribed in Table 6
Contingency Planning			
6	Include a list of key contacts of water suppliers that could assist to provide additional water for Garrawarra Centre Complex (if required)	Section 8	Complete

The risk control measures and procedures identified during the risk assessment for Longwalls 301-303 will be implemented for the extraction of Longwall 304.

Subsequent to the Risk Assessment an agreement has been reached between South Eastern Sydney Local Health District and Metropolitan Coal to remove designated Garrawarra centre assets as part of risk mitigation process. The Memorandum of Understanding – signed 31 August 2017 details that Cottages B04a-B09a, water tank B14t02, Kiln F01b and building B03d will be removed subject to Wollongong City Council development approval, these features have been securely fenced awaiting development approval.

5 PERFORMANCE MEASURES AND INDICATORS

The Project Approval requires Metropolitan Coal not to exceed the subsidence impact performance measures outlined in Table 1 of Condition 1, Schedule 3. The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

> *Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.*

Of specific relevance to the Garrawarra Centre Complex, a subsidence impact performance measure outlined in Table 1 of Condition 1, Schedule 3 in relation to items of historical or heritage significance at the Garrawarra Centre is:

> *Negligible damage (that is fine or hairline cracks that do not require repair), unless the owner of the item and the appropriate heritage authority agree otherwise in writing.*

The performance indicators proposed to ensure that the above performance measure is achieved include:

- no greater tilt impact to buildings than Category A or B (i.e. mining induced ground tilt of less than 7 mm/m) for items of historical or heritage significance (i.e. either 'high' or 'exceptional' in the *Conservation Plan for the Garrawarra Centre for Aged Care* [Howard Tanner & Associates, 1993]);
- no greater strain impact to buildings than Category 0 or 1 (i.e. crack width of less than 1 mm) for items of historical or heritage significance (i.e. either 'high' or 'exceptional' in the *Conservation Plan for the Garrawarra Centre for Aged Care* [Howard Tanner & Associates, 1993]);
- no more than repairable (minor) defects (cracks, etc.) in the structural integrity for all other buildings, houses, structures and other services (including telecommunications towers and compounds, powerlines, pipelines and associated connections) due to mining;
- the electrical clearance from vegetation is maintained;
- serviceability of the private roads and access roads/tracks has been maintained; and
- the land in general is expected to experience minor cracking consistent with that observed during the extraction of previous longwalls at Metropolitan Coal (i.e. no more than minor cracking).

Section 7 of this BFMP-GAR describes the monitoring that will be conducted to assess the Project against the above performance measure. Section 9 of this BFMP-GAR provides a Contingency Plan in the event the performance measure is exceeded.

6 BASELINE DATA

An audit on the occupied NSW Health assets at the Garrawarra Centre Complex (i.e. houses and aged care buildings) was conducted within the Study area prior to extraction of Longwall 301 to document the current condition of building structures.

John Matheson and Associates (JMA) (2016) prepared a preliminary structural inspection report for the Garrawarra Centre Complex and includes the construction type of different buildings / structures, including abandoned (non-occupied) buildings. A copy of the report has been provided to NSW Health.

6.1 HOSPITAL BUILDINGS (ABANDONED)

The locations of the hospital building structures (A01a-A01k and B03a-B03l) at the Garrawarra Centre Complex are shown on Figure 6.

No abandoned hospital buildings will be directly undermined by Longwalls 301-304. The abandoned hospital buildings are located more than 375 m away from the nearest longwall. No hospital buildings (including Former Male Wards [i.e. Wards 1 to 8 and Dining Room], Former Female Wards [i.e. Wards 1 to 9 and Library/Canteen], Laundry/Boilerhouse or Workshops nor the Gatehouse and Gate Piers are within the predicted 20 mm subsidence contour for Longwalls 301-303 or Longwall 304.

Photographs of the abandoned hospital building structures are shown on Plates 1 to 4.

Plates 1 & 2 – Abandoned Hospital Buildings [A01a] {Former Male Wards}
(Source: MSEC, 2016)

Plates 3 & 4 – Abandoned Hospital Buildings [B03a] {Laundry / Boilerhouse}
(Source: MSEC, 2016)

6.2 AGED CARE BUILDINGS

The locations of the aged care building structures (B01a-B01j and B02a-B02h) and other associated structures (B01k-B01q and B02i-B02j) at the Garrawarra Centre Complex are shown on Figure 6.

No aged care building structures will be directly undermined by Longwalls 301-304. The aged care buildings are located more than 250 m away from the nearest longwall. No aged care buildings (including the Nurses Quarters and Administration/Kitchen Group) are within the predicted 20 mm subsidence contour for Longwalls 301-303 or Longwall 304.

Photographs of the aged care building structures are shown on Plates 5 to 10.

Plates 5 & 6 – Aged Care Building Structures [B01a-B01d] {Administration}
(Source: MSEC, 2016)

Plates 7 & 8 – Aged Care Building Structures [B01e] {Nurses Quarters} (Source: MSEC, 2016)

Plates 9 & 10 – Aged Care Building Structures [B02a & B02b] {Administration/Kitchen Group} (Source: MSEC, 2016)

6.3 HOUSES

No houses will be directly undermined by Longwalls 301-304.

The locations of the houses (A01m, A02a-A09a and B04a-B09a) and other associated structures (A01l, A02b, A03b-A03d, A06b, A08b-A08f and A09b) at the Garrawarra Centre Complex are shown on Figure 6.

Houses A01m and A02a-A08a are located outside the Study area for Longwalls 301-303 and Longwall 304 (more than 600 m from the nearest longwalls). House A09a & A09b {Palmer House and adjacent garage/stable} is located outside the predicted 20 mm subsidence contour for Longwalls 301-303 and Longwall 304.

Houses B04a-B09a are within the predicted 20 mm subsidence contour for Longwalls 301-303 and Longwall 304. Subsequent to the Risk Assessment an agreement has been reached between South Eastern Sydney Local Health District and Metropolitan Coal to remove cottages B04a-B09a as part of risk mitigation process. The Memorandum of Understanding – signed 31 August 2017 details the structures to be removed subject to Wollongong City Council development approval. These abandoned house structures will be fenced until development approval is granted.

Plates 11 & 12 – Houses [A09a & A09b] {Palmer House and Adjacent Garage/Stable} (Source: MSEC, 2016)

Plates 13 & 14 – Houses [B06a & B08a] {Staff Residences} (Source: MSEC, 2016)

6.4 WATER STORAGE TANKS

No water storage tanks will be directly undermined by Longwalls 301-303 or Longwall 304. Water storage tanks B14t01 and B14t02 are within the predicted 20 mm subsidence contour for Longwalls 301-303 and Longwall 304.

The locations of the water storage tanks (B01t01, B01t02, B14t01, B14t02, B16t01-B16t03, B17t01 and B18t01) and the trickle filter tank (B15t01) at the Garrawarra Centre Complex are shown on Figure 6.

It is understood that while the water storage tanks within the Garrawarra Centre Complex (including Garrawarra Reservoir WS0406 and connecting pipelines) are used by Sydney Water, the assets are owned by NSW Health.

The two large water storage tanks (B14t01 and B14t02) and the below ground water storage tanks (B16t01-B16t03) are shown on Plates 15 and 16. It is noted that no water is currently stored in the elevated tank structure (Plate 15 - reservoir on the left).

Subsequent to the Risk Assessment an agreement has been reached between South Eastern Sydney Local Health District and Metropolitan Coal to remove derelict water tank B14t02 as part of risk mitigation process. The Memorandum of Understanding – signed 31 August 2017 details the structures to be removed subject to Wollongong City Council development approval. This derelict structure will be fenced during active subsidence effect periods or until removed.

Plates 15 & 16 – Large Water Storage Tanks (Source: MSEC, 2016)

The fire water tank and steel tank adjacent the pump house (B17t01 and B18t01), and the trickle filter tank (B15t01) are shown on Plates 17 and 18.

Plates 17 & 18 – Fire Water Tank and Steel Tank Adjacent Pump House, and Trickle Filter Tank (Source: MSEC, 2016)

A baseline audit was conducted to assess the integrity of the water storage tanks at the Garrawarra Centre Complex. Subject to the outcomes of the baseline audit, Metropolitan Coal will determine the type of temporary fencing and signage required around the two large water storage tanks at the Garrawarra Centre Complex and timing for installation (i.e. during active mining which may result in impact on the tanks).

6.5 GAS STORAGE TANK

The location of the gas storage tank (B01t03) at the Garrawarra Centre Complex is shown on Figure 6.

The gas storage tank will not be directly undermined by Longwalls 301-304. The gas storage tank is located more than 310 m away from the nearest longwall. The gas storage tank is not within the predicted 20 mm subsidence contour for Longwalls 301-303 or Longwall 304.

The gas storage tank is shown on Plate 19.

Plate 19 – Gas Storage Tank (Source: MSEC, 2016)

A baseline audit will be conducted to confirm the system of connection between gas storage tank and associated pipeline(s) at the Garrawarra Centre Complex. Subject to the outcomes of the baseline audit, Metropolitan Coal will consider the need for providing a flexible connection between the gas storage tank and the pipelines(s) at the Garrawarra Centre Complex.

6.6 KILN

Subsequent to the Risk Assessment an agreement has been reached between South Eastern Sydney Local Health District and Metropolitan Coal to remove derelict structure F01b as part of risk mitigation process. The Memorandum of Understanding – signed 31 August 2017 details the structures to be removed subject to Wollongong City Council development approval. This derelict structure will be fenced during active subsidence effect periods or until removed.

The kiln is shown on Plate 20.

Plate 20 – Kiln (Source: JMA, 2016)

6.7 TELECOMMUNICATION TOWERS AND COMPOUNDS

The locations of the telecommunications towers and associated compounds (B06b and B10a-B12a) at the Garrawarra Centre Complex are shown on Figure 6.

Separate BFMPs for the telecommunication towers and compounds have been developed in consultation with the relevant asset owners (i.e. Axicom, Telstra and Sydney Trains).

6.8 OTHER SERVICES

The locations of other built features and services at the Garrawarra Centre Complex include private access roads/tracks, potable water and sewer pipelines, powerlines and telecommunications cables at the Garrawarra Centre Complex are shown on Figure 6.

Separate BFMPs have been developed in consultation with:

- Sydney Water for relevant water infrastructure / services owned by Sydney Water.
- Endeavour Energy for relevant electricity infrastructure / services owned by Endeavour Energy.
- Telstra for relevant telecommunication services owned by Telstra.

6.9 KEY CONTACTS LIST

The list of key contacts for Peabody and NSW Health during the development and implementation of this BFMP are provided in Table 5.

Table 5
List of Key Contacts

Company	Position	Contact
Peabody (Metropolitan Coal)	Manager – Technical Services Jon Degotardi	Metropolitan Coal 24hr Control Room 02 4294 7333
NSW Health	General Manager/Nurse Unit Manager Jan Heiler	Garrawarra Centre (office hours) 02 8545 4700

7 MONITORING

A monitoring program will be implemented to monitor the impacts of the Project on the Garrawarra Centre Complex as determined in consultation with NSW Health. Table 6 summarises the BFMP-GAR monitoring components.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts for comparison with baseline photographic records.

NSW Health or their delegates will conduct ongoing visual inspections. Metropolitan Coal will be notified of the timing of inspections and accompany NSW Health or delegates if considered necessary. All personnel will complete necessary inductions or orientation relevant to the tasks required.

South Eastern Sydney Local Health District will continue to have primary responsibility for existing hazardous material monitoring as per Garrawarra Hazardous Material Management Plan (HMMP) 2017. Monitoring of asbestos will be undertaken by SESLHD, unless otherwise agreed.

The frequency of monitoring will be further reviewed either:

- in accordance with the Annual Review outlined in Section 12; or
- if triggered as a component of the Contingency Plan as outlined in Section 9 of this BFMP-GAR.

Table 6
BFMP-GAR Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Baseline	Garrawarra Centre Complex site	Survey	Adjacent optic / water subsidence line points at approximately 20 m spacing	Establish base conditions	Prior to Longwall 301 extraction	Once
	Garrawarra Centre Complex buildings	Condition Report (Preliminary Structural Inspection Report)		Establish base condition	Prior to Longwalls 301 and 304 extraction	Twice
		Pre-mining Inspection (Buildings within predicted subsidence > 20 mm)		Establish base condition	Prior to Longwalls 302 and 304 extraction	Twice
	Private roads and access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Establish base condition	Prior to Longwalls 302 and 304 extraction	Twice
During Mining	Garrawarra Centre Complex site	Survey (subsidence, tilt, strain)	Adjacent optic / water subsidence line points at approximately 20 m spacing	Monitor subsidence effects during mining	Weekly on commencement of Longwall 303 & 304 extraction until subsidence reduces below level of survey accuracy. At the completion of each longwall	Weekly on commencement of LW303 & 304 Once per Longwall 301, 302, 303 & 304
	Garrawarra Centre Complex (aged care buildings)	Visual inspection of: • Building structures (B01a-B01e) (Figure 6). • Administration / Kitchen Group (Buildings B02a and B02b) (Figure 6).		Monitor structural integrity and cracking at pre-existing rock joints. Monitor opening and closing of joints (between Buildings B02a and B02b only).	At the completion of Longwalls 302, 303 and 304	Once per longwall
	Garrawarra Centre Complex (house structures)	Visual inspection of: • Houses (B04a-B09a) (Figure 6). (Unless removed as per MoU) • Palmer House (A09a) (Figure 6).		Monitor structural integrity and cracking at pre-existing rock joints	At the completion of Longwalls 302, 303 and 304	Once per longwall

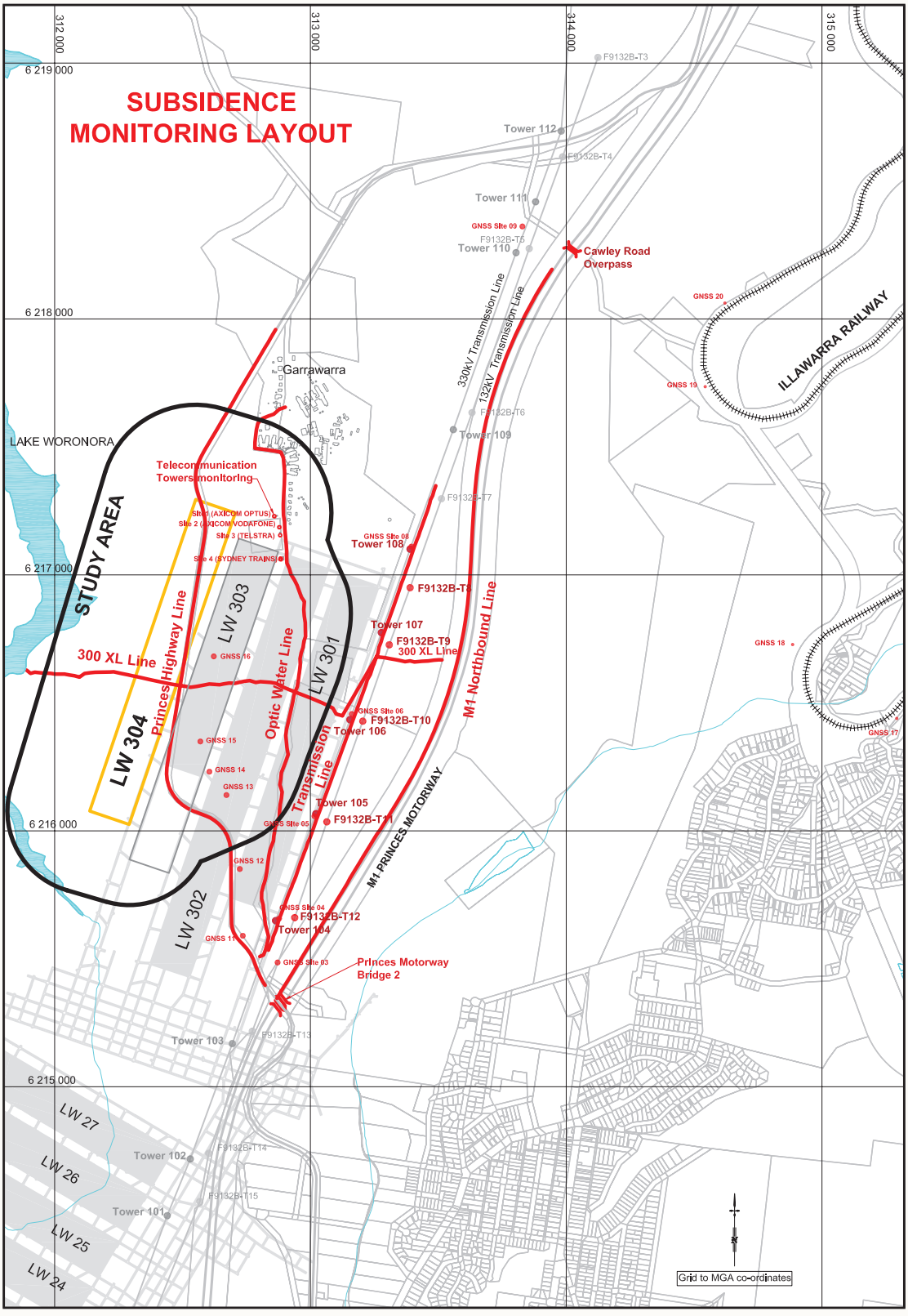
Table 6 (Continued)
BFMP-GAR Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
During Mining (Cont.)	Garrawarra Centre Complex (water storage tanks)	Visual inspection of: Water storage tanks (B14t01, B14t02, B16t01-B16t03, B17t01 and B18t01) and trickle filter tank (B15t01) (Figure 6).		Monitor structural integrity, leaks, and cracking in columns, elevated ring beam or central access shaft (B14t01).	At the completion of Longwall 302, 303 and 304	Once per longwall
					At B14t02 on commencement of Longwalls 303 and 304 until extraction has retreated away 400m from tank.	Weekly
	Telecommunications Services and Towers	As per Telstra, Axicom and Sydney Trains BFMPs				
	Other Services (powerlines and poles)	Visual inspection of: water pipelines (Figures 7 and 8)		Monitor for cracks or leakage in the pipelines and surface ground cracks	At the completion of Longwalls 302, 303 and 304	Once per longwall
		As per Sydney Water BFMP				
	Private roads and access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Monitor for surface cracks, buckling and general safety	At the completion of Longwalls 302, 303 and 304	Once per longwall
					As per Longwall 304 LMP	
Post Mining	Garrawarra Centre Complex site and buildings	Condition Report		Determine level of impact of mining (if any)	Within 3 months of the completion Longwalls 303 and 304 (or as otherwise agreed with NSW Health subject to future longwall extraction)	Once per longwall

7.1 SUBSIDENCE PARAMETERS

Subsidence parameters (i.e. subsidence, tilt, tensile strain, compressive strain, absolute horizontal translation, and differential leg movement) associated with mining will be measured in accordance with the Longwall 304 Subsidence Monitoring Program (Figure 8).

In summary, surveys will be conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence movements (i.e. subsidence, tilt, tensile strain and compressive strain) will be measured along subsidence lines that have been positioned across the general landscape.



MET-18-13_304 EP BFMP_018A

Source: MSEC (2019)

Peabody

METROPOLITAN COAL

Subsidence Monitoring Layout

Figure 8

Monitoring of subsidence parameters specific to the Garrawarra Centre Complex will be measured by a single survey line along the nearby optic / water line, and by survey of telecommunications towers (as a component of separate BFMPs).

7.2 SUBSIDENCE IMPACTS

7.2.1 Garrawarra Centre Complex

Visual inspections will be conducted at the Garrawarra Centre Complex at the buildings and structures, and private roads prescribed in Table 6 or as otherwise determined in consultation with NSW Health.

Specific details that will be noted and/or photographed include:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- assessment against the performance indicators and performance measure;
- whether any actions are required (e.g. initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The information will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 4) and reported in accordance with the Project Approval conditions.

7.2.2 Access Roads/Tracks

Visual inspection of the access roads/tracks to the NSW Health assets were undertaken prior to the commencement of Longwall 302, and will be conducted following extraction of each longwall panel.

Visual observations of access roads/tracks would occur as part of routine works and inspections within 600 m of Longwalls 301-304 secondary extraction as described in the Metropolitan Coal Longwall 304 Land Management Plan (Longwall 304 LMP).

Specific details that will be noted and/or photographed that are relevant to the NSW Health access roads/tracks include:

- the location, approximate dimensions (length, width and depth), and orientation of surface tension cracks;
- the location of the surface tension crack in relation to the access road/track to the NSW Health asset;
- whether any actions are required (e.g. implementation of management measures as outlined in the Longwall 304 LMP, initiation of the Contingency Plan as outlined in the Longwall 304 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The date of the observation, details of the observer and the location of longwall extraction will also be documented.

The information obtained will be recorded in the Longwall 304 LMP - Subsidence Impact Register and reported in accordance with the Project Approval conditions.

The information obtained will be used to assess the potential environmental consequences of the subsidence impact (described in the Longwall 304 LMP) and to identify required management measures. Management measures are discussed in the Longwall 304 LMP.

In the event the subsidence impacts are deemed to present a safety hazard (i.e. regardless of the nature or extent of the subsidence impact), actions will be implemented in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan.

7.3 ENVIRONMENTAL CONSEQUENCES

Metropolitan Coal and NSW Health will compare the results of the subsidence impact monitoring against the built features performance measure and indicators. In the event the observed subsidence impacts exceed the performance measure or indicators, Metropolitan Coal and NSW Health will assess the consequences of the exceedance in accordance with the Contingency Plan described in Section 9.

8 MANAGEMENT MEASURES

A number of potential management measures in relation to the Garrawarra Centre Complex are considered to be applicable.

For buildings or houses requiring repairs, normal building maintenance techniques could be applied in consultation with NSW Health and relevant authorities.

For the water storage tanks, if the tank base or lower sections of the tank walls were to develop leakage or if pre-existing leakage were to increase, the tank could be temporarily drained and lined with high-density polyethylene (HDPE) to establish a watertight envelope. For water pipelines, leaks could be remediated by locally exposing the pipeline and repairing or replacing the affected section.

A list of potential water suppliers (and key contact details) to temporarily supply water to the Garrawarra Centre Complex (if required) is provided below:

- Aquarius (02 4776 2496); and
- CAC Transport (0418 386 177).

For powerlines and poles, management measures may include alteration of conductor tensions or strengthening of timber poles footings.

Where significant subsidence impacts on access roads/tracks are detected (e.g. those that affect the serviceability) or at any time Metropolitan Coal, NSW Health or the landholder considers that the integrity of the access roads/tracks may be compromised, the following management measures will be implemented. Where significant cracks are detected, the cracks would be repaired as soon as practicable in consultation with the landholder. This may include the use of earthmoving equipment if considered the most appropriate means of repair. Appropriate sedimentation controls will be implemented during repair works. Management measures for access roads/tracks will be implemented in accordance with the Longwalls 304 Land Management Plan.

For the kiln, a barrier fence will be erected to maintain an exclusion zone with a radius of 1.5 times the chimney height during active mining (i.e. which may result in impact on the kiln, up to Longwall 303).

Management measures for other services at the Garrawarra Centre Complex have also been developed separately with each asset owner in the BFMPs (e.g. Endeavour Energy, Sydney Water, Telstra, Axicom and Sydney Trains).

Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures. Management measures will be reported in the Annual Review (Section 12).

9 CONTINGENCY PLAN

In the event the subsidence impacts observed exceed the performance measure or indicators detailed in Section 5 of this BFMP, Metropolitan Coal will implement the following Contingency Plan (Appendix 4):

- The observation will be reported to the Metropolitan Coal Manager - Technical Services within 24 hours.
- With the exception of access roads/tracks, the observation will be recorded in the Built Features Management Plan – Subsidence Impact Register (Appendix 3) consistent with the monitoring program described in Section 7 of this BFMP-GAR.
- If relating to an access road/track, the observation will be recorded in the Metropolitan Coal Longwalls 304 Land Management Plan – Subsidence Impact Register.
- Metropolitan Coal will report any exceedance of the performance measure or indicators to the DP&E and NSW Health as soon as practicable after Metropolitan Coal becomes aware of the exceedance.
- Metropolitan Coal will assess public safety and where appropriate implement safety measures in accordance with the Metropolitan Coal Longwalls 304 Public Safety Management Plan;
- Metropolitan Coal will conduct an investigation to evaluate the potential contributing factors. The investigation will:
  - include the re-survey of relevant subsidence monitoring lines;
  - compare and critically analyse measured versus predicted subsidence parameters;
  - review measured subsidence parameters against the observed impact; and
  - review the subsidence monitoring program and update the program where appropriate.
- The course of action with respect to the identified impact(s), in consultation with specialists and relevant agencies, will include:
  - a program to review the effectiveness of the contingency measures; and
  - consideration of adaptive management.

  Contingency measures are provided in Section 9.1.
- Metropolitan Coal will submit the proposed course of action to the DP&E for approval.
- Metropolitan Coal will implement the approved course of action to the satisfaction of the DP&E.

In accordance with Condition 6, Schedule 6 of the Project Approval, Metropolitan Coal will provide a suitable offset to compensate for the impact to the satisfaction of the Director-General (now Secretary) of DP&E if either the contingency measures implemented by Metropolitan Coal have failed to remediate the impact or the Director-General (now Secretary) determines that it is not reasonable or feasible to remediate the impact.

Metropolitan Coal will comply with the NSW *Coal Mine Subsidence Compensation Act, 2017* in the event that property damages occur as a result of mining Longwalls 301-304.

9.1 CONTINGENCY MEASURES

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of environmental consequences). Contingency measures that could be considered in the event the performance measures or indicators are exceeded are summarised in Table 7. The decision trees for the contingency measures are shown in Appendix 4.

Table 7
Contingency Measures

Environmental Consequence	Contingency Measures	
	Measure	**Description**
Impact on:		
Buildings or houses	Repair of building	• Building maintenance techniques (in consultation with the relevant authorities). • Installation of supports.
Items of historical or heritage significance	Repair of building	• Building maintenance techniques (in consultation with the relevant heritage authorities).
Water storage tanks	Redundancy	• Alternate water storage tanks in Helensburgh.
Water pipelines	Replacement	• Construction of new section of water main.
	Contingency	• Alternative water supply provided to service properties while repair of the water main is in progress.
Timber poles	Stabilisation	• Installation of supports.
	Rebuilding	• Construction of new pole(s) or emergency structures.
Powerline wires	Stabilisation	• Sheaving of conductors and/or earth wires.
	Rebuilding	• Construction of new powerlines.
Telecommunication towers	Stabilisation	• Installation of tower supports such as guy wires in response to tilt.
	Rebuilding	• Construction of new tower and foundations.
	Contingency	• Deployment of temporary broadcast/receiving tower as per special event infrastructure (temporary mobile tower systems available).
	Redundancy	• Alternate phone towers nearby.
Building compounds	Repair of building	• Building maintenance techniques. • Replacement of building compound.
Kiln	Stabilisation techniques	• Installation of supports.
Fibre Optic Cable (Telstra)	Stabilisation	• Technician travels to tower and undertakes localised monitoring to identify location of issue. Soil removed at location to allow fibre to flex.
	Emergency	• Spare cores available in cable. Bypass affected cores to re-establish functionality.
	Rebuilding	• Fibre heat treatment to soften compression point and return affected cores to operation.
	Redundancy	• Phone tower operation requires 2 cores; fibre supplying tower has 12 cores, 10 spare.
Copper Cable	Emergency	• Failure in local phone cables at Garrawarra Centre Complex rectified by repairs. If extended duration outage then temporary mobile phone connection to be provided to Garrawarra Centre Complex commercial user by Telstra.
	Redundancy	• Mobile phone coverage to replace landlines, all commercial carriers have towers located at Garrawarra Centre Complex.

10 TARP – MANAGEMENT TOOL

The framework for the various components of the BFMP-GAR are summarised in the BFMP-GAR TARPs shown in Tables 8 and 9. The BFMP-GAR TARPs illustrates how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

The TARP comprises:

- baseline conditions;
- predicted subsidence impacts;
- trigger levels from monitoring to assess performance; and
- triggers that flag implementation of contingency measures.

The TARP system provides a simple and transparent snapshot of the monitoring of environmental performance and the implementation of management and/or contingency measures.

11 FUTURE EXTRACTION PLANS

In accordance with Condition 7, Schedule 3 of the Project Approval, Metropolitan Coal will collect baseline data for the next Extraction Plan (i.e. Longwalls 305-310). The baseline (and post-mining) data collected for Longwalls 301-304 will be used as baseline for Longwalls 305 onward as longwall mining progressively moves further away from the Garrawarra Centre Complex.

In addition to the baseline data collection, consideration of the environmental performance and management measures in accordance with the review(s) conducted as part of this BFMP-GAR will inform the appropriate type and frequency of monitoring relevant to the next Extraction Plan.

Table 8
Trigger Action Response Plan – Buildings/Structures (Excluding Services)

NSW HEALTH – Garrawarra Centre Complex Buildings/Structures		
NSW Health – Garrawarra Centre Complex Buildings/Structures	*Risk: Subsidence effect on buildings/structures resulting in damage (beyond baseline conditions).*	
	TRIGGER LEVEL	**RESPONSE**
	Level 1 - Normal **Expected subsidence conditions**	
	Subsidence • less than 25 mm Tilt • less than 0.5 mm/m Tensile strain • less than 0.9 mm/m Compressive strain • less than 1.6 mm/m	**Normal Operations** • Negligible impact to Garrawarra Centre Complex buildings/structures – safe and serviceable (or as per baseline conditions). • Continue monitoring activities as planned.
	Level 2 - Monitor **Subsidence elevated up to +15% of predicted but condition normal**	
	Subsidence • between 25 and 30 mm Strain • between 1.6 and 2.0 mm/m	**Continue operations but report on subsidence anomaly** • Negligible impact to Garrawarra Centre Complex buildings/structures – safe and serviceable (or as per baseline conditions). **Metropolitan Coal** • Immediately resurvey subsidence line to confirm results. • Engage subsidence expert to assess results. • Confirm results are consistent with other subsidence lines. • Compare and critically analyse measured versus predicted subsidence. • Inform and provide report to NSW Health of subsidence results. • Collaboratively share information with NSW Health to monitor situation. **NSW Health** • Assess information provided by Metropolitan Coal.

Table 8 (Continued)
Trigger Action Response Plan – Buildings/Structures (Excluding Services)

NSW HEALTH – Garrawarra Centre Complex Buildings/Structures		
NSW Health – Garrawarra Centre Complex Buildings/Structures	*Risk: Subsidence effect on buildings/structures resulting in damage (beyond baseline conditions).*	
	TRIGGER LEVEL	**RESPONSE**
	Level 3 - Cautionary **Anomalous service condition detected or Subsidence beyond +15% of predicted**	
	Subsidence • greater than 30 mm Strain • greater than 2.0 mm/m Fine or hair line cracks that do not require repair for items of historical or heritage significance at the Garrawarra Centre Complex (i.e. large buildings which have important heritage values) Cracking at pre-existing rock joints, columns, opening and closing of joints, or tilting of piers Water tank leaks	**Investigate & Resolve** • Negligible impact to Garrawarra Centre Complex buildings/structures – safe and serviceable (or as per baseline conditions). **Metropolitan Coal** • Steps as per Level 2 event, plus: o Increase frequency of subsidence line surveys to weekly in affected area. o In conjunction with NSW Health identify impact location and work with NSW Health to resolve. o Review the subsidence monitoring program and update the program where appropriate. o Provide report on issue to both NSW Health and DP&E. **NSW Health** • In conjunction with Metropolitan Coal identify impact location; and determine if maintenance/restoration works are to be carried out. • Make determination if other measures necessary to avoid further impact (e.g. stabilisation, lining of water tanks, etc.).
	Level 4 – Restoration **Building Damage (beyond baseline conditions)**	
	Buildings Damage (beyond baseline conditions) • Structural integrity compromised	**Implement Contingency Plan** • As per BFMP Section 9 and Appendix 4. **Metropolitan Coal** • As per Level 3 event, plus: o General Manager to be involved in all decision making processes. o Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwall 304 Public Safety Management Plan. o Report exceedance of the performance measure or indicators to the DP&E and NSW Health as soon as practicable. o Update the 'Built Features Management Plan – Subsidence Impact Register'. o Investigate circumstances of the damage and determine requirement for adaptive management of mining operations prior to future operations in vicinity of the Garrawarra Centre Complex buildings/structures. **NSW Health** • As per Level 3 event, plus: o Determine appropriate course of action for restoration and repairs works. o Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.

Table 9
Trigger Action Response Plan – Services

NSW HEALTH – Services		
NSW Health – Services	*Risk: Subsidence effect on buildings/structures resulting in damage (beyond baseline conditions).*	
	TRIGGER LEVEL	**RESPONSE**
	Level 1 - Normal **Expected subsidence conditions**	
	Subsidence For LW 301-302 • less than 325 mm Tilt • less than 3.0 mm/m Tensile strain • less than 0.9 mm/m Compressive strain less than 1.6 mm/m For LW 303 and LW304 • less than 450 mm Tilt • less than 4.0 mm/m Tensile strain • less than 0.9 mm/m Compressive strain • less than 1.6 mm/m	**Normal Operations** • Negligible impact to services – safe and serviceable (or as per baseline conditions). • Continue monitoring activities as planned.

Table 9 (Continued)
Trigger Action Response Plan – Services

NSW HEALTH – Services		
NSW Health – Services	*Risk: Subsidence effect on buildings/structures resulting in damage (beyond baseline conditions).*	
	TRIGGER LEVEL	**RESPONSE**
	Level 2 – Monitor **Subsidence elevated up to +15% of predicted but condition normal**	
	Subsidence For LW 301-302 • between 325 and 375 mm Strain • between 1.6 and 2.0 mm/m For LW 303 and LW304 • between 450 and 520 mm Strain • between 1.6 and 2.0 mm/m	**<u>Continue operations but report on subsidence anomaly</u>** • Negligible impact to services – safe and serviceable (or as per baseline conditions). **<u>Metropolitan Coal</u>** • Immediately resurvey subsidence line to confirm results. • Engage subsidence expert to assess results. • Confirm results are consistent with other subsidence lines. • Compare and critically analyse measured versus predicted subsidence. • Inform and provide report to NSW Health of subsidence results. • Collaboratively share information with NSW Health to monitor situation. **<u>NSW Health</u>** • Assess information provided by Metropolitan Coal.

Table 9 (Continued)
Trigger Action Response Plan – Services

NSW HEALTH – Services		
NSW Health – Services	*Risk: Subsidence effect on buildings/structures resulting in damage (beyond baseline conditions).*	
	TRIGGER LEVEL	**RESPONSE**
	Level 3 - Cautionary **Anomalous service condition detected or Subsidence beyond +15% of predicted**	
	Subsidence For LW 301-302 • greater than 375 mm Strain • greater than 2.0 mm/m Significant ground tension cracking For LW 303 and LW304 • greater than 520 mm Strain • greater than 2.0 mm/m Significant ground tension cracking (also refer to separate TARPs in BFMPs for Telstra, Endeavour Energy, Sydney Trains, Sydney Water and Axicom)	**Investigate & Resolve** • Negligible impact to services – safe and serviceable (or as per baseline conditions). **Metropolitan Coal** • Steps as per Level 2 event, plus: o Increase frequency of subsidence line surveys to weekly in affected area. o In conjunction with NSW Health identify impact location and work with NSW Health to resolve. o Review the subsidence monitoring program and update the program where appropriate. o Provide report on issue to both NSW Health and DP&E. **NSW Health** • In conjunction with Metropolitan Coal identify impact location; and determine if maintenance/restoration works are to be carried out. • Make determination if other measures necessary to avoid further impact (e.g. stabilisation).

Table 9 (Continued)
Trigger Action Response Plan – Services

NSW HEALTH – Services		
NSW Health – Services	*Risk: Subsidence effect on buildings/structures resulting in damage (beyond baseline conditions).*	
	TRIGGER LEVEL	**RESPONSE**
	Level 4 – Restoration **Fault Occurs**	
	• Fault occurs (also refer to separate TARPs in BFMPs for Telstra, Endeavour Energy, Sydney Trains, Sydney Water and Axicom)	**Implement Contingency Plan** • As per BFMP Section 9 and Appendix 4. **Metropolitan Coal** • As per Level 3 event, plus: o General Manager to be involved in all decision making processes. o Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwall 304 Public Safety Management Plan. o Report exceedance of the performance measure or indicators to the DP&E and NSW Health as soon as practicable. o Update the 'Built Features Management Plan – Subsidence Impact Register'. o Investigate circumstances of the fault and determine requirement for adaptive management of mining operations prior to future operations in vicinity of the Garrawarra Centre Complex services. **NSW Health** • As per Level 3 event, plus: o Determine appropriate course of action for restoration and repairs works (in consultation with relevant service provider). o Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.

12 ANNUAL REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

In accordance with Condition 3, Schedule 7 of the Project Approval, Metropolitan Coal will conduct an Annual Review of the environmental performance of the Project by the end of March each year.

The Annual Review will:

- describe the works carried out in the past year, and the works proposed to be carried out over the next year;
- include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the EA, Preferred Project Report and Extraction Plan;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

As described in Section 2, this BFMP will be reviewed within three months of the submission of an Annual Review, and revised where appropriate.

13 INCIDENTS

An incident is defined as a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval.

The reporting of incidents will be conducted in accordance with Condition 6, Schedule 7 of the Project Approval. Metropolitan Coal will notify the Director-General (now Secretary) of DP&E and any other relevant agencies of any incident associated with the Project as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of DP&E and any relevant agencies with a detailed report on the incident.

NSW Health will be notified within 24 hours of any access limitations or restrictions.

14 COMPLAINTS

A protocol for the managing and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

The Environment & Community Superintendent is responsible for maintaining a system for recording complaints.

Metropolitan Coal will maintain public signage advertising the telephone number on which environmental complaints can be made. The Environment & Community Superintendent is responsible for ensuring that the currency and effectiveness of the service is maintained. Notifications of complaints received are to be provided as quickly as practicable to the Environment & Community Superintendent.

Complaints and enquiries do not have to be received via the telephone line and may be received in any other form. Any complaint or enquiry relating to environmental management or performance is to be relayed to the Environment & Community Superintendent as soon as practicable. All employees are responsible for ensuring the prompt relaying of complaints. All complaints will be recorded in a complaints register.

For each complaint, the following information will be recorded in the complaints register:

- date and time of complaint;
- method by which the complaint was made;
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- nature of the complaint;
- the action(s) taken by Metropolitan Coal in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken by Metropolitan Coal, the reason why no action was taken.

The Environment & Community Superintendent is responsible for ensuring that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary.

In accordance with Condition 10, Schedule 7 of the Project Approval, the complaints register will be made publicly available on the website and updated on a monthly basis. A summary of complaints received and actions taken will be presented to the Community Consultative Committee as part of the operational performance review.

15 NON-COMPLIANCES WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with Metropolitan Coal, and will be developed through promotion of Metropolitan Coal ownership under the direction of the General Manager.

The Manager - Technical Services and/or Environment & Community Superintendent will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 13, Metropolitan Coal will notify the Director-General (now Secretary) of the DP&E and any other relevant agencies of any incident associated with Metropolitan Coal as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of the DP&E and any relevant agencies with a detailed report on the incident.

A review of Metropolitan Coal's compliance with all conditions of the Project Approval, mining leases and all other approvals and licenses will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the Peabody website.

Additionally, in accordance with Condition 8, Schedule 7 of the Project Approval, an independent environmental audit was undertaken by the end of December 2011, and is undertaken a minimum of once every three years thereafter. A copy of the audit report will be submitted to the Director-General (now Secretary) of the DP&E and made publicly available on the Peabody website. The independent audit will be undertaken by an appropriately qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General (now Secretary) of the DP&E.

16 REFERENCES

Department of Planning & Environment and Division of Resources and Energy (2015) *Guidelines for the Preparation of Extraction Plans*.

Helensburgh Coal Pty Ltd [HCPL] (2008) *Metropolitan Coal Project Environmental Assessment*.

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Howard Tanner & Associates (1993) *Conservation Plan for the Garrawarra Centre for Aged Care.*

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Mine Subsidence Engineering Consultants (2016) *Metropolitan Colliery – Proposed Longwalls 301 to 303 Subsidence Predictions and Impact Assessments for the Garrawarra Complex*, dated 24 October 2016.

Mine Subsidence Engineering Consultants (2019) *Metropolitan Colliery – Proposed Longwall 304 Subsidence Predictions and Impact Assessments for the Garrawarra Complex*.

APPENDIX 1

MSEC (2016) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 301 TO 303 - SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE GARRAWARRA COMPLEX, DATED 24 OCTOBER 2016

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

24th October 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-03

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Garrawarra Complex

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the built features of the Garrawarra Complex resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery. Several services within the Garrawarra Complex are owned by other stakeholders and will be assessed and managed as necessary, through consultation with the relevant owners.

The locations of the Garrawarra Complex and the proposed longwalls are shown in the attached Drawing No. MSEC844-03a. The locations of the building structures, private roads and services on the complex are shown in Drawings Nos. MSEC844-03b and MSEC844-03c.

The type and size of the building structures are shown in the attached Table A.1 at the end of this letter report. There are a total of 86 building structures on the complex, comprising 57 residential or hospital buildings and 29 ancillary structures. All residential and hospital buildings are located outside the footprint of the proposed longwalls. There are also nine water storage tanks and a number of telecommunications towers located within the complex.

The *hospital* building structures are Refs. A01a to A01k and B03a to B03l. These structures are located outside the extents of the longwalls at a minimum distance of 375 metres from Longwalls 301 to 303. The buildings are not currently in use and have been fenced off. Photographs of the main hospital building structures are provided in Figure 1 and Figure 2.

Figure 1 Hospital Building Structure (Ref. A01a)

Figure 2 Hospital Building Structure (Ref. B03a)

The main *aged care* building structures are Refs. B01a to B01j and B02a to B02h. The other buildings associated with the aged care are Refs. B01k to B01q, B02i and B02j.

Structure Refs. B01a to B01d are the main patient wards currently in use and are located at a minimum distance of 210 metres from Longwall 303. These buildings comprise single storey structures founded on a combination of ground slabs, strip footings and pad footings. The external walls are brick-veneer and the internal walls are of lightweight construction. The roofs are steel framed with metal sheeting. Photographs of these structures are provided in Figure 3.

Figure 3 Aged Care Building Structure Refs. B01a to B01d

Structure Ref. B01e is located at a minimum distance of 315 metres from Longwall 303. This building is a double storey brick structure founded on a ground slab with a tiled roof. Photographs of this structure are provided in Figure 4.

Figure 4 Aged Care Building Structure Ref. B01e

Structure Refs. B02a to B02h are located at a minimum distance of 290 metres from Longwall 302. These buildings comprise one and two storey structures founded on strip footings and ground slabs. The perimeter walls are double brick, but in some cases the upper levels have timber framed walls. The suspended floors are timber framed and in some cases are supported on steel frames. The tiled roofs are supported by timber frames. Photographs of two of these structures are provided in Figure 5.

Figure 5 Aged Care Building Structure Refs. B02a and B02b

The *houses* are Refs. A01m, A02a to A09a and B04a to B09a. The other buildings associated with the houses are Refs. A01l, A02b, A03b to A03d, A06b, and A08b to A08f.

Structure Refs. A01m, A02a to A09a are located at a minimum distance of 350 metres from Longwall 303. Structure Ref. A09a is the nearest structure to Longwall 303. This building is a two storey double brick structure on strip footings with timber floor and a tiled roof. Photographs of this house and the associated structure are provided in Figure 6.

Figure 6 House Structure Ref. A09a (left side) and A09b (right side)

Structure Refs. B04a to B09a are located at a minimum distance of 60 metres to a maximum distance of 185 metres from Longwall 303. These houses are one storey structures founded on brick piers and low level perimeter brickwalls with timber floors, fibro walls and tiled roofs. Photographs of two of these houses are provided in Figure 7.

Figure 7 Houses Structure Refs. B06a (left side) and B08a (right side)

The other main structures on the complex include water storage tanks (Refs. B14t01, B14t02, B16t01 to B16t03, B17t01, and B18t01), above ground gas storage tank (Ref. B01t03), trickle filter tank B15t01, and telecommunications towers and compounds (Refs. B06b and B10a to B12a). Photographs of these features are provided in Figure 8 to Figure 12.

Figure 8 Water Storage Tanks Refs. B14t01 and B14t02 (left side) and Refs. B16t01 to B16t03 (right side)

Figure 9 Water Storage Tanks Refs. B17t01 (poly tank) and B18t01 (steel tank)

Figure 10 Gas Storage Tanks Refs. B01t03 and B01t04

Figure 11 Trickle Filter Tank B15t01

Figure 12 Telecommunications Towers and Compounds Refs. B10a (left side) and B12a (right side)

Other built features on the complex include the private roads, potable water and sewer pipelines, powerlines and telecommunications cables.

The predictions and impact assessments for the built features on the Garrawarra Complex are provided in the following sections.

Conventional Subsidence Parameters for the Built Features

The following provides summaries of the maximum predicted conventional movements for the built features resulting from the extraction of Longwalls 301 to 303. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

The maximum predicted subsidence, tilt and curvature for each of the building structures and tanks, resulting from the extraction of Longwalls 301 to 303, are provided in Table A.1 at the end of this letter report. The values are the maxima within a distance of 20 metres from the mapped extents of these features.

Summaries of the maximum predicted values of total subsidence, tilt and curvature are provided in: Table 1 for the hospital building structures; Table 2 and Table 3 for the aged care building structures; Table 4 and Table 5 for the houses; Table 6 for the water storage tanks; Table 7 for the above ground gas storage tanks; and Table 8 for the telecommunications towers and compounds.

Table 1 Maximum Predicted Total Subsidence, Tilt and Curvature for the Hospital Building Structures (Refs. A01a to A01k and B03a to B03l)

Longwall	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})
After LW301	< 20	< 0.5	< 0.01	< 0.01
After LW302	< 20	< 0.5	< 0.01	< 0.01
After LW303	< 20	< 0.5	< 0.01	< 0.01

Table 2 Maximum Predicted Total Subsidence, Tilt and Curvature for the Aged Care Building Structures (Refs. B01a to B01c, B01e to B01q, and B02a to B02j)

Longwall	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})
After LW301	< 20	< 0.5	< 0.01	< 0.01
After LW302	< 20	< 0.5	< 0.01	< 0.01
After LW303	< 20	< 0.5	< 0.01	< 0.01

Table 3 Maximum Predicted Total Subsidence, Tilt and Curvature for the Aged Care Building Structures (Ref. B01d)

Longwall	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})
After LW301	< 20	< 0.5	< 0.01	< 0.01
After LW302	< 20	< 0.5	< 0.01	< 0.01
After LW303	25	< 0.5	< 0.01	< 0.01

Table 4 Maximum Predicted Total Subsidence, Tilt and Curvature for the Northern Houses (Refs. A01m and A02a to A09a)

Longwall	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})
After LW301	< 20	< 0.5	< 0.01	< 0.01
After LW302	< 20	< 0.5	< 0.01	< 0.01
After LW303	< 20	< 0.5	< 0.01	< 0.01

Table 5 Maximum Predicted Total Subsidence, Tilt and Curvature for the Southern Houses (Refs. B04a to B09a)

Longwall	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})
After LW301	< 20	< 0.5	< 0.01	< 0.01
After LW302	25	< 0.5	< 0.01	< 0.01
After LW303	100	1.0	< 0.01	< 0.01

Table 6 Maximum Predicted Total Subsidence, Tilt and Curvature for the Water Tanks and Trickle Filter Tank (Refs. B14t01, B14t02, B15t01, B16t01 to B16t03, B17t01 B18t01)

Longwall	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})
After LW301	< 20	< 0.5	< 0.01	< 0.01
After LW302	25	< 0.5	< 0.01	< 0.01
After LW303	125	1.5	0.02	< 0.01

Table 7 Maximum Predicted Total Subsidence, Tilt and Curvature for the Gas Storage Tank (Ref. B01t03)

Longwall	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})
After LW301	< 20	< 0.5	< 0.01	< 0.01
After LW302	< 20	< 0.5	< 0.01	< 0.01
After LW303	< 20	< 0.5	< 0.01	< 0.01

Table 8 Maximum Predicted Total Subsidence, Tilt and Curvature for the Telecommunications Towers and Compounds (Refs. B06b and B10a to B12a)

Longwall	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})
After LW301	< 20	< 0.5	< 0.01	< 0.01
After LW302	125	2.0	0.03	< 0.01
After LW303	525	3.5	0.03	0.04

A large proportion of the building structures are located outside or close to the Study Area boundary and are not expected to experience measurable conventional vertical subsidence, tilts or curvatures.

The private roads and the services directly associated with the hospital and residential building structures are located outside the footprint of the proposed Longwalls 301 to 303 and are therefore expected to experience negligible predicted movements, consistent with the above tables. A short section of access road and powerlines are located above the northern ends of Longwalls 302 and 303. A summary of the maximum predicted subsidence, tilt and curvature for the services located above the proposed longwalls, resulting from the extraction of Longwalls 301 to 303, is provided in Table 9.

Table 9 Maximum Predicted Total Subsidence, Tilt and Curvature for the Private Roads and Services on the Garrawarra Complex

Longwall	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})
After LW301	20	< 0.5	< 0.01	< 0.01
After LW302	325	3.0	0.02	0.02
After LW303	450	4.0	0.03	0.03

The maximum predicted total subsidence for the private roads and services is 450 mm. The maximum predicted conventional tilt is 4.0 mm/m (i.e. 0.4 %, or 1 in 250). The maximum predicted conventional curvatures are 0.03 km^{-1} hogging and sagging, which equate to minimum radii of curvature of 33 kilometres.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the built features has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

Where features are located above the proposed longwalls, predicted strains have been determined from observed strains above previously extracted longwalls. A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 13. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

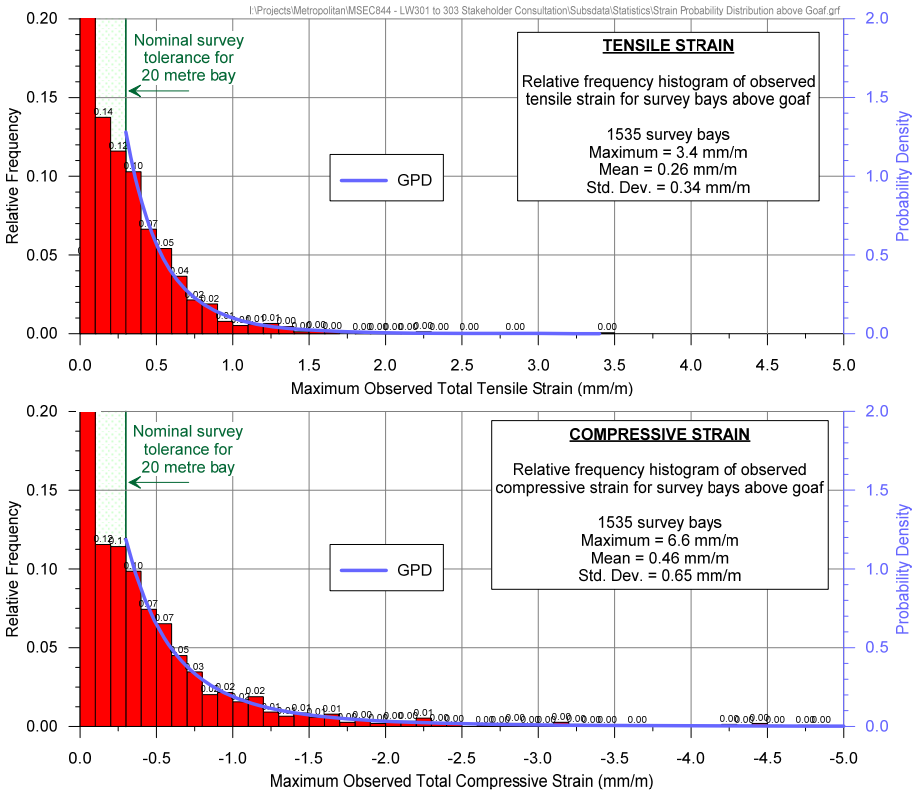

Figure 13 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based on the fitted GPDs, is provided in Table 10.

Table 10 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Where features are located outside the proposed longwalls, as is the case for the majority of the structures at the Garrawarra complex, the database has been analysed to extract the maximum tensile and compressive strains outside the longwalls, referred to as '*above solid coal'.* The majority of building structures are greater than 100 metres from the longwalls and, therefore, the database has been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located outside and within 100 metres to 250 metres of the nearest longwall goaf edge.

A histogram of the maximum observed tensile and compressive strains measured in survey bays located above solid coal, for monitoring lines in the Southern Coalfield, is provided in Figure 14. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

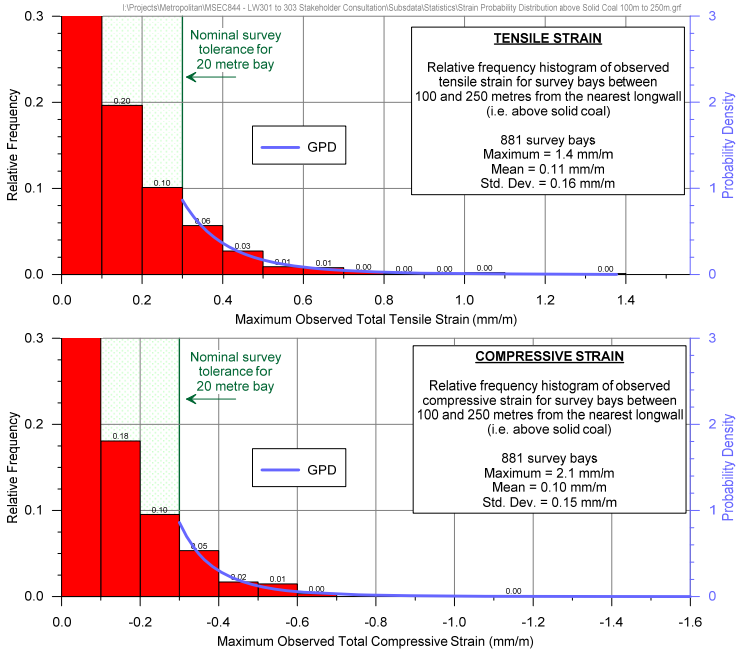

Figure 14 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Solid Coal (100 to 250 metres)

The 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal (100 to 250 metres) experienced at any time during mining are 0.4 mm/m tensile and compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.7 mm/m tensile and 0.6 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures and the streams are shown in Drawing No. MSEC844-03a.

There are no mapped geological structures above Longwalls 301 to 303 or within the Garrawarra Complex. The Metropolitan Fault is located to the north east of the property boundary for the complex. It is possible that the built features located above the longwalls could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). The location of the Garrawarra complex is at a topographical high point and the likelihood of significant unknown geological structures at his location is considered to be low. The range of strains provided in the previous section include those resulting from irregular anomalous movements.

There are no major streams located within the complex. The built features, therefore, are not expected to experience any measurable valley closure effects.

Impact Assessments for the Building Structures

Longwall layouts have been modified in order to minimise predicted subsidence movements at the Garrawarra building structures B01a to B01e, which house aged care patients and administrative support. The longwall layouts have been modified to limit the predicted conventional curvature to less than normal limits of survey accuracy, or < 0.01 km^{-1}. In addition, based on a longwall offset distance of 100 to 250 metres from buildings B01a to B01e the 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.4 mm/m tensile and compressive.

A structural assessment of the building structures was undertaken by John Matheson and Associates Pty Ltd (JMA 2016). A summary of the results of the structural inspection is provided in Table 3 of JMA (2016). The assessment indicates that based on the Longwall 301 to 303 layout, the likelihood of greater than negligible damage developing in the building structures is low, with an assessed probability of exceedance for Category 1 damage (i.e. fine cracks of less than 1mm) of 1% or less for all buildings with the exception of Building B02c. The abandoned building B02c has a probability of exceedance of 10% for Category 1 damage and a probability of exceedance of 1% for a 2 mm crack in Category 2. The assessed probability exceedance of 1% is generally associated with large masonry structures. The assessed probability exceedance for the smaller building structures is generally unlikely to remote. The buildings were expected to remain safe and serviceable and potential impacts could be repaired using normal building maintenance techniques.

A detailed discussion of the structural assessments is provided in the report by JMA (2016).

Impact Assessments for the Water Tanks and Trickle Filter Tank

The maximum predicted tilt for the water tanks and trickle filter tank is 1.5 mm/m (i.e. 0.15 %, or 1 in 667). The magnitude of tilt is very small (i.e. less than 1 %) and therefore unlikely to adversely impact on these structures. Tilt can potentially affect the stored water levels within these tanks. It is recommended that infrastructure owner reviews the potential changes in freeboard resulting from the mining induced tilt.

The maximum predicted conventional curvatures are 0.02 km^{-1} hogging and less than 0.01 km^{-1} sagging, which equate to minimum radii of curvature of 50 kilometres and greater than 100 kilometres, respectively.

The tanks are located at distances of 30 metres or greater from the longwalls. The strain database has therefore been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located outside between zero and 100 metres of the nearest longwall goaf edge.

A histogram of the maximum observed tensile and compressive strains measured in survey bays located above solid coal, for monitoring lines in the Southern Coalfield, is provided in Figure 15. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

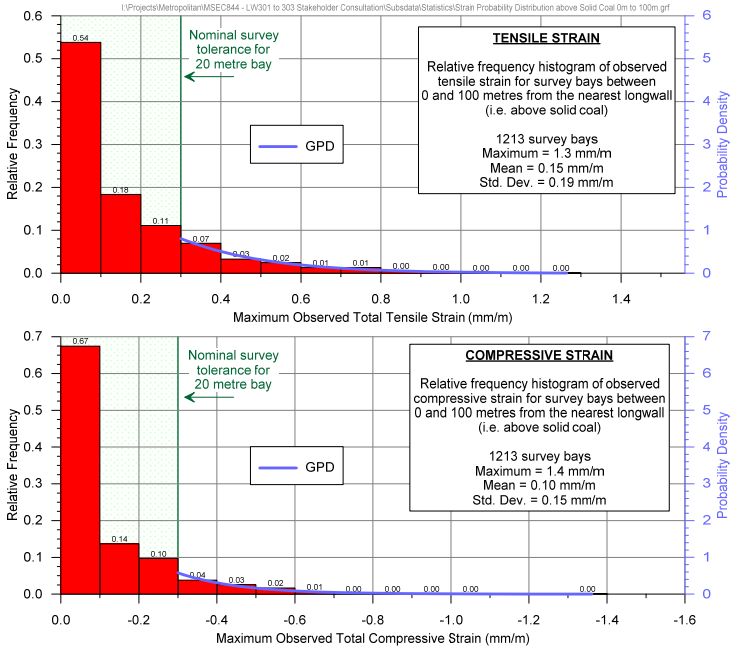

Figure 15 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Solid Coal (0 to 100 metres)

The 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal (0 to 100 metres) experienced at any time during mining are 0.5 mm/m tensile and 0.4 mm/m compressive. The 99 %

confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.8 mm/m tensile and 0.7 mm/m compressive.

As assessment of the tanks was undertaken by John Matheson and Associates Pty Ltd (JMA 2016). A summary of the results of the structural inspection is provided in Table 3 of JMA (2016). The assessment indicates that based on the Longwall 301 to 303 layout, the likelihood of greater than negligible damage developing in the water storage tanks is 20% for Category 1 damage (i.e. fine cracks of less than 1mm) of 1% or less. The tanks were expected to remain safe and serviceable and potential impacts could be repaired using normal building maintenance techniques.

It is recommended that monitoring and management strategies are developed, in consultation with the infrastructure owner, to manage the potential impacts on the water storage tanks and trickle filter tank. It is expected that these tanks can be maintained in safe and serviceable conditions with the implementation of the appropriate monitoring and management strategies.

Impact Assessments for the Gas Storage Tank

The gas storage tank is located more than 310 metres from the proposed longwalls. The maximum predicted subsidence parameters are negligible and therefore unlikely to adversely impact on this tank.

The maximum predicted conventional curvatures are 0.01 km^{-1} hogging and less than 0.01 km^{-1} sagging, which equate to minimum radii of curvature of 100 kilometres and greater than 100 kilometres, respectively. The predicted strains are less than 0.5 mm/m tensile and compressive based on the 95 % confidence level.

The gas storage tank is supported on a concrete slab above the ground and therefore is unlikely to experience the mining induced curvatures and strains.

At this distance, it is unlikely that the storage tank and pipework would experience adverse impacts as a result of the extraction of Longwalls 301 to 303.

Impact Assessments for the Telecommunications Towers and Compounds

The maximum predicted tilt for these installations is 3.5 mm/m (i.e. 0.35 %, or 1 in 285). The magnitude of tilt is very small (i.e. less than 1 %) and therefore unlikely to adversely impact on the towers or compounds. Tilt can potentially affect directional antennas (i.e. microwave dishes) and therefore it is recommended that the radio engineers review the predicted change in alignment. If adverse impacts were anticipated, the alignments of the directional antennas could be adjusted during active subsidence.

The maximum predicted conventional curvatures are 0.03 km^{-1} hogging and 0.04 km^{-1} sagging, which equate to minimum radii of curvature of 33 kilometres and 25 kilometres, respectively. The predicted strains are 0.9 mm/m tensile and 1.6 mm/m compressive based on the 95 % confidence level and 1.5 mm/m tensile and 3.2 mm/m compressive based on the 99 % confidence level.

The predictions and assessment of potential impacts for the telecommunications towers and compounds are provided in Reports Nos. MSEC844-04, MSEC844-07, and MSEC844-14.

It is recommended that the structural engineers review the structural integrity of the tower structures based on the predicted conventional subsidence, tilt and curvatures and the predicted distributions of strain. If adverse impacts were anticipated, then preventive measures should be implemented that could include the installation of additional bracing members and/or strengthening members to the existing frame.

The building enclosures are either brick structures on ground slabs or steel framed structures supported above the ground on piers. The building enclosures could potentially experience adverse impacts such as cracking of the brickwork or sticky entry doors. It is unlikely that the steel framed structures would experience adverse impacts due to their lightweight constructions and their elevation above natural ground. It is expected that the enclosures would remain in safe and serviceable conditions during and after mining. Adverse impacts could be remediated using normal building maintenance techniques.

Impact Assessments for the Private Roads

The private roads on the complex with bitumen seals are located outside the proposed longwalls. Experience from the Southern Coalfield indicates that the impacts on these roads are not expected.

Short lengths of road comprising chip seal or gravel surface are located above the proposed longwalls. The roads are not well maintained. Potential impacts to these roads may include minor and isolated cracks. Any impacts can be managed using monitoring (visual or ground survey lines) during active subsidence and remediation of impacts using normal road maintenance techniques.

It is expected that the private roads can be maintained in safe and serviceable conditions with the development of the appropriate monitoring and management plans.

Impact Assessments for the Services

The consumer powerlines comprise aerial conductors supported on timber poles and buried cables. Experience from the Southern Coalfield indicates that the potential impacts on these types of powerlines are rare and generally of a minor nature. Some remedial measures have been required, which include adjustments to cable catenaries, pole tilts and consumer cables which connect between the poles and building structures. The incidence of these impacts, however, was very low.

The predictions and assessment of potential impacts for the Telstra optical fibre cable are provided in Report No. MSEC844-04. The predictions and assessments for the copper telecommunications have also been provided in that report and have been reproduced below.

The copper telecommunications cables within the Study Area include both buried and aerial cables. The buried cables can be affected by curvatures and ground strains and the aerial cables can be affected by the changes in cable catenaries. Copper telecommunications cables are flexible and it has been found that these types of cables can typically tolerate strains up to 20 mm/m without adverse impacts.

Extensive experience of mining beneath copper telecommunications cables in the NSW Coalfields, where the observed strains were similar or greater than those predicted for the longwalls, indicates that incidences of impacts is very low and generally of a minor nature. Some remedial measures have been required, which include adjustments to cable catenaries, pole tilts and consumer cables which connect between the poles and building structures. The incidence of these impacts, however, was very low.

The predictions and assessment of potential impacts for the Sydney Water potable water and sewer pipelines are provided in Report No. MSEC844-09. The distribution network on the complex comprises Cast Iron Cement Lined (CICL) pipelines with diameters ranging between 150 mm and 300 mm.

Experience from the Southern Coalfield indicates that the potential impacts on these types of pipelines are rare and generally of a minor nature. It is possible that some minor leaks could develop as a result of the extraction of Longwalls 301 to 303. It is expected that any impacts could be remediated by locally exposing the pipeline and repairing or replacing the affected section.

It is expected that the services can be maintained in safe and serviceable conditions with the development of the appropriate monitoring and management plans.

Summary

The building structures and services associated with the Garrawarra Complex are located outside the proposed longwalls to the north of Longwall 303. The main patient wards are located more than 210 metres from the nearest longwall. Assessments of the building structures were carried out by JMA (2016) and indicate that the structures can be maintained in a safe and serviceable condition during the extraction of Longwalls 301 to 303.

It is expected that the potential impacts on the building structures and services could be managed with the implementation of the appropriate monitoring and management strategies. These strategies should be developed in consultation with SESLHD and other relevant asset owners.

Yours sincerely

Peter DeBono

Attachments:
Drawing No. MSEC844-03a – Longwalls 301 to 303 – Location Plan
Drawing No. MSEC844-03b – Longwalls 301 to 303 – Buildings and Structures
Drawing No. MSEC844-03c – Longwalls 301 to 303 – Services

Table A.1 Predicted Subsidence, Tilt and Curvature for the Building Structures

References:

John Matheson and Associates (JMA 2016), Garrawarra:R0295-Rev 3 *Preliminary Structural Inspection Report.* 10 October 2016

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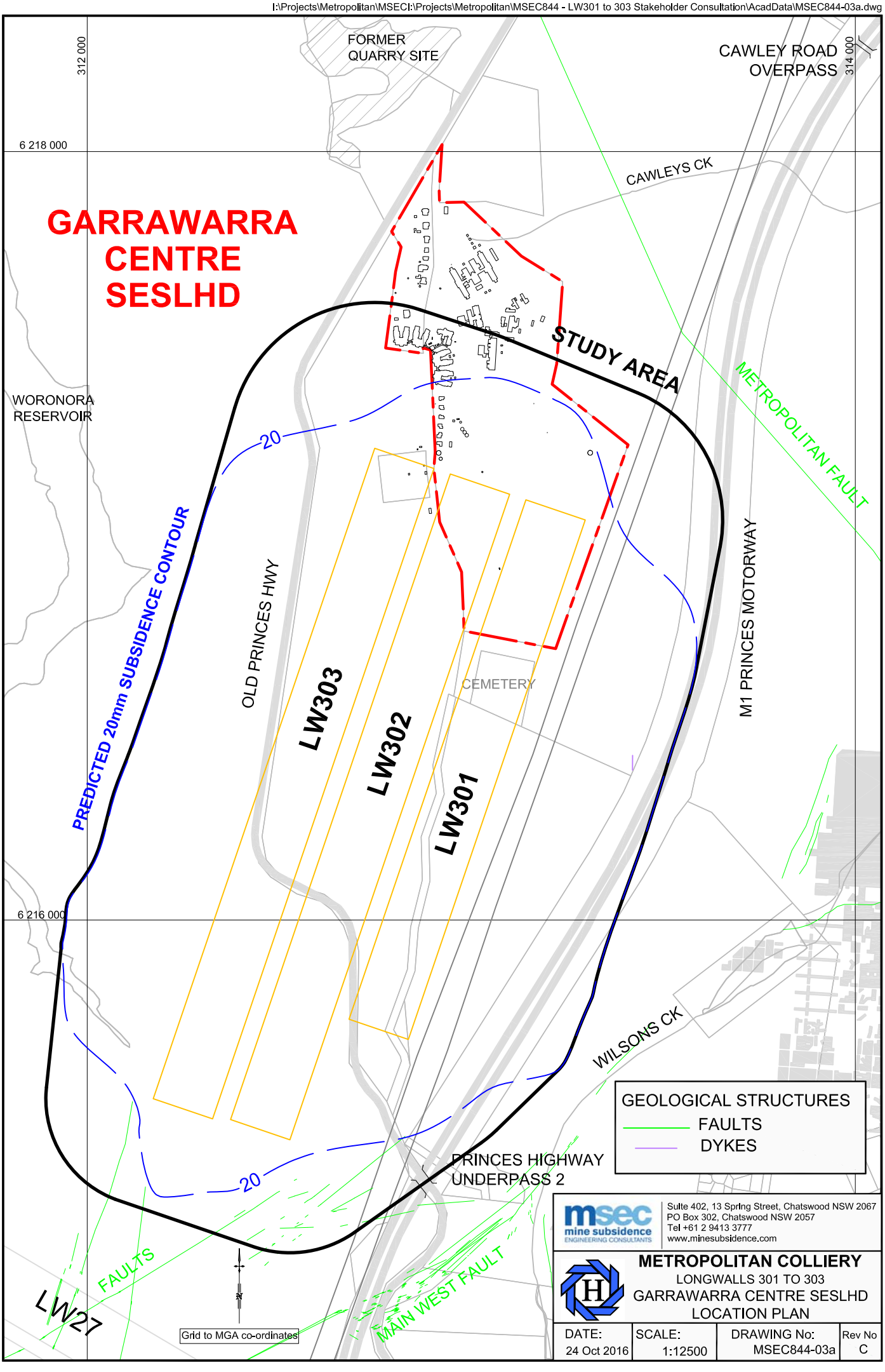

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
GARRAWARRA CENTRE SESLHD
LOCATION PLAN

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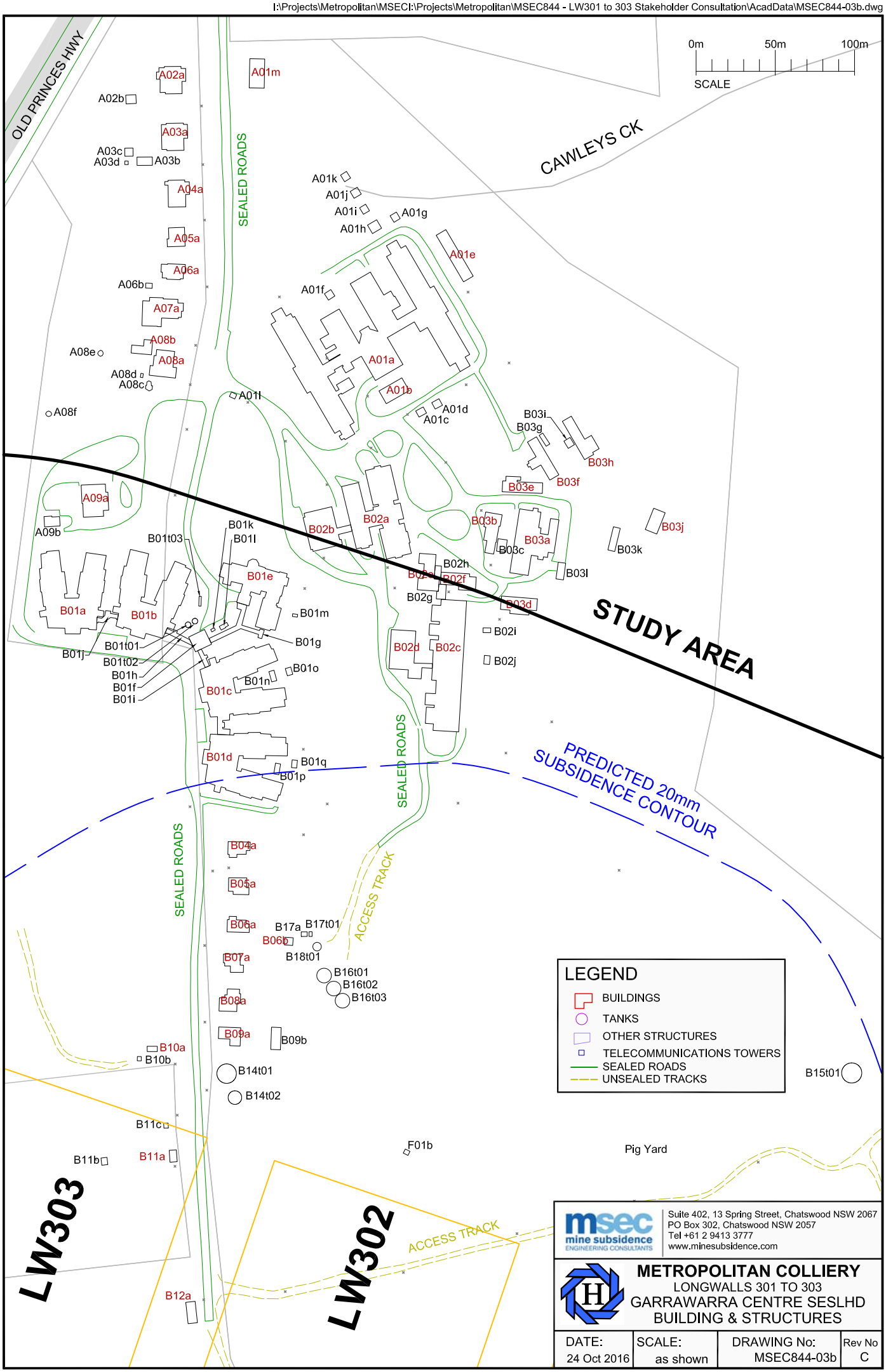

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Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
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GARRAWARRA CENTRE SESLHD
BUILDING & STRUCTURES

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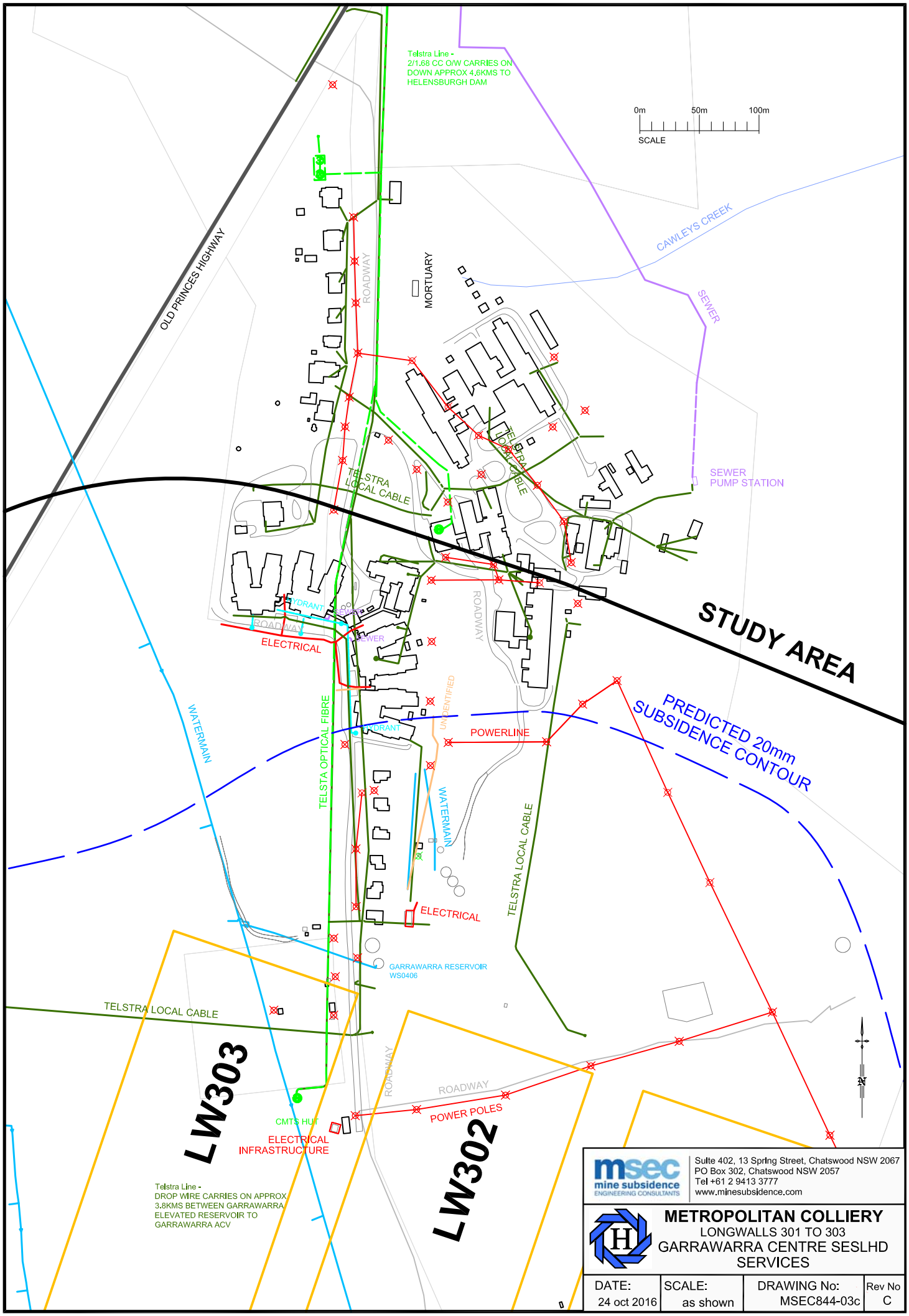

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Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

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GARRAWARRA CENTRE SESLHD
SERVICES

DATE:	SCALE:	DRAWING No:	Rev No
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Table A.1 - Predicted Subsidence, Tilt and Curvature for the Building Structures

Structure Ref.	Description	Maximum Dimension (m)	Predicted Total Subsidence after LW301 (mm)	Predicted Total Subsidence after LW302 (mm)	Predicted Total Subsidence after LW303 (mm)	Predicted Total Tilt after LW301 (mm/m)	Predicted Total Tilt after LW302 (mm/m)	Predicted Total Tilt after LW303 (mm/m)	Predicted Total Hogging Curvature after LW301 (1/km)	Predicted Total Hogging Curvature after LW302 (1/km)	Predicted Total Hogging Curvature after LW303 (1/km)	Predicted Total Sagging Curvature after LW301 (1/km)	Predicted Total Sagging Curvature after LW302 (1/km)	Predicted Total Sagging Curvature after LW303 (1/km)
A01a	Hospital	38	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A01b	Hospital	17	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A01c	Hospital	5	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A01d	Hospital	5	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A01e	Hospital	34	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A01f	Hospital	5	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A01g	Hospital	5	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A01h	Hospital	7	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A01i	Hospital	5	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A01j	Hospital	5	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A01k	Hospital	5	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A01l	Shed	4	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A01m	House	18	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A02a	House	11	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A02b	Shed	6	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A03a	House	16	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A03b	Shed	10	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A03c	Shed	5	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A03d	Shed	2	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A04a	House	14	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A05a	House	12	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A06a	House	11	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A06b	Shed	4	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A07a	House	16	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A08a	House	17	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A08b	Shed	13	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A08c	Shed	3	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A08d	Shed	3	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A08e	Shed	2	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A08f	Shed	2	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A09a	House	15	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
A09b	Shed	10	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01a	Retirement Home	14	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01b	Retirement Home	14	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01c	Retirement Home	14	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01d	Retirement Home	15	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01e	Retirement Home	19	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01f	Retirement Home	11	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01g	Retirement Home	21	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01h	Retirement Home	19	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01i	Retirement Home	12	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01j	Retirement Home	6	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01k	Shed	3	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01l	Shed	5	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01m	Shed	3	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01n	Shed	7	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01o	Shed	5	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01p	Shed	7	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01q	Shed	5	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01t01	Tank	4	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

Table A.1 - Predicted Subsidence, Tilt and Curvature for the Building Structures

Structure Ref.	Description	Maximum Dimension (m)	Predicted Total Subsidence after LW301 (mm)	Predicted Total Subsidence after LW302 (mm)	Predicted Total Subsidence after LW303 (mm)	Predicted Total Tilt after LW301 (mm/m)	Predicted Total Tilt after LW302 (mm/m)	Predicted Total Tilt after LW303 (mm/m)	Predicted Total Hogging Curvature after LW301 (1/km)	Predicted Total Hogging Curvature after LW302 (1/km)	Predicted Total Hogging Curvature after LW303 (1/km)	Predicted Total Sagging Curvature after LW301 (1/km)	Predicted Total Sagging Curvature after LW302 (1/km)	Predicted Total Sagging Curvature after LW303 (1/km)
B01t02	Tank	4	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B01t03	Tank	6	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B02a	Retirement Home	40	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B02b	Retirement Home	21	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B02c	Retirement Home	83	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B02d	Retirement Home	25	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B02e	Retirement Home	15	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B02f	Retirement Home	18	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B02g	Retirement Home	9	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B02h	Retirement Home	8	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B02i	Shed	5	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B02j	Shed	5	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B03a	Hospital	41	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B03b	Hospital	11	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B03c	Hospital	8	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B03d	Hospital	23	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B03e	Hospital	25	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B03f	Hospital	28	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B03g	Hospital	8	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B03h	Hospital	28	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B03i	Hospital	5	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B03j	Hospital	14	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B03k	Hospital	15	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B03l	Hospital	11	< 20	< 20	< 20	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B04a	House	14	< 20	< 20	25	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B05a	House	11	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B06a	House	14	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B06b	Shed	5	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B07a	House	11	< 20	< 20	75	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B08a	House	11	< 20	< 20	75	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B09a	House	14	< 20	25	100	< 0.5	< 0.5	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B09b	Shed	14	< 20	25	100	< 0.5	< 0.5	1.0	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B10a	Shed	6	< 20	< 20	100	< 0.5	< 0.5	1.0	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01
B10b	Shed	3	< 20	25	100	< 0.5	< 0.5	1.0	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01
B11a	Shed	7	< 20	50	200	< 0.5	0.5	2.5	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.01
B11b	Shed	5	< 20	50	200	< 0.5	< 0.5	2.5	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01
B11c	Shed	3	< 20	25	150	< 0.5	< 0.5	2.0	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01
B12a	Shed	14	< 20	125	525	< 0.5	2.0	3.5	< 0.01	0.03	0.03	< 0.01	< 0.01	0.04
B14t01	Reservoir	12	< 20	25	125	< 0.5	< 0.5	1.0	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01
B14t02	Reservoir	8	< 20	25	125	< 0.5	< 0.5	1.5	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01
B15t01	Tank	13	< 20	25	25	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B16t01	Tank	9	< 20	25	75	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B16t02	Tank	9	< 20	25	75	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B16t03	Tank	9	< 20	25	75	< 0.5	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B17a	Pump house	4	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B17t01	Fire water tank	3	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
B18t01	Tank	5	< 20	< 20	50	< 0.5	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

APPENDIX 2

MSEC (2019) METROPOLITAN COLLIERY – PROPOSED LONGWALL 304 – SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE GARRAWARA COMPLEX

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

16th March 2019

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-03

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Garrawarra Complex

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the built features of the Garrawarra Complex resulting from the extraction of the proposed Longwalls 304 at Metropolitan Colliery. Several services within the Garrawarra Complex are owned by other stakeholders and will be assessed and managed as necessary, through consultation with the relevant owners.

The locations of the Garrawarra Complex and the proposed longwalls are shown in the attached Drawing No. MSEC1013-03a, 03b and 03c. A Study Area is shown in the drawings and is based on the outer limits of a 35° angle of draw line from Longwall 304 and the predicted 20mm subsidence contour for Longwall 304.

The type and size of the building structures are shown in the attached Table A.1 at the end of this letter report. There are a total of 86 building structures on the complex, comprising 57 residential or hospital buildings and 29 ancillary structures. All residential and hospital buildings are located outside the footprint of the proposed longwalls. There are also nine water storage tanks and a number of telecommunications towers located within the complex.

The *hospital* building structures are Refs. A01a to A01k and B03a to B03l. These structures are located outside the extents of the longwalls at a minimum distance of 470 m from Longwall 304. The buildings are not currently in use and have been fenced off. Photographs of the main hospital building structures are provided in Figure 1 and Figure 2.

Figure 1 Hospital Building Structure (Ref. A01a)

Figure 2 Hospital Building Structure (Ref. B03a)

The main *aged care* building structures are Refs. B01a to B01j and B02a to B02h. The other buildings associated with the aged care are Refs. B01k to B01q, B02i and B02j.

Structure Refs. B01a to B01d are located over 250 m to the north of Longwall 304. These buildings comprise single storey structures founded on a combination of ground slabs, strip footings and pad footings. The external walls are brick-veneer and the internal walls are of lightweight construction. The roofs are steel framed with metal sheeting. The roofs are steel framed with metal sheeting. Photographs of these structures are provided in Figure 3.

Figure 3 Aged Care Building Structure Refs. B01a to B01d

Structure Ref. B01e is located 350 m to the north of Longwall 304. This building is a double storey brick structure founded on a ground slab with a tiled roof. Photographs of this structure are provided in Figure 4.

Figure 4 Aged Care Building Structure Ref. B01e

Structure Refs. B02a to B02h are located outside the Study Area. These buildings comprise one and two storey structures founded on strip footings and ground slabs. The perimeter walls are double brick, but in some cases the upper levels have timber framed walls. The suspended floors are timber framed and in some cases are supported on steel frames. The tiled roofs are supported by timber frames. Photographs of two of these structures are provided in Figure 5.

Figure 5 Aged Care Building Structure Refs. B02a and B02b

The *houses* are Refs. A01m, A02a to A09a and B04a to B09a. The other buildings associated with the houses are Refs. A01l, A02b, A03b to A03d, A06b, and A08b to A08f.

Structure Refs. A01m, A02a to A09a are located outside the Study Area. Only Structure Ref. A09a is located within the Study Area boundary. This building is a two storey double brick structure on strip footings with timber floor and a tiled roof. Photographs of this house and the associated structure are provided in Figure 6.

Figure 6 House Structure Ref. A09a (left side) and A09b (right side)

Structure Refs. B04a to B09a are located 200 m to 240 m to the north east of Longwall 304. These houses are one storey structures founded on brick piers and low level perimeter brickwalls with timber floors, fibro walls and tiled roofs. Photographs of two of these houses are provided in Figure 7. The houses are currently vacant and have been fenced off in preparation for demolition.

Figure 7 Houses Structure Refs. B06a (left side) and B08a (right side)

The other main structures on the complex include water storage tanks (Refs. B14t01, B14t02, B16t01 to B16t03, B17t01, and B18t01), above ground gas storage tank (Ref. B01t03), and trickle filter tank B15t01. Photographs of these features are provided in Figure 8 to Figure 11.

Figure 8 Water Storage Tanks Refs. B14t01 and B14t02 (left side) and Refs. B16t01 to B16t03 (right side)

Figure 9 Water Storage Tanks Refs. B17t01 (poly tank) and B18t01 (steel tank)

Figure 10 Gas Storage Tank B01t03

Figure 11 Trickle Filter Tank B15t01

Other built features on the complex include telecommunications towers and compounds (Refs. B06b and B10a to B12a), potable water and sewer pipelines, powerlines and telecommunications cables.

The predictions and impact assessments for the built features in the Garrawarra Complex are provided in the following sections.

Conventional Subsidence Parameters for the Built Features

The following provides summaries of the maximum predicted conventional movements for the built features resulting from the extraction of Longwalls 304. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

The maximum predicted subsidence, tilt and curvature for each of the building structures and tanks, after the extraction of Longwall 303 and after the extraction of Longwall 304, are provided in Table A.1 at the end of this letter report. The values are the maxima within a distance of 20 metres from the mapped extents of these features.

Summaries of the maximum predicted values of total subsidence, tilt and curvature are provided in: Table 1 for the hospital building structures; Table 2 for the aged care building structures; Table 3 and Table 4 for the houses; Table 5 for the water storage tanks; and Table 6 for the above ground gas storage tank.

Table 1 Maximum Predicted Total Subsidence, Tilt and Curvature for the Hospital Building Structures (Refs. A01a to A01k and B03a to B03l)

Longwall	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})
After LW303	< 20	< 0.5	< 0.01	< 0.01
After LW304	< 20	< 0.5	< 0.01	< 0.01

Table 2 Maximum Predicted Total Subsidence, Tilt and Curvature for the Aged Care Building Structures (Refs. B01a to B01q, and B02a to B02j)

Longwall	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})
After LW303	< 20	< 0.5	< 0.01	< 0.01
After LW304	< 20	< 0.5	< 0.01	< 0.01

Table 3 Maximum Predicted Total Subsidence, Tilt and Curvature for the Northern Houses (Refs. A01m and A02a to A09a)

Longwall	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})
After LW303	< 20	< 0.5	< 0.01	< 0.01
After LW304	< 20	< 0.5	< 0.01	< 0.01

Table 4 Maximum Predicted Total Subsidence, Tilt and Curvature for the Southern Houses (Refs. B04a to B09a)

Longwall	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})
After LW303	50	< 0.5	< 0.01	< 0.01
After LW304	90	0.5	< 0.01	< 0.01

Table 5 Maximum Predicted Total Subsidence, Tilt and Curvature for the Water Tanks and Trickle Filter Tank (Refs. B14t01, B14t02, B15t01, B16t01 to B16t03, B17t01 B18t01)

Longwall	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})
After LW303	70	0.5	< 0.01	< 0.01
After LW304	125	1.0	0.01	< 0.01

Table 6 Maximum Predicted Total Subsidence, Tilt and Curvature for the Gas Storage Tank (Ref. B01t03)

Longwall	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})
After LW303	< 20	< 0.5	< 0.01	< 0.01
After LW304	< 20	< 0.5	< 0.01	< 0.01

A large proportion of the building structures are located outside or close to the Study Area boundary and are not expected to experience measurable conventional vertical subsidence, tilts or curvatures.

The private roads and the services directly associated with the hospital and residential building structures are located outside the footprint of Longwall 304 and are therefore expected to experience low levels of predicted movements, consistent with the above tables. A summary of the maximum predicted subsidence, tilt and curvature for the private roads and services, resulting from the extraction of Longwall 303 and 304, is provided in Table 7.

Table 7 Maximum Predicted Total Subsidence, Tilt and Curvature for the Private Roads and Services on the Garrawarra Complex

Longwall	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})
After LW303	200	2.0	0.03	< 0.01
After LW304	300	3.0	0.03	< 0.01

The maximum predicted total subsidence for the private roads and services is 300 mm. The maximum predicted conventional tilt is 3.0 mm/m (i.e. 0.3 %, or 1 in 330). The maximum predicted conventional curvatures are 0.03 km^{-1} hogging and < 0.01 sagging, which equate to minimum radii of curvature of 33 km and 100 km respectively.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the built features has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

Where features are located outside the proposed longwalls, as is the case for the structures at the Garrawarra complex, the database has been analysed to extract the maximum tensile and compressive strains outside the longwalls, referred to as '*above solid coal'*. The majority of building structures are greater than 100 metres from the longwalls and, therefore, the database has been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located outside and within 100 metres to 250 metres of the nearest longwall goaf edge.

A histogram of the maximum observed tensile and compressive strains measured in survey bays located above solid coal, for monitoring lines in the Southern Coalfield, is provided in Figure 12. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

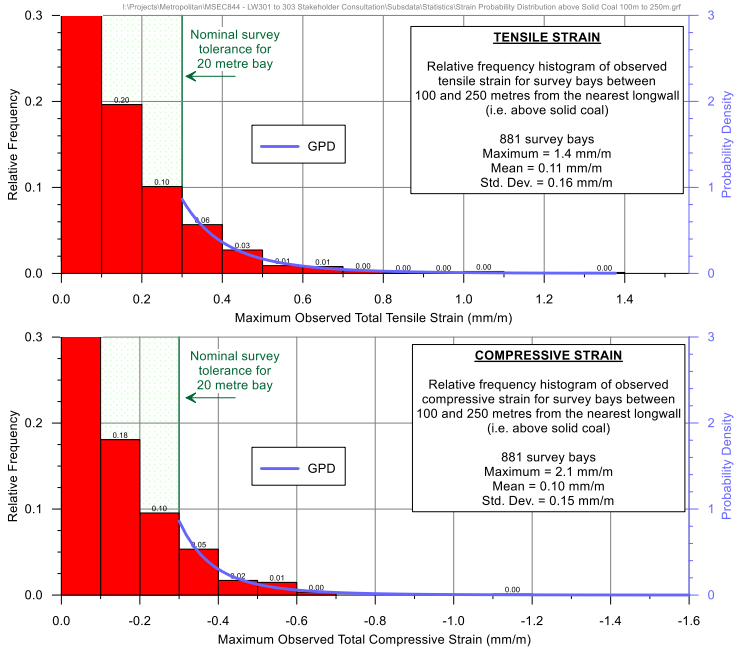

Figure 12 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Solid Coal (100 to 250 metres)

The 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal (100 to 250 metres) experienced at any time during mining are 0.4 mm/m tensile and compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.7 mm/m tensile and 0.6 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures at seam level and the major streams are shown in Drawing No. MSEC1013-03a. There are no mapped faults located within the Study Area that extend beneath the Garrawarra Complex. It is possible that structures could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). Non-conventional or anomalous movements have not been identified during the extraction of Longwalls 301 and 302 and part extraction of Longwall 303. The range of strains provided in the previous section include those resulting from irregular anomalous movements.

There are no major streams located within the complex. The built features, therefore, are not expected to experience any measurable valley closure effects.

Impact Assessments for the Building Structures

Longwall layouts have been modified in order to minimise predicted subsidence movements at the Garrawarra building structures B01a to B01e, which house aged care patients and administrative support.

A structural assessment of the building structures within the Garrawarra Complex was undertaken by John Matheson and Associates Pty Ltd (JMA 2016). A summary of the results of the structural inspection is provided in Table 3 of JMA (2016). The assessment is based on predicted subsidence parameters for Longwall 301 to 303 and indicates that the likelihood of greater than negligible damage developing in the building structures is low, with an assessed probability of exceedance for Category 1 damage (i.e. fine cracks of less than 1mm) of 1% or less for all buildings with the exception of Building B02c. The abandoned building B02c has a probability of exceedance of 10% for Category 1 damage and a probability of exceedance of 1% for a 2 mm crack in Category 2. The assessed probability exceedance of 1% is generally associated with large masonry structures. The assessed probability exceedance for the smaller building structures is generally unlikely to remote. A detailed discussion of the structural assessments is provided in the report by JMA (2016). Since the preparation of the structural assessment report, the Longwalls 301 to 303 were shortened by 90 m. The predicted subsidence parameters for the structures after Longwall 304 are generally unchanged or similar to those assessed in the report by JMA (2016) and the resulting assessments for the structures do not change. The buildings are expected to remain safe and serviceable and potential impacts could be repaired using normal building maintenance techniques.

A detailed discussion of the structural assessments is provided in the report by JMA (2016).

Impact Assessments for the Water Tanks and Trickle Filter Tank

The maximum predicted tilt for the water tanks and trickle filter tank is 1.0 mm/m (i.e. 0.1 %, or 1 in 1000). The magnitude of tilt is very small (i.e. less than 1 %) and therefore unlikely to adversely impact on these structures. Tilt can potentially affect the stored water levels within these tanks. It is recommended that infrastructure owner reviews the potential changes in freeboard resulting from the mining induced tilt.

The maximum predicted conventional curvatures are 0.01 km^{-1} hogging and less than 0.01 km^{-1} sagging, which equate to minimum radii of curvature of 50 km and greater than 100 km, respectively.

The tanks are located at distances of 200 m or greater from Longwall 304. The 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.4 mm/m tensile and compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.7 mm/m tensile and 0.6 mm/m compressive.

As assessment of the tanks was undertaken by John Matheson and Associates Pty Ltd (JMA 2016). A summary of the results of the structural inspection is provided in Table 3 of JMA (2016). The assessment is based on predicted subsidence parameters for Longwall 301 to 303 and indicates that the likelihood of greater than negligible damage developing in the water storage tanks is 20% for Category 1 damage (i.e. fine cracks of less than 1mm) of 1% or less. Since the preparation of the structural assessment report, the Longwalls 301 to 303 were shortened by 90 m. The predicted subsidence parameters for the structures after Longwall 304 are unchanged or less than those assessed in the report by JMA (2016) and the resulting assessments for the structures therefore do not change. The tanks are expected to remain safe and serviceable and potential impacts could be repaired using normal building maintenance techniques.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301-303 are updated, in consultation with the infrastructure owner, to manage the potential impacts on the water storage tanks and trickle filter tank. It is expected that these tanks can be maintained in safe and serviceable conditions with the implementation of the appropriate monitoring and management strategies.

Impact Assessments for the Gas Storage Tank

The gas storage tank is located more than 330 m from Longwall 304. The maximum predicted subsidence parameters are negligible and therefore unlikely to adversely impact on this tank.

The maximum predicted conventional curvatures are less than 0.01 km^{-1} for both hogging and sagging curvature, which equate to minimum radii of curvature of greater than 100 km. The predicted strains are less than 0.5 mm/m tensile and compressive based on the 95 % confidence level.

The gas storage tank is supported on a concrete slab above the ground and therefore is unlikely to experience the mining induced curvatures and strains.

At this distance, it is unlikely that the storage tank and pipework would experience adverse impacts as a result of the extraction of Longwall 304.

Impact Assessments for the Private Roads and Services

The private roads in the complex with bitumen seals and private services within the complex are located outside Longwall 304. Experience from the Southern Coalfield indicates that the impacts on these roads and services are unlikely.

Short lengths of road comprising chip seal or gravel surface are located above Longwall 302. The roads are not well maintained. Potential impacts to these roads may include minor and isolated cracks. The impacts can be managed using monitoring (visual or ground survey lines) during active subsidence and remediation of impacts using normal road maintenance techniques.

It is expected that the private roads and service can be maintained in safe and serviceable conditions with the development of the appropriate monitoring and management plans.

Summary

The building structures and services associated with the Garrawarra Complex are located to the north east of Longwall 304. The main patient wards are located more than 250 metres from Longwall 304. Assessments of the building structures were carried out by JMA (2016) and indicate that the structures can be maintained in a safe and serviceable condition.

It is expected that the potential impacts on the building structures and services could be managed with the implementation of the appropriate monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:
Drawing No. MSEC1013-03a – Longwall 304 – Location Plan
Drawing No. MSEC1013-03b – Longwall 304 – Buildings and Structures
Drawing No. MSEC1013-03c – Longwall 304 – Services

Table A.1 Predicted Subsidence, Tilt and Curvature for the Building Structures

References:

John Matheson and Associates (JMA 2016), Garrawarra:R0295-Rev 3 *Preliminary Structural Inspection Report.* 10 October 2016

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COLLIERY
LONGWALL 304
GARRAWARRA CENTRE SESLHD
LOCATION PLAN

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	1:10000	MSEC1013-03a	02

FORMER QUARRY SITE

6 218 000

312 000

GARRAWARRA CENTRE SESLHD

CAWLEYS CK

METROPOLITAN FAULT

WORONORA RESERVOIR

STUDY AREA

PREDICTED 20mm SUBSIDENCE CONTOUR

LW304

OLD PRINCES HWY

LW303

LW302

LW301

CEMETERY

6 216 000

GEOLOGICAL STRUCTURES
FAULTS
DYKES

WILSONS CK

PRINCES HIGHWAY UNDERPASS 2

Grid to MGA co-ordinates

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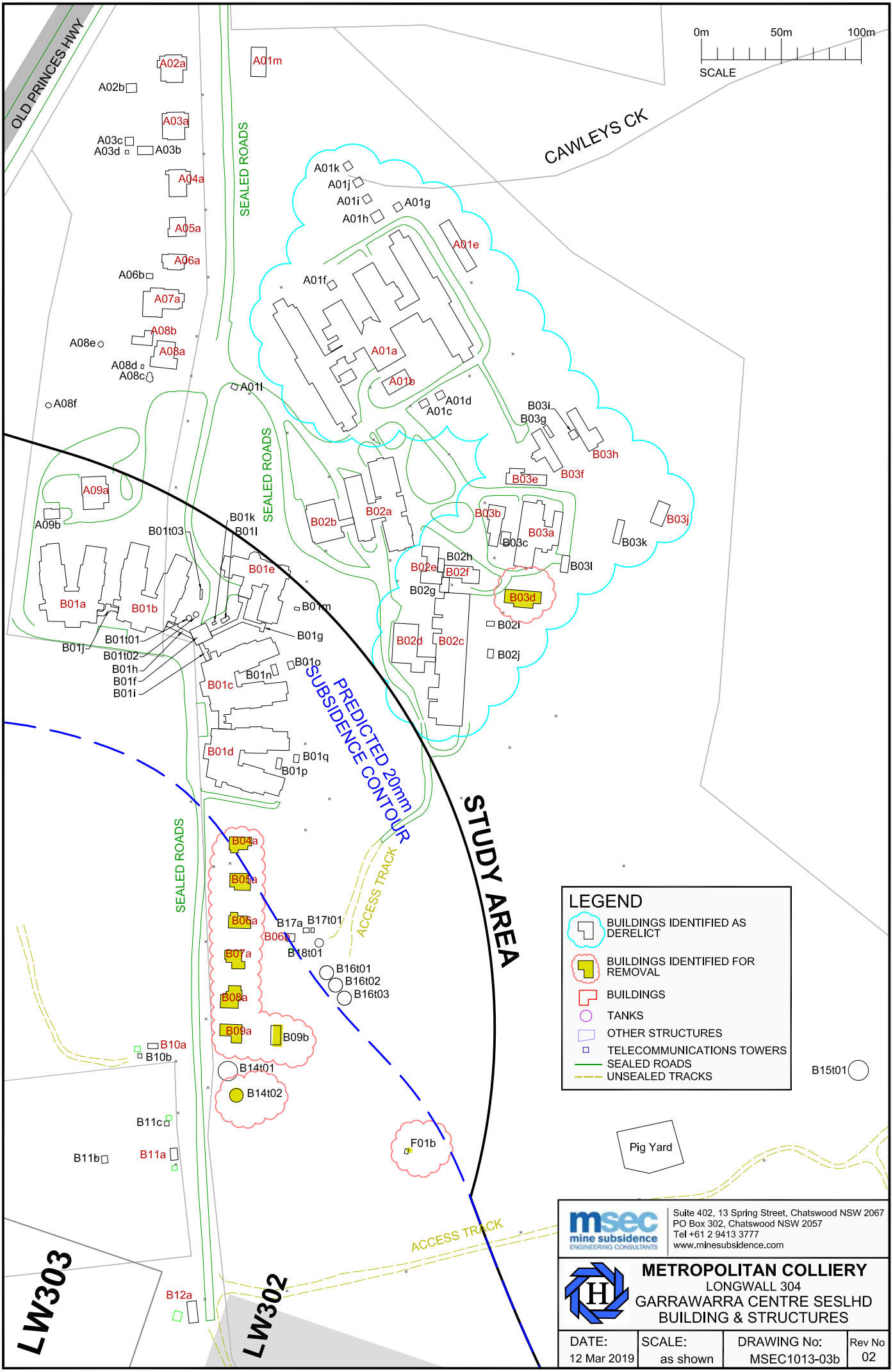

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COLLIERY
LONGWALL 304
GARRAWARRA CENTRE SESLHD
BUILDING & STRUCTURES

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	as shown	MSEC1013-03b	02

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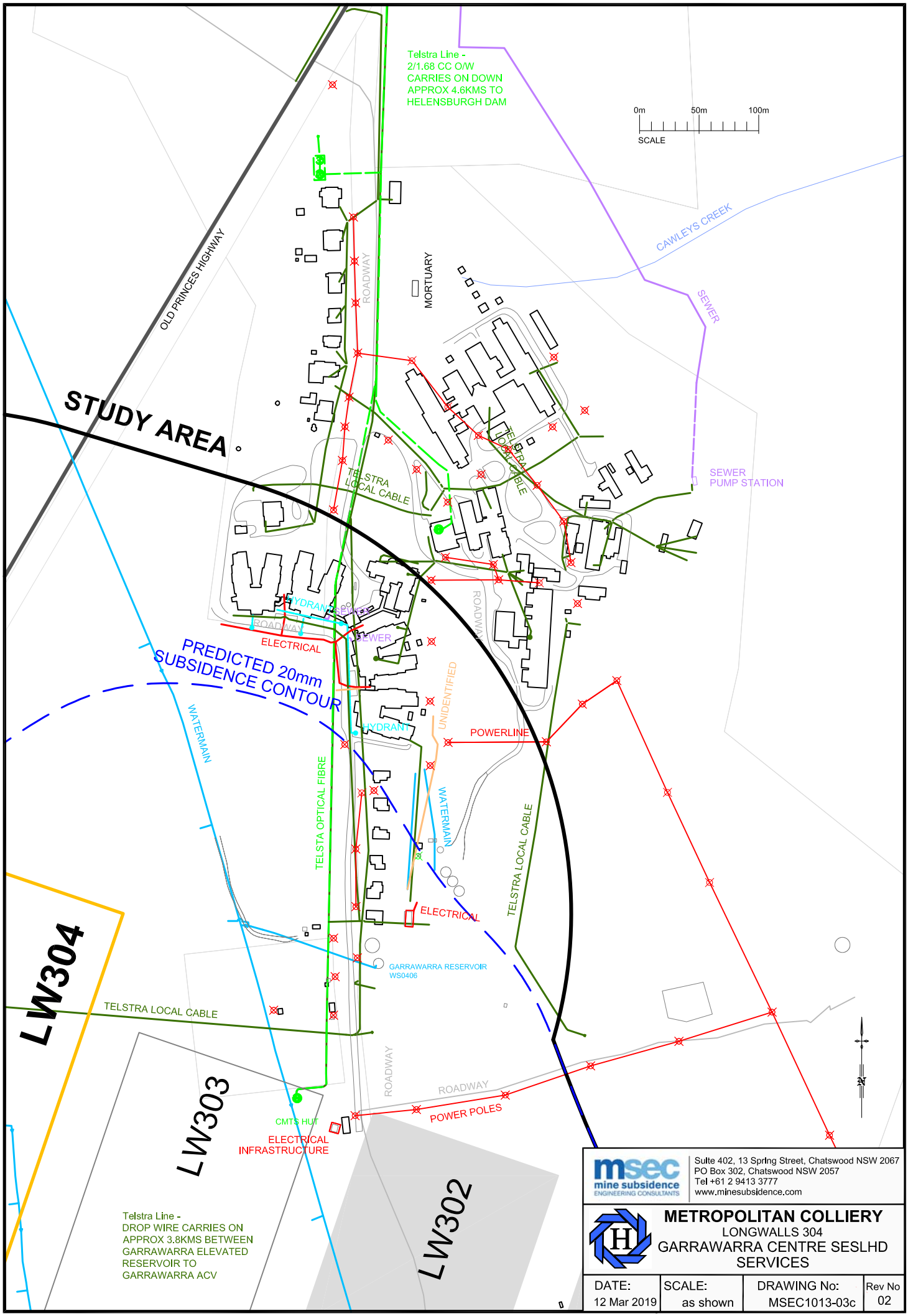

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Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
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LONGWALLS 304
GARRAWARRA CENTRE SESLHD SERVICES

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	as shown	MSEC1013-03c	02

Table A.01 - Maximum Predicted Subsidence Parameters for the Building Structures

Ref.	Description	Maximum Dimension (m)	Maximum Predicted Total Subsidence based on the Extraction Plan Layout after LW303 (mm)	Maximum Predicted Total Subsidence based on the Extraction Plan Layout after LW304 (mm)	Maximum Predicted Total Tilt based on the Extraction Plan Layout after LW303 (mm/m)	Maximum Predicted Total Tilt based on the Extraction Plan Layout after LW304 (mm/m)	Maximum Predicted Total Hogging Curvature based on the Extraction Plan Layout after LW303 (1/km)	Maximum Predicted Total Hogging Curvature based on the Extraction Plan Layout after LW304 (1/km)	Maximum Predicted Total Sagging Curvature based on the Extraction Plan Layout after LW303 (1/km)	Maximum Predicted Total Sagging Curvature based on the Extraction Plan Layout after LW304 (1/km)
A01a	Hospital	38	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01b	Hospital	17	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01c	Hospital	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01d	Hospital	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01e	Hospital	34	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01f	Hospital	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01g	Hospital	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01h	Hospital	7	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01i	Hospital	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01j	Hospital	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01k	Hospital	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01l	Shed	4	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A01m	House	18	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A02a	House	11	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A02b	Shed	6	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A03a	House	16	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A03b	Shed	10	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A03c	Shed	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A03d	Shed	2	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A04a	House	14	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A05a	House	12	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A06a	House	11	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A06b	Shed	4	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A07a	House	16	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A08a	House	17	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A08b	Shed	13	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A08c	Shed	3	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A08d	Shed	3	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A08e	Shed	2	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A08f	Shed	2	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A09a	House	15	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
A09b	Shed	10	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01a	Retirement Home	14	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01b	Retirement Home	14	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01c	Retirement Home	14	*< 20*	20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01d	Retirement Home	15	*< 20*	30	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01e	Retirement Home	19	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01

Table A.01 - Maximum Predicted Subsidence Parameters for the Building Structures

Ref.	Description	Maximum Dimension (m)	Maximum Predicted Total Subsidence based on the Extraction Plan Layout after LW303 (mm)	Maximum Predicted Total Subsidence based on the Extraction Plan Layout after LW304 (mm)	Maximum Predicted Total Tilt based on the Extraction Plan Layout after LW303 (mm/m)	Maximum Predicted Total Tilt based on the Extraction Plan Layout after LW304 (mm/m)	Maximum Predicted Total Hogging Curvature based on the Extraction Plan Layout after LW303 (1/km)	Maximum Predicted Total Hogging Curvature based on the Extraction Plan Layout after LW304 (1/km)	Maximum Predicted Total Sagging Curvature based on the Extraction Plan Layout after LW303 (1/km)	Maximum Predicted Total Sagging Curvature based on the Extraction Plan Layout after LW304 (1/km)
B01f	Retirement Home	11	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01g	Retirement Home	21	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01h	Retirement Home	19	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01i	Retirement Home	12	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01j	Retirement Home	6	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01k	Shed	3	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01l	Shed	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01m	Shed	3	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01n	Shed	7	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01o	Shed	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01p	Shed	7	*< 20*	30	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01q	Shed	5	*< 20*	20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01t01	Tank	4	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01t02	Tank	4	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B01t03	Tank	6	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02a	Retirement Home	40	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02b	Retirement Home	21	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02c	Retirement Home	83	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02d	Retirement Home	25	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02e	Retirement Home	15	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02f	Retirement Home	18	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02g	Retirement Home	9	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02h	Retirement Home	8	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02i	Shed	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B02j	Shed	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03a	Hospital	41	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03b	Hospital	11	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03c	Hospital	8	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03d	Hospital	23	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03e	Hospital	25	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03f	Hospital	28	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03g	Hospital	8	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03h	Hospital	28	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03i	Hospital	5	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03j	Hospital	14	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03k	Hospital	15	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B03l	Hospital	11	*< 20*	< 20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B04a	House	14	*< 20*	40	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01

Table A.01 - Maximum Predicted Subsidence Parameters for the Building Structures

Ref.	Description	Maximum Dimension (m)	Maximum Predicted Total Subsidence based on the Extraction Plan Layout after LW303 (mm)	Maximum Predicted Total Subsidence based on the Extraction Plan Layout after LW304 (mm)	Maximum Predicted Total Tilt based on the Extraction Plan Layout after LW303 (mm/m)	Maximum Predicted Total Tilt based on the Extraction Plan Layout after LW304 (mm/m)	Maximum Predicted Total Hogging Curvature based on the Extraction Plan Layout after LW303 (1/km)	Maximum Predicted Total Hogging Curvature based on the Extraction Plan Layout after LW304 (1/km)	Maximum Predicted Total Sagging Curvature based on the Extraction Plan Layout after LW303 (1/km)	Maximum Predicted Total Sagging Curvature based on the Extraction Plan Layout after LW304 (1/km)
B05a	House	11	*20*	50	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B06a	House	14	*30*	60	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B06b	Shed	5	*30*	50	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B07a	House	11	*30*	70	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01
B08a	House	11	*40*	80	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01
B09a	House	14	*50*	90	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01
B09b	Shed	14	*50*	90	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01
B10a	Shed	6	*50*	125	< 0.5	1.0	< 0.01	0.01	< 0.01	< 0.01
B10b	Shed	3	*50*	125	< 0.5	1.0	< 0.01	0.01	< 0.01	< 0.01
B11a	Shed	7	*90*	175	1.0	2.0	< 0.01	0.02	< 0.01	< 0.01
B11b	Shed	5	*90*	225	1.0	2.5	< 0.01	0.03	< 0.01	< 0.01
B11c	Shed	3	*80*	150	0.5	1.5	< 0.01	0.02	< 0.01	< 0.01
B12a	Shed	14	*250*	400	3.0	3.5	0.03	0.03	< 0.01	< 0.01
B14t01	Reservoir	12	*60*	100	0.5	1.0	< 0.01	< 0.01	< 0.01	< 0.01
B14t02	Reservoir	8	*70*	125	0.5	1.0	< 0.01	0.01	< 0.01	< 0.01
B15t01	Tank	13	*< 20*	20	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B16t01	Tank	9	*40*	60	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B16t02	Tank	9	*40*	60	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B16t03	Tank	9	*40*	60	< 0.5	0.5	< 0.01	< 0.01	< 0.01	< 0.01
B17a	Pump house	4	*30*	50	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B17t01	Fire water tank	3	*30*	50	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
B18t01	Tank	5	*30*	50	< 0.5	< 0.5	< 0.01	< 0.01	< 0.01	< 0.01
F01b	Kiln	3	*80*	100	0.5	1.0	< 0.01	< 0.01	< 0.01	< 0.01

APPENDIX 3

BUILT FEATURES MANAGEMENT PLAN – SUBSIDENCE IMPACT REGISTER

Built Features Management Plan - Subsidence Impact Register

Impact Register Number[1]	Built Feature[2]	Impact Description	Does Impact Exceed the Built Feature Performance Measure/Indicators? (Yes/No)	Management Measures Implemented	Were Management Measures Effective? (Yes/No)

Notes:

1: Fill out all details in the Assessment Form and record the register number here.

2: Built feature (e.g. transmission line, tower, etc.).

3: Impacts to access roads/tracks to be included in the Land Management Plan – Subsidence Impact Register.

Built Feature Management Plan – Subsidence Impact Register
Assessment Form

Date:

Observer (Name and position):

Register Number (i.e. Number 1, 2, etc.):

Longwall Number and Chainage:

Location of Observed Impact:

(Examples: location of tower, include GPS co-ordinates and a sketch)

Description of Observed Impact:

(Examples: nature and extent of impact - cracks in road etc any relevant information, attach photographs)

Person Notified:	Manager - Technical Services	☐

Description of Photographs:

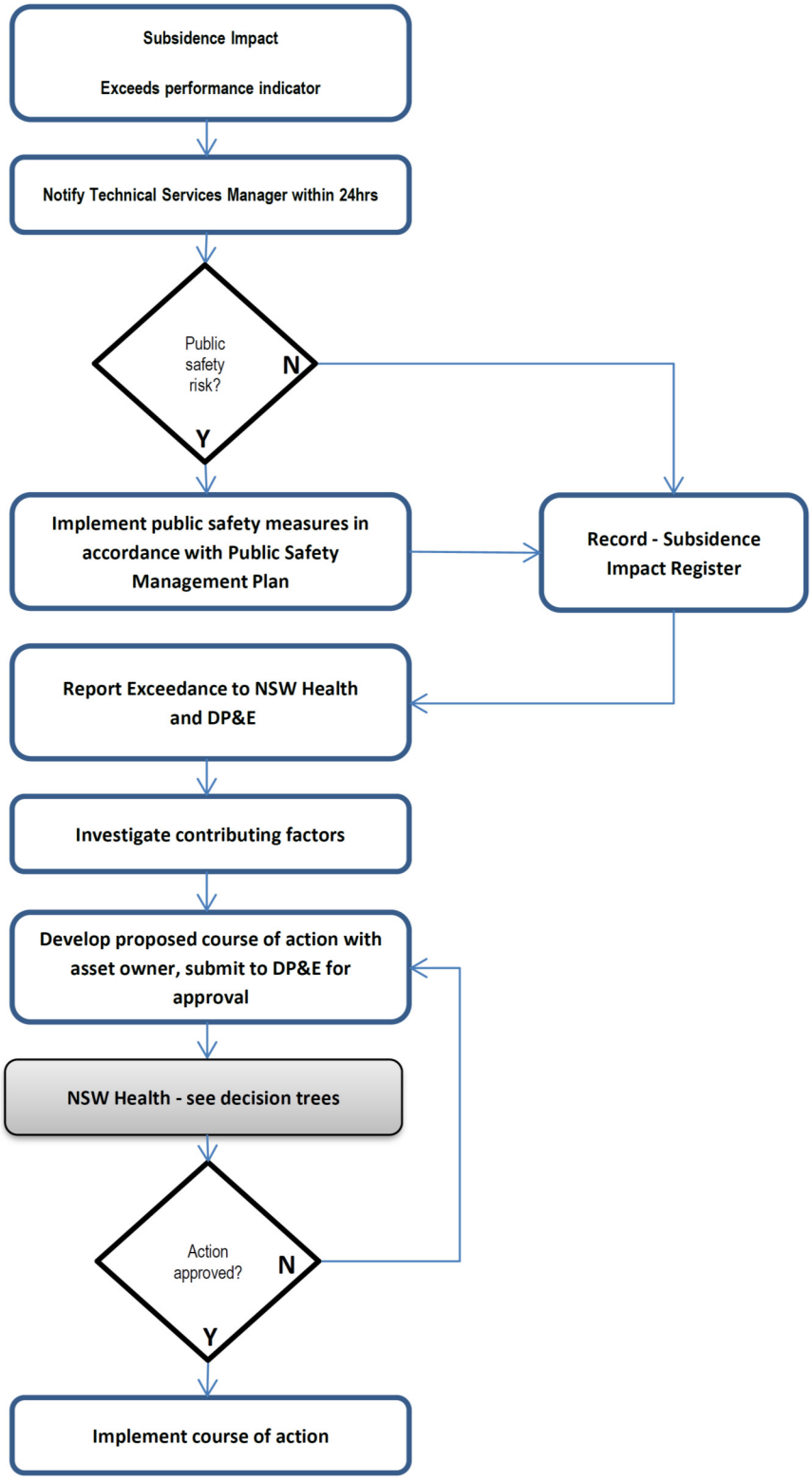
Actions Required:	Contingency Plan Initiated	☐
	Incident Notification	☐
	Safety Measures/Public Safety Management Plan Requirements	☐

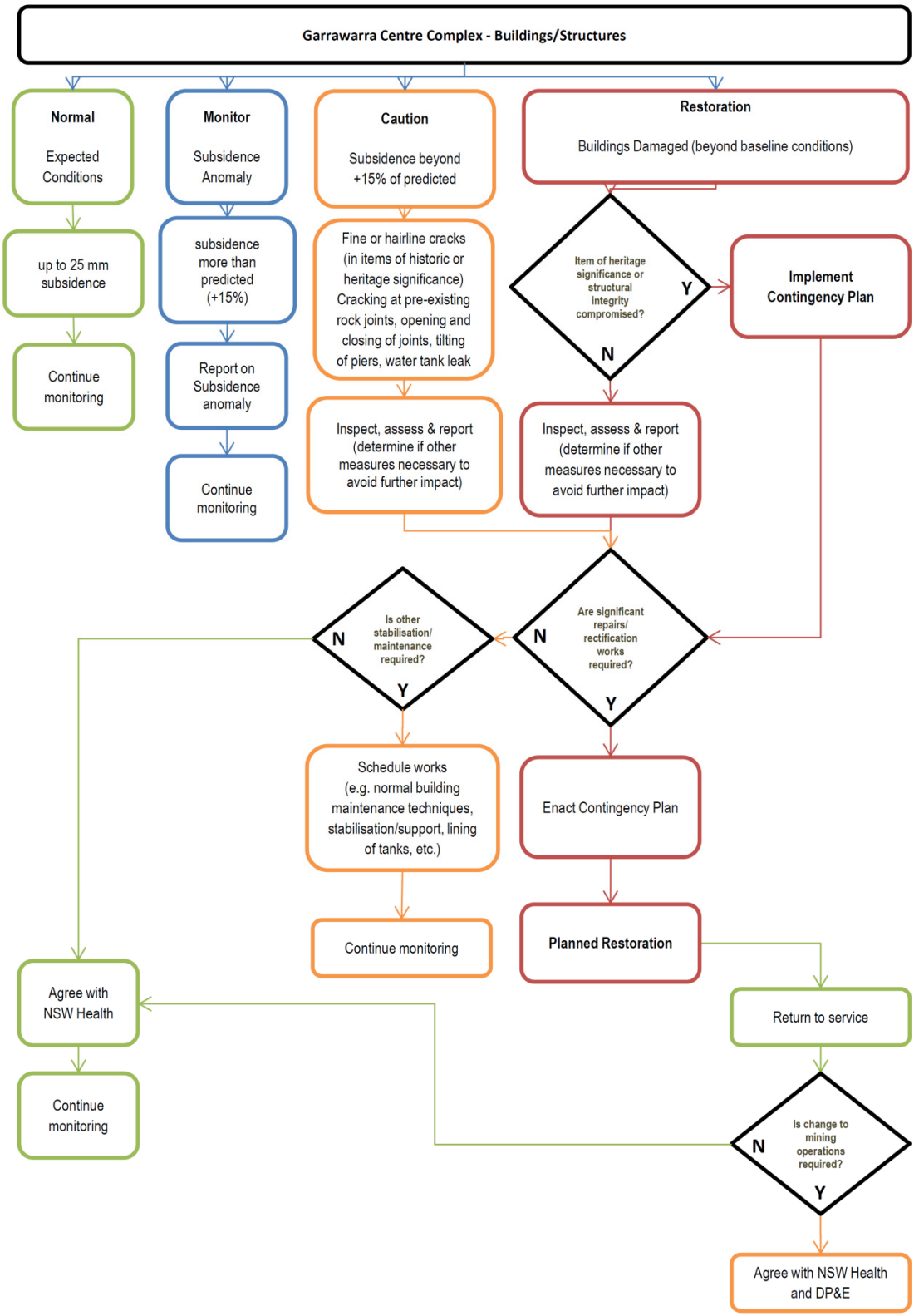
Management or Contingency Measures Implemented:

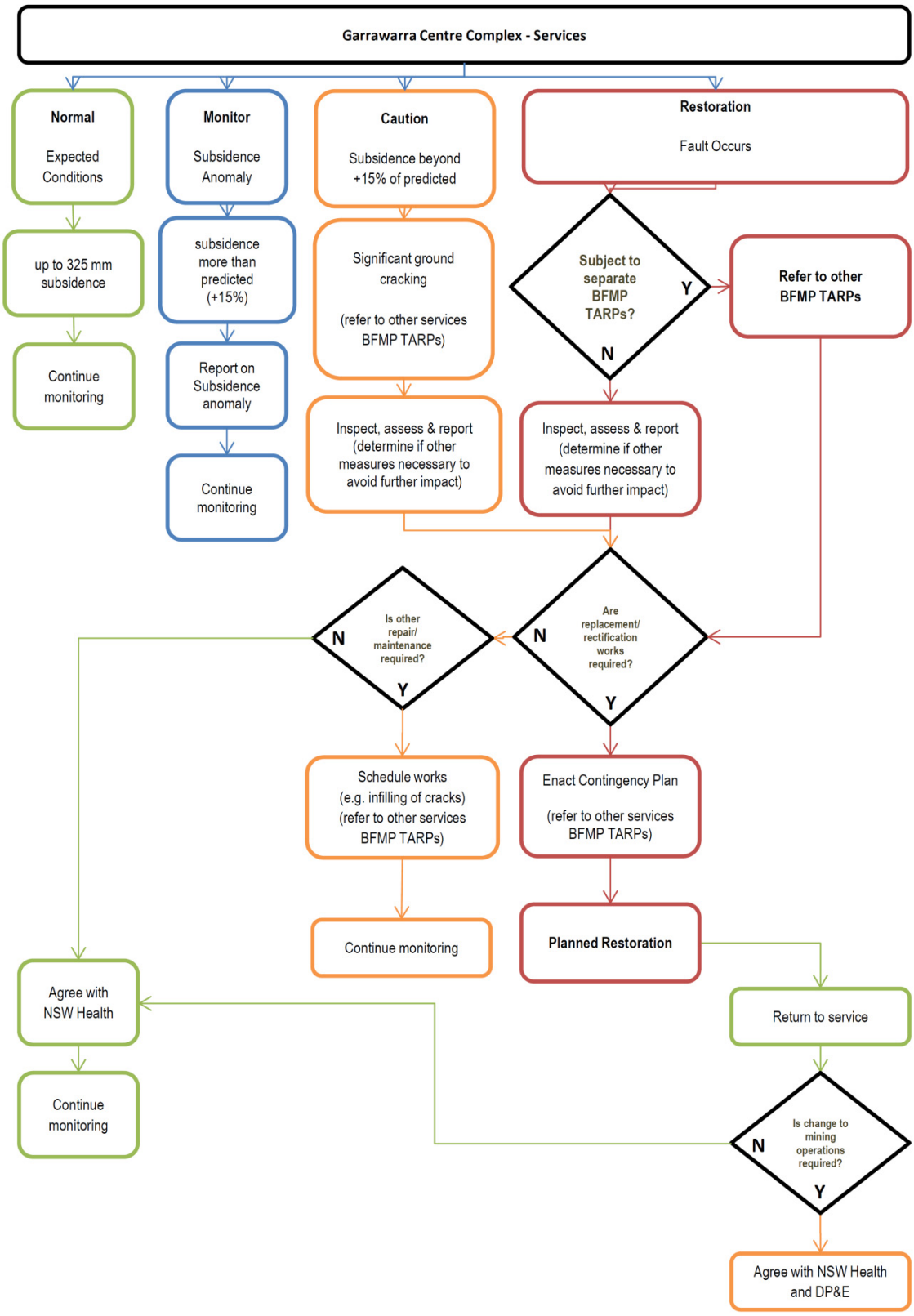
Effectiveness of Management or Contingency Measures:

APPENDIX 4

CONTINGENCY PLAN PROCEDURE AND DECISION TREES


Subsidence Impact
Exceeds performance indicator
Notify Technical Services Manager within 24hrs
Public safety risk?
N
Y
Implement public safety measures in accordance with Public Safety Management Plan
Record - Subsidence Impact Register
Report Exceedance to NSW Health and DP&E
Investigate contributing factors
Develop proposed course of action with asset owner, submit to DP&E for approval
NSW Health - see decision trees
Action approved?
N
Y
Implement course of action


Garrawarra Centre Complex - Buildings/Structures
Normal
Expected Conditions
Monitor
Subsidence Anomaly
Caution
Subsidence beyond +15% of predicted
Restoration
Buildings Damaged (beyond baseline conditions)
up to 25 mm subsidence
subsidence more than predicted (+15%)
Fine or hairline cracks (in items of historic or heritage significance) Cracking at pre-existing rock joints, opening and closing of joints, tilting of piers, water tank leak
Item of heritage significance or structural integrity compromised?
Y
N
Implement Contingency Plan
Continue monitoring
Report on Subsidence anomaly
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Continue monitoring
Is other stabilisation/ maintenance required?
N
Y
Are significant repairs/ rectification works required?
N
Y
Schedule works (e.g. normal building maintenance techniques, stabilisation/support, lining of tanks, etc.)
Enact Contingency Plan
Continue monitoring
Planned Restoration
Agree with NSW Health
Return to service
Continue monitoring
Is change to mining operations required?
N
Y
Agree with NSW Health and DP&E


Garrawarra Centre Complex - Services
Normal
Expected Conditions
Monitor
Subsidence Anomaly
Caution
Subsidence beyond +15% of predicted
Restoration
Fault Occurs
up to 325 mm subsidence
subsidence more than predicted (+15%)
Significant ground cracking
(refer to other services BFMP TARPs)
Subject to separate BFMP TARPs?
Y
N
Refer to other BFMP TARPs
Continue monitoring
Report on Subsidence anomaly
Continue monitoring
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Is other repair/ maintenance required?
N
Y
Are replacement/ rectification works required?
N
Y
Schedule works (e.g. infilling of cracks) (refer to other services BFMP TARPs)
Enact Contingency Plan
(refer to other services BFMP TARPs)
Continue monitoring
Planned Restoration
Agree with NSW Health
Return to service
Continue monitoring
Is change to mining operations required?
N
Y
Agree with NSW Health and DP&E

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BUILT FEATURES MANAGEMENT PLAN
ENDEAVOUR ENERGY

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&E Approval Date
All	LW301-303 BFMP_END-R01-A	Original – Draft for Consultation	Endeavour Energy, DRG and DP&E	-
Section 4.2.3 (removed), Table 4 and Figure 4	LW301-303 BFMP_END-R01-B	Revised – including updates	Endeavour Energy, DRG and DP&E	11 May 2017*
Tables 2, 6 & 8 and Appendix 3	LW301-303 BFMP_END-R01-C	Revised – Addressing DP&E and DRG requirements	Endeavour Energy, DRG and DP&E	-
All	LW301-303 BFMP_END-R01-D	Revised TARP. Revised for LW 303	Endeavour Energy and DRG	-
Table 5	LW301-303 BFMP_END-R01-E	Revised to update Endeavour Energy contacts	Endeavour Energy	8 November 2018#
All	BFMP_END-R01-F	Inclusion of Longwall 304 into BFMP	Endeavour Energy	-

* The approval allows for the extraction of Longwalls 301 and 302 only.

Approval for the extraction of Longwall 303.

April 2019

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Appendix 2 MSEC (2019) Metropolitan Colliery – Proposed Longwall 304 – Subsidence Predictions and Impact Assessments for the Endeavour Energy Infrastructure
Appendix 3 Built Features Management Plan – Subsidence Impact Register
Appendix 4 Contingency Plan Procedure and Decision Tree

1 INTRODUCTION

Metropolitan Coal is a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under section 75J of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com).

The Project comprises the continuation, upgrade and extension of underground coal mining operations (Longwalls 20-27 and Longwalls 301-317) and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1. Following the completion of Longwall 27 in 2017, Longwalls 301, 302, 303 and 304 define the next mining sub-domains within the Project underground mining area (Figures 1 to 3).

1.1 PURPOSE AND SCOPE

In accordance with Condition 6(f), Schedule 3 of the Project Approval, this Built Features Management Plan – Endeavour Energy (BFMP-END) has been developed to manage the potential consequences of longwall extraction on the Endeavour Energy assets associated with the 132 kV transmission line and towers, and other high voltage powerlines and poles.

The relationship of this BFMP-END to the Metropolitan Coal Environmental Management Structure is shown on Figure 4.

In accordance with Condition 6, Schedule 3 of the Project Approval, the suitably qualified and experienced experts that have prepared this BFMP-END, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and Metropolitan Coal were endorsed by the Director-General (now Secretary) of the Department of Planning and Environment (DP&E). This BFMP-END has been prepared in consultation with Endeavour Energy, including consideration of prior consultation during the development of the previously approved Built Features Management Plans.

1.2 STRUCTURE OF THE BFMP-END

The remainder of the BFMP-END is structured as follows:

Section 2: Describes the review and update of the BFMP-END.

Section 3: Outlines the statutory requirements applicable to the BFMP-END.

Section 4: Provides a revised assessment of the potential subsidence impacts and environmental consequences for Longwalls 301-304.

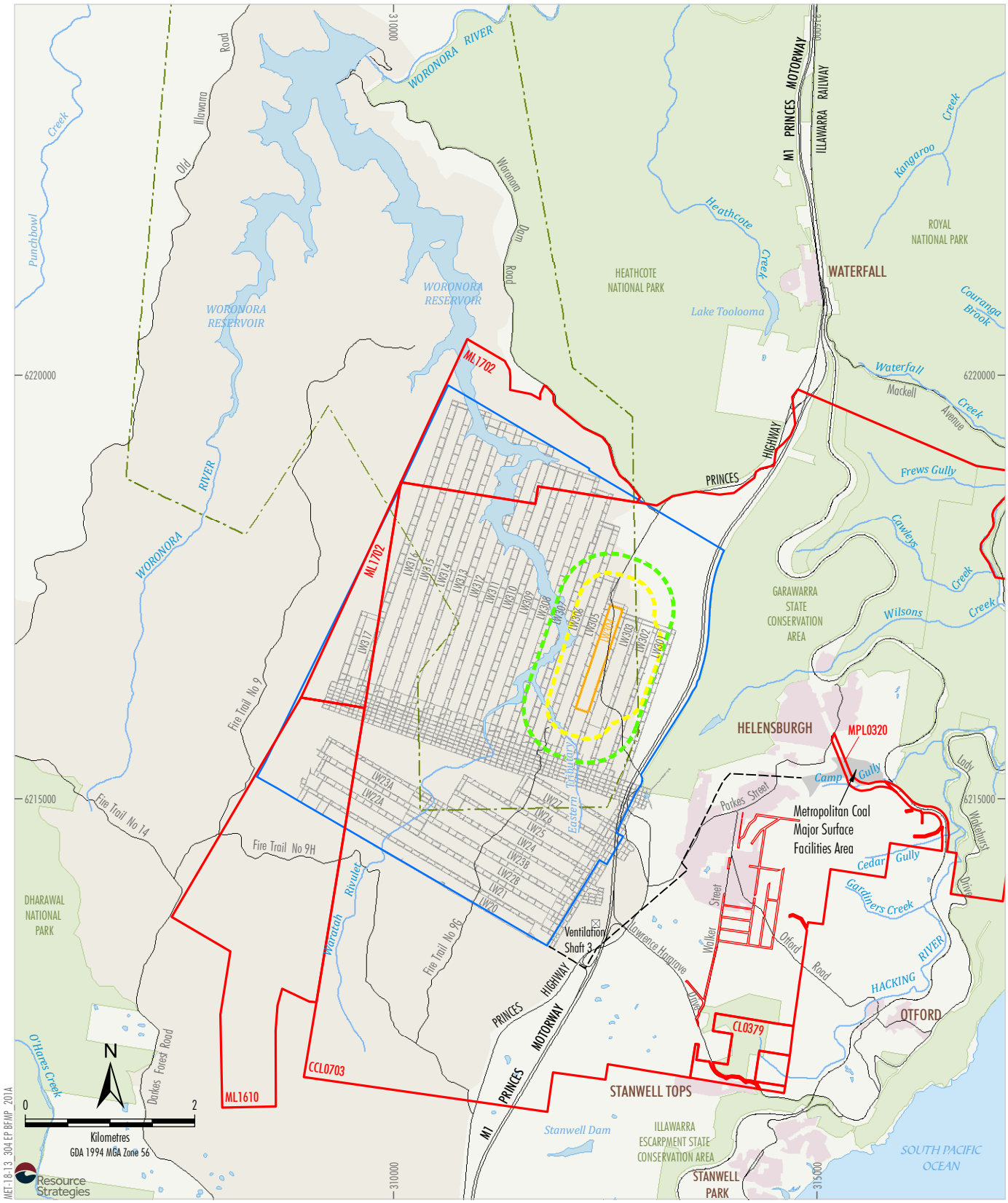
Section 5: Details the performance measures and indicators that will be used to assess the Project.

Section 6: Provides the detailed baseline data.

Section 7: Describes the monitoring program.

Section 8: Describes the management measures that will be implemented.

Section 9: Provides a contingency plan to manage any unpredicted impacts and their consequences.



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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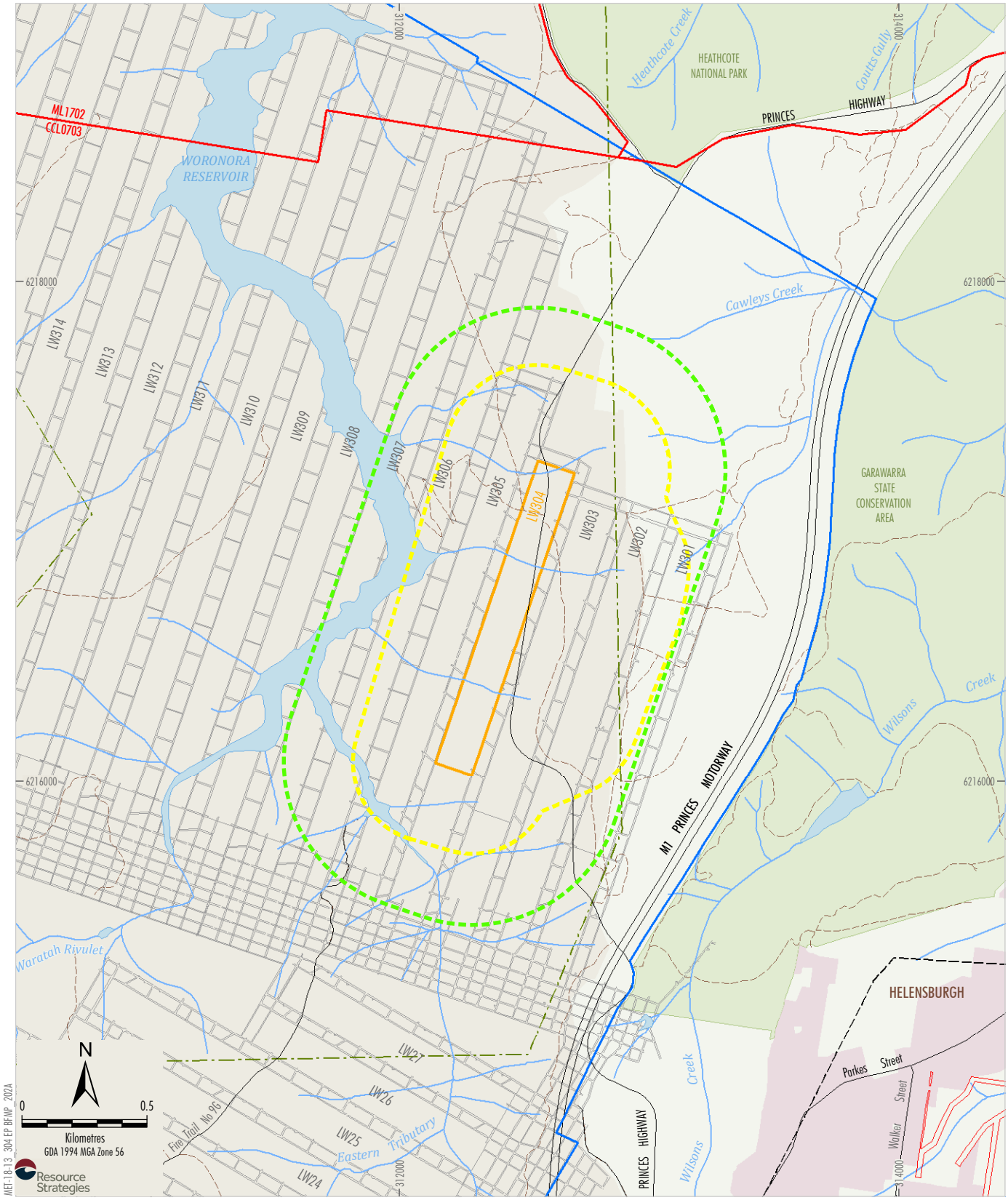
Longwalls 20-27 and Longwalls 301-317 Layout

Figure 1



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)
- Vehicular Track

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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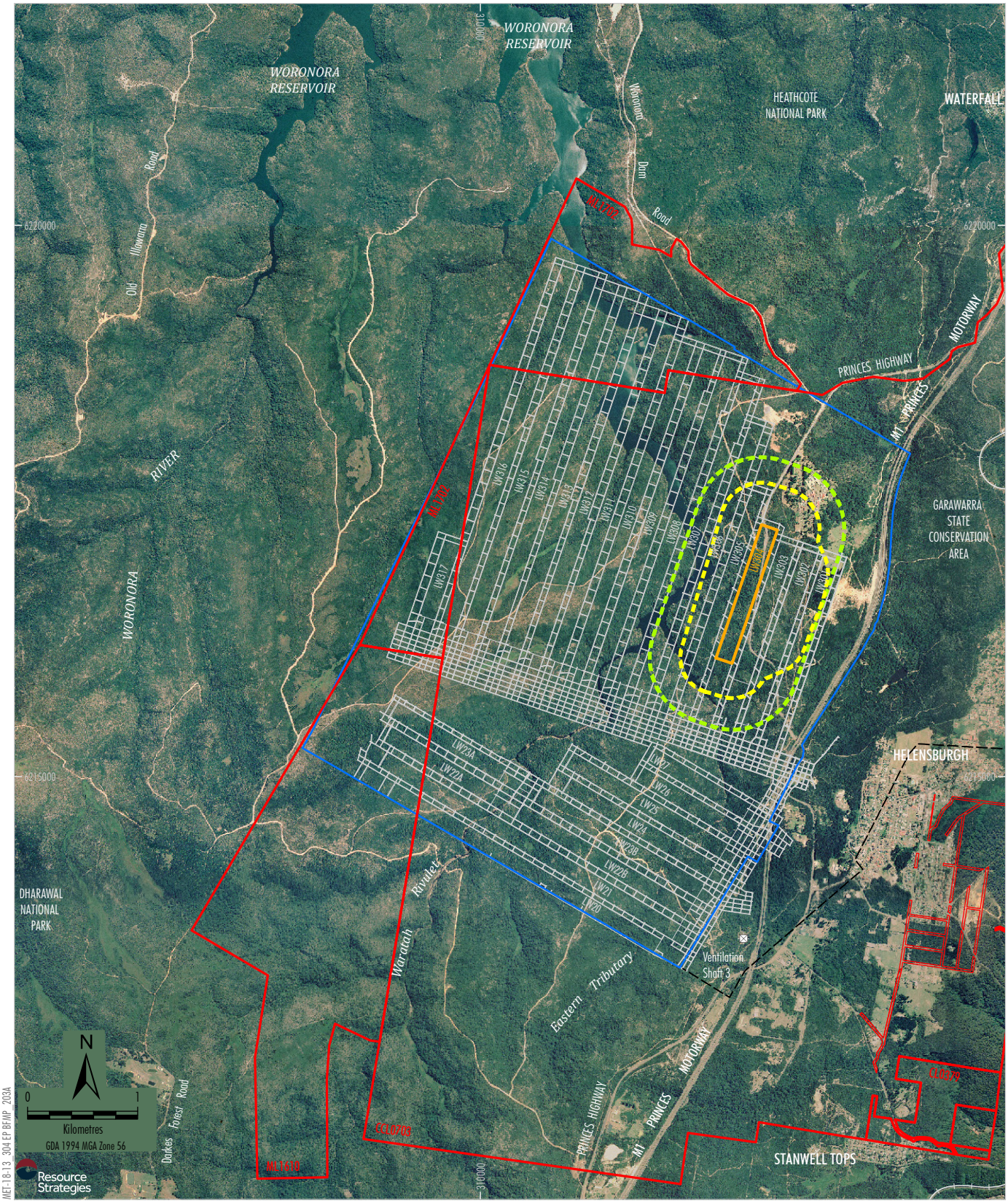
Longwalls 301-304 Layout

Figure 2



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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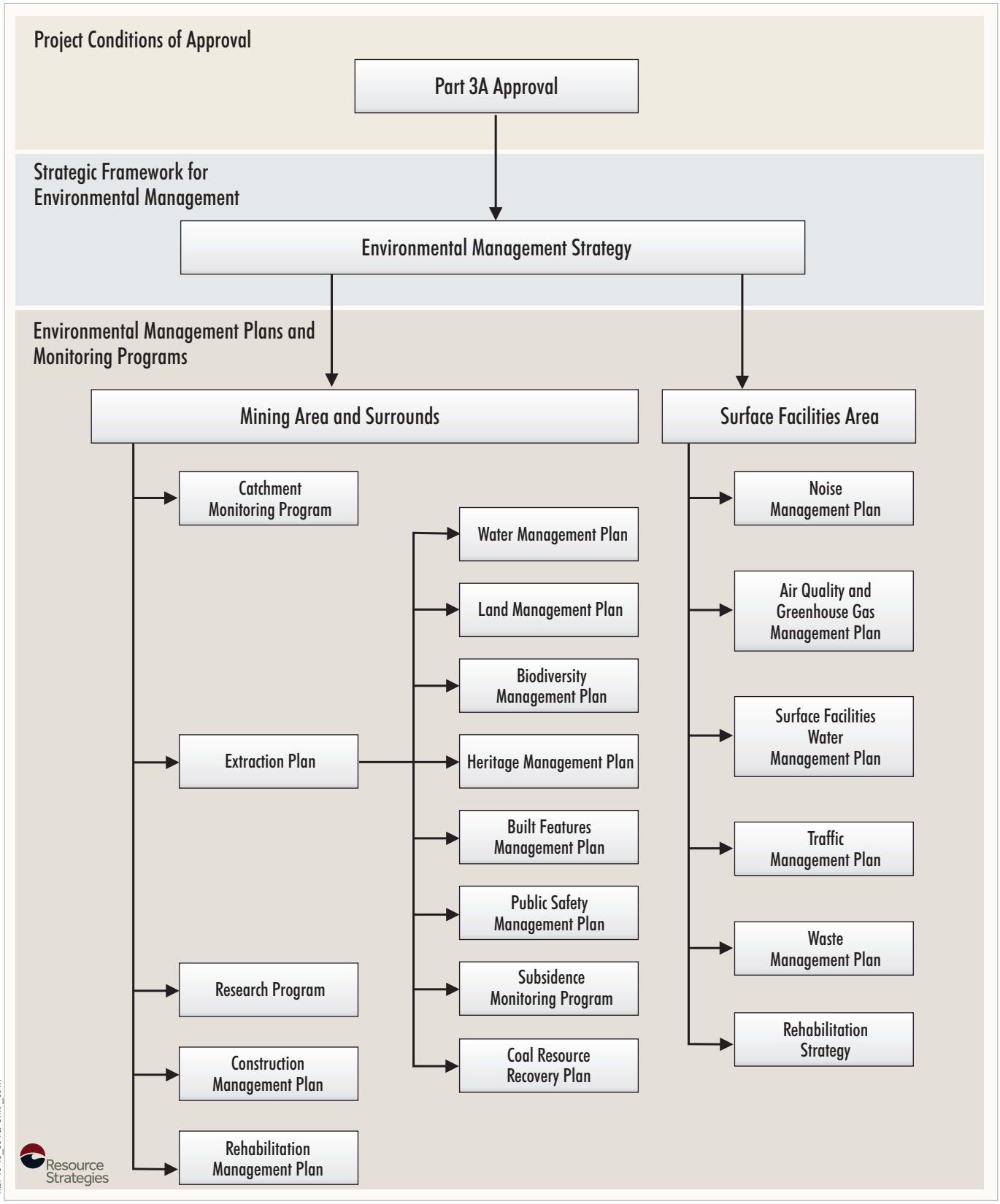
Longwalls 20-27 and Longwalls 301-317 Layout - Aerial Photograph

Figure 3



MET-18-13_304 EP BHMP_001A

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Environmental Management Structure

Figure 4

Section 10: Describes the Trigger Action Response Plan (TARP) management tool.

Section 11: Describes the program to collect sufficient baseline data for future Extraction Plans.

Section 12: Describes the annual review and improvement of environmental performance.

Section 13: Outlines the management and reporting of incidents.

Section 14: Outlines the management and reporting of complaints.

Section 15: Outlines the management and reporting of non-compliances with statutory requirements.

Section 16: Lists the references cited in this BFMP-END.

2 BFMP-END REVIEW AND UPDATE

In accordance with Condition 4, Schedule 7 of the Project Approval, this BFMP-END will be reviewed within three months of the submission of:

- an audit under Condition 8 of Schedule 7;
- an incident report under Condition 6 of Schedule 7;
- an annual review under Condition 3 of Schedule 7; and

if necessary, revised to the satisfaction of the Director-General (now Secretary) of the DP&E, to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

This BFMP will also be reviewed within three months of approval of any Project modification and if necessary, revised to the satisfaction of the DP&E.

The revision status of this document is indicated on the title page of each copy of the BFMP-END. The distribution register for controlled copies of the BFMP-END is described in Section 2.1.

Revisions to any documents listed within this BFMP-END will not necessarily constitute a revision of this document.

2.1 DISTRIBUTION REGISTER

In accordance with Condition 10, Schedule 7 ‘Access to Information’, Metropolitan Coal will make the BFMP-END publicly available on the Peabody website. A hard copy of the BFMP-END will also be maintained at the Metropolitan Coal site.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format. An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom the Metropolitan Coal plans and programs, such as the BFMP-END, will be distributed;
- the format (i.e. electronic or hard copy) of distribution; and
- the format of revision notification.

Metropolitan Coal has made the Distribution Register publicly available on the Peabody website.

Metropolitan Coal will be responsible for maintaining the Distribution Register and for ensuring that the notification of revisions is sent by email or post as appropriate.

In addition, Metropolitan Coal employees with local computer network access will be able to view the controlled electronic version of this BFMP-END on the Metropolitan Coal local area network. Metropolitan Coal will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on Metropolitan Coal's computer system and the Peabody website.

3 STATUTORY REQUIREMENTS

Metropolitan Coal's statutory obligations are contained in:

(i) the conditions of the Project Approval;

(ii) relevant licences and permits, including conditions attached to mining leases; and

(iii) other relevant legislation.

These are described below.

3.1 EP&A ACT APPROVAL

Condition 6(f), Schedule 3 of the Project Approval requires the preparation of a BFMP as a component of Extraction Plan(s) for second workings. Project Approval Condition 6(f), Schedule 3 states:

> ***SECOND WORKINGS***
>
> ***Extraction Plan***
>
> *6. The Proponent shall prepare and implement an Extraction Plan for all second workings in the mining area to the satisfaction of the Director-General. This plan must:*
>
> *…*
>
> *(f) include a:*
>
> *…*
>
> - *Built Features Management Plan, which has been prepared in consultation with the owner of the relevant feature, to manage the potential environmental consequences of the Extraction Plan on any built features;*
>
> *…*

In addition, Condition 2, Schedule 7 and Condition 7, Schedule 3 of the Project Approval outline management plan requirements that are applicable to the preparation of the BFMP-END. Table 1 indicates where each component of the conditions is addressed within this BFMP-END.

Table 1
Management Plan Requirements

Project Approval Condition	BFMP-END Section
Condition 2 of Schedule 7	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Section 6
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 3
• any relevant limits or performance measures/criteria;	Section 5
• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 5
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Sections 7, 8, 9 and 10
d) a program to monitor and report on the:	Sections 7, 8 and 12
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 9 and Appendix 4
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Sections 7 and 12
g) a protocol for managing and reporting any;	
• incidents;	Section 13
• complaints;	Section 14
• non-compliances with statutory requirements; and	Section 15
• exceedances of the impact assessment criteria and/or performance criteria; and	Section 9 and Appendix 4
h) a protocol for periodic review of the plan.	Section 2
Condition 7 of Schedule 3	
7. In addition to the standard requirements for management plans (see condition 2 of schedule 7), the Proponent shall ensure that the management plans required under condition 6(f) above include:	
a) a program to collect sufficient baseline data for future Extraction Plans;	Section 11
b) a revised assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval;	Section 4
c) a detailed description of the measures that would be implemented to remediate predicted impacts; and	Section 8
d) a contingency plan that expressly provides for adaptive management.	Section 9 and Appendix 4

3.2 LICENCES, PERMITS AND LEASES

In addition to the Project Approval, all activities at or in association with the Metropolitan Coal Mine will be undertaken in accordance with the following licences, permits and leases which have been issued or are pending issue:

- The conditions of mining leases issued by the NSW Division of Resources and Geoscience (DRG), under the NSW *Mining Act, 1992* (e.g. Consolidated Coal Lease [CCL] 703, Mining Lease [ML] 1610, ML 1702, Coal Lease [CL] 379 and Mining Purpose Lease [MPL] 320).

- The *Metropolitan Coal Mining Operations Plan* 1 October 2012 to 30 September 2019 approved by the DRG.
- The conditions of Environment Protection Licence (EPL) No. 767 issued by the NSW Environment Protection Authority (EPA) under the NSW *Protection of the Environment Operations Act, 1997*. Revision of the EPL will be required prior to the commencement of Metropolitan Coal activities that differ from those currently licensed.
- The prescribed conditions of specific surface access leases within CCL 703 for the installation of surface facilities as required.
- Water Access Licences (WALs) issued by the NSW Department of Primary Industries – Water (now the Department of Industry – Water) under the NSW *Water Management Act, 2000*, including WAL 36475 under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* and WAL 25410 under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*.
- Mining and workplace health and safety related approvals granted by the NSW Resources Regulator and WorkCover NSW.
- Supplementary approvals obtained from WaterNSW for surface activities within the Woronora Special Area (e.g. fire road maintenance activities).

3.3 OTHER LEGISLATION

Metropolitan Coal will conduct the Project consistent with the Project Approval and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to the conduct of the Project (Helensburgh Coal Pty Ltd [HCPL], 2008)[1]:

- *Biodiversity Conservation Act, 2016;*
- *Biosecurity Act, 2015;*
- *Contaminated Land Management Act, 1997;*
- *Crown Land Management Act, 2016;*
- *Dams Safety Act, 2015;*
- *Dangerous Goods (Road and Rail Transport) Act, 2008;*
- *Energy and Utilities Administration Act, 1987;*
- *Fisheries Management Act, 1994;*
- *Mining Act, 1992;*
- *Protection of the Environment Operations Act, 1997;*
- *Rail Safety (Adoption of National Law) Act, 2012;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Water NSW Act, 2014;*

[1] The list of potentially applicable Acts has been updated to reflect changes to the Acts that were in force at the time of submission of the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008).

- *Work Health and Safety Act, 2011; and*
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

Relevant licences or approvals required under these Acts will be obtained as required.

4 REVISED ASSESSMENT OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

4.1 EXTRACTION LAYOUT

Longwalls 301-304 and the area of land within 600 metres (m) of Longwall 304 secondary extraction are shown on Figures 2 and 3. Longwall extraction occurs from north to south. The longwall layouts include 163 m panel widths (void) with 45 m pillars (solid).

The provisional extraction schedule for Longwalls 301-304 is provided in Table 2.

Table 2
Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
301	June 2017	6 months	February 2018
302	March 2018	7 months	October 2018
303	November 2018	7 months	May 2019
304	July 2019	6 months	December 2019

The future Extraction Plans will consider the cumulative subsidence effects, subsidence impacts and/or environmental consequences. Note that the total cumulative predicted subsidence effects, subsidence impacts and/or environmental consequences at the completion of the Project are considered in the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008) and the Preferred Project Report (HCPL, 2009).

4.1.1 Endeavour Energy Assets

Figure 5 illustrates the Endeavour Energy 132 kilovolt (kV) transmission line and towers. The Bellambi Heathcote 132 kV double circuit transmission line consists of:

- Circuit OS/98E which is out of service and is used for emergency backup supply to the Bellambi 132/33 kV Transmission Substation; and
- Circuit 7028 which supplies Helensburgh Zone Substation.

The Bellambi Transmission Substations supplies all northern suburbs of Wollongong and the associated major commercial areas, industrial areas and mines including Metropolitan Coal. Circuit 7028 is one of three 33 kV lines which supply Helensburgh Zone Substation which directly supplies Metropolitan Coal.

The 132 kV transmission line and towers are located to the east of Longwalls 301-304 and the longwalls will not pass beneath these electrical services. There are seven towers located near the 35 degree angle of draw and/or predicted 20 mm subsidence contour for Longwall 304, as shown on Drawing No. MSEC1013-01 (Figure 5). The distances from the towers to the nearest longwall are summarised in Table 3 below.

Table 3
Transmission Towers Distance to Longwalls 301-304

Tower Number	Tower Type	Nearest Longwall	Approximate Distance to Longwall (m)
F9132B – T13	Suspension	Longwall 301	320
F9132B – T12	Suspension	Longwall 301	100
F9132B – T11	Suspension	Longwall 301	100
F9132B – T10	Suspension	Longwall 301	110
F9132B – T9	Suspension	Longwall 301	110
F9132B – T8	Suspension	Longwall 301	120
F9132B – T7	Suspension	Longwall 301	330

Figure 5 also illustrates the Endeavour Energy infrastructure which consists of aerial and buried high voltage powerlines which service the Garrawarra Centre Complex. The feeder aerial powerline that runs between Helensburgh and the Garrawarra Centre Complex is referred in this BFMP as Powerline 1 (Figure 5).

4.2 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

4.2.1 Revised Subsidence Predictions

Subsidence predictions for Longwalls 20-44 in relation to the Endeavour Energy assets was conducted by MSEC (2008) as part of the Metropolitan Coal Project EA. MSEC (2008) includes a table summarising the incremental systematic subsidence parameters for the extraction of each longwall from Longwalls 20-44.

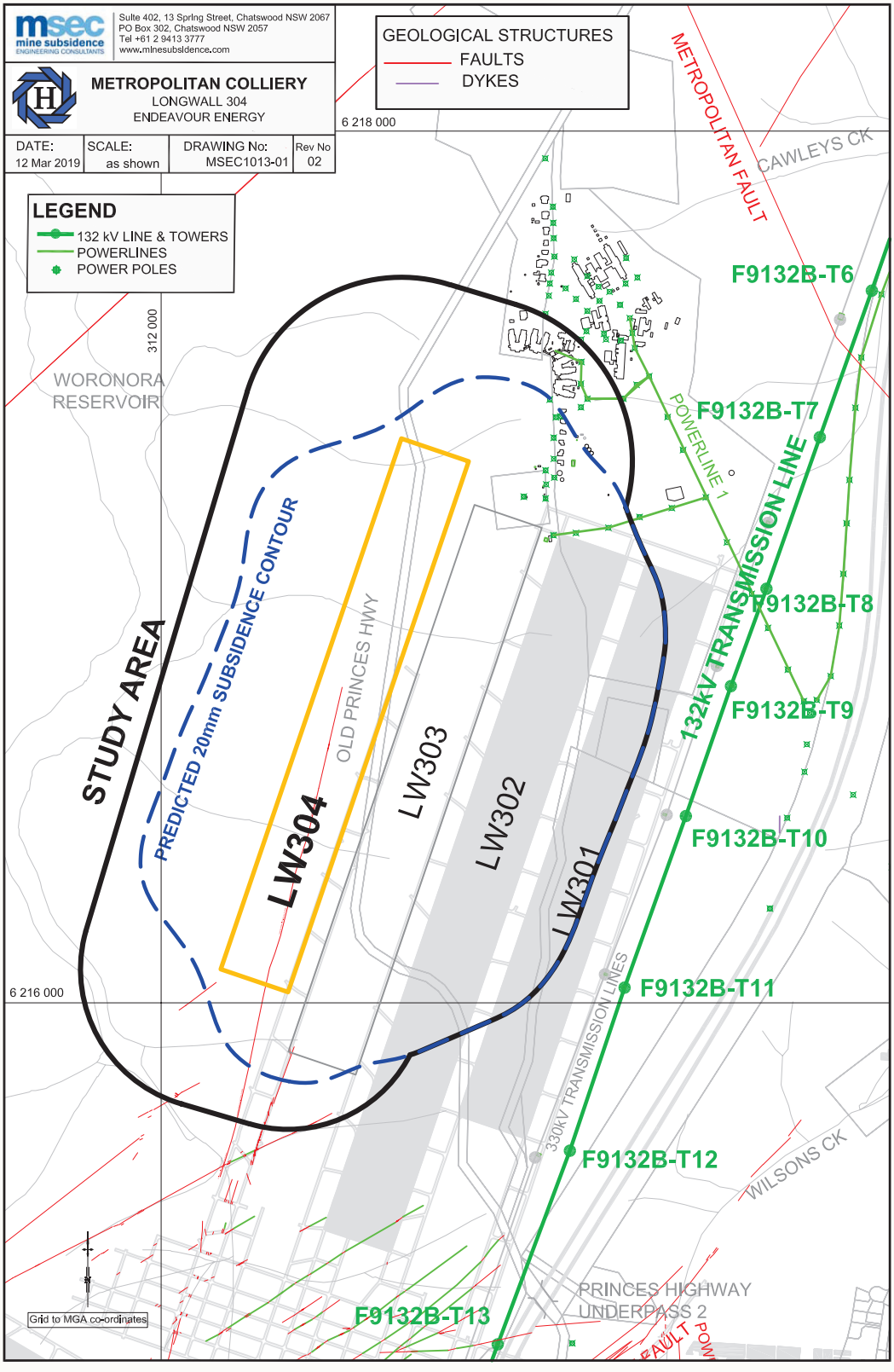
These include:

- maximum predicted incremental subsidence (vertical movement);
- maximum predicted incremental tilt along alignment;
- maximum predicted incremental tilt across alignment;
- maximum predicted incremental tensile strain; and
- maximum predicted incremental compressive strain.

Revised subsidence and impact predictions for the extraction of Longwalls 301-303 and Longwall 304 on Endeavour Energy assets were conducted by MSEC and reported in MSEC (2016) and MSEC (2019) (Appendices 1 and 2), respectively.

In relation to subsidence predictions for Longwalls 301-303, MSEC (2016) make the following conclusions:

- The 132 kV transmission towers are predicted to experience up to 90 mm subsidence resulting from the extraction of Longwalls 301 to 303.
- The maximum predicted conventional tilts at the 132 kV transmission towers are not measurable, at less than 0.5 mm/m or 1 in 2,000.
- The maximum predicted horizontal movement at the top of the towers (i.e. T11) is -30 mm orientated to the west (towards the longwalls).



MET-18-13_304 EP BHMP_005A

Source: MSEC (2019)

Peabody

METROPOLITAN COAL

Endeavour Energy Assets

Figure 5

- The 95% confidence levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.4 mm/m tensile and 0.4 mm/m compressive. The 99% confidence levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.7 mm/m tensile and 0.6 mm/m compressive.
- The feeder powerline (Powerline 1) is located outside the extents of Longwalls 301-303.
- The aerial conductors are supported by timber poles above the ground and therefore are not expected to experience adverse impacts due to curvature or strain.
- The buried cables located directly above the longwalls could experience the mining induced curvatures and strains.
- Extensive experience of mining beneath aerial and buried powerlines in the Southern Coalfield indicates that the potential mining impacts are rare and generally of a minor nature.

In relation to subsidence predictions for Longwall 304, MSEC (2019) make the following conclusions:

- The 132kV transmission line is located to the east of the proposed Longwall 304 and is located outside the Study Area at distances of 730 m or more from Longwall 304. At this distance, the transmission line is not expected to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwall 304. The transmission towers could experience low level far-field horizontal movement. It is considered unlikely that the transmission lines would experience adverse impacts as a result of predicted movements due to the extraction of Longwall 304.
- The feeder powerline (Powerline 1) is located to the east of the study area, not directly above Longwall 304 and is not expected to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwall 304.
- The aerial powerlines/power poles and buried cables within the Study Area that service the Garrawarra Centre Complex are located to the north-east of Longwall 304. The maximum predicted total subsidence is 300 mm. The maximum predicted conventional tilt is 3.0 mm/m (i.e. 0.3 %, or 1 in 330). The maximum predicted conventional curvatures are 0.03 km-1 hogging and < 0.01 sagging, which equate to minimum radii of curvature of 33 km and 100 km respectively. The aerial conductors are supported by timber poles above the ground and therefore are not expected to experience adverse impacts due to curvature or strain.
- It is expected that the 11kV powerlines can be maintained in safe and serviceable conditions with the development of the appropriate monitoring and management plans.

4.2.2 Risk Assessment Meeting

In accordance with the *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) a risk assessment meeting was held on 19 August 2016 for Longwalls 301-303. Attendees at the risk assessment meeting included representatives from Metropolitan Coal, Endeavour Energy, MSEC, Resource Strategies and Axys Consulting (risk assessment facilitator).

The investigation and analysis methods used during the risk assessment included:

- preliminary identification of Endeavour Energy assets;
- review of the revised subsidence predictions and potential impacts on Endeavour Energy assets (including consideration of past experience in the Southern Coalfield); and
- development of a preliminary monitoring plan.

A number of risk control measures and procedures were identified during the risk assessment which considered the extraction of coal beneath the land within the Study area and in proximity to the Endeavour Energy assets, and are summarised as follows:

Baseline Data / Validation

1. Carry out a visual audit of the Endeavour Energy assets (i.e. 132 kV transmission line and high voltage powerlines) within the Study area.
2. Obtain available information from Endeavour Energy regarding the make-up of the 132 kV structures and foundations.
3. Conduct a visual inspection of the access roads/tracks to the Endeavour Energy assets to document the existing condition and serviceability.
4. Carryout an investigation (dial before you dig) to identify the presence and ownership of the 11 kV cables that may be buried underground in the areas that may be affected by Longwalls 301 to 303.

Management / Monitoring / Response Measures

5. Establish a key contacts list between Peabody and Endeavour Energy to provide a regular update of status of mining activities, and for ongoing liaison.
6. Include in the BFMP a schedule of times/frequency of communication with Endeavour Energy for the status of mining of Longwalls 301-303.
7. Develop a Trigger Action Response Plan (TARP) and include triggers for conditions that may need to be actioned by Endeavour Energy.
8. Include in the BFMP relevant details regarding the potential for underground blast vibration impacts at the surface.

Metropolitan Coal considers all risk control measures and procedures to be feasible to manage all identified risks.

The proposed risk control measures and procedures have been incorporated where relevant in this BFMP and the program for implementation is summarised in Table 4.

4.3 UNDERGROUND BLAST VIBRATION IMPACTS

Use of explosives is not required for existing or proposed general underground coal mining. Occasionally, geological structures (e.g. dykes) may be encountered underground that have to be broken up using very low mass explosives. This underground blasting would be undertaken at significant depth (e.g. greater than 400 m below the surface).

Ground vibration and airblast levels which cause human discomfort are generally lower than the recommended structural damage limits. Therefore, compliance with the lowest applicable human comfort criteria ensures that the potential to cause structural damage is minimal. Based on the assessment results presented in the Metropolitan Coal Project Noise Impact Assessment (Heggies, 2008), ground vibration levels are predicted to meet the most stringent night-time criteria of 1 mm/s at a distance of 500 m from the blast site. As blasting is conducted at least 400 m below the surface, vibration impacts are likely to be minimal (which is consistent with the existing Metropolitan Colliery blasting practices and experience).

Table 4
Program for Implementation of Proposed Risk Control Measures and Procedures

	Risk Control Measure / Procedure	BFMP Section	Timing
Baseline Data / Validation			
1	Carry out a visual audit of the Endeavour Energy assets (i.e. 132kV transmission line and high voltage powerlines) in the Study area	Section 6	Complete
2	Obtain available information from Endeavour Energy regarding the make-up of the 132 kV structures and foundations	Section 6	Complete
3	Conduct a visual inspection of the access roads/tracks to the Endeavour Energy assets	Section 7.2.3	Complete
4	Carryout an investigation (dial before you dig) to identify the presence and ownership of the 11 kV cables that may be buried underground in the areas that may be affected by Longwalls 301 to 303	Appendix 1 / BFMP-Garrawarra	Complete
Management / Monitoring / Response Measures			
5	Establish key contacts list in the BFMP	Section 6.1	Complete
6	Include a schedule of times/frequency of communication with Endeavour Energy for the status of mining of Longwalls 301-303 in the BFMP	Sections 7 and 10 / Table 2	Complete
7	Include in the TARP triggers for conditions that may need to be actioned by Endeavour Energy	Section 10 / Table 8	Complete
8	Include in the BFMP relevant details regarding the potential for underground blast vibration impacts at the surface	Section 4.3	Complete

The risk control measures and procedures identified during the risk assessment for Longwalls 301-303 will be implemented for the extraction of Longwall 304.

5 PERFORMANCE MEASURES AND INDICATORS

The Project Approval requires Metropolitan Coal not to exceed the subsidence impact performance measures outlined in Table 1 of Condition 1, Schedule 3. The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

> *Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.*

The performance indicators proposed to ensure that the above performance measure is achieved include:

- the structural integrity of the 132 kV transmission lines and towers is maintained;
- the structural integrity of the timber poles and high voltage powerlines is maintained;
- the electrical clearance from vegetation is maintained; and
- the serviceability of the access roads/tracks is maintained.

Section 7 of this BFMP-END describes the monitoring that will be conducted to assess the Project against the above performance measure. Section 9 of this BFMP-END provides a Contingency Plan in the event the performance measure is exceeded.

6 BASELINE DATA

A photograph of a 132 kV transmission tower is shown in Plate 1.

Plate 1 – 132 kV Transmission Tower (Source: MSEC, 2016)

The powerlines which service the Garrawarra Centre Complex comprise copper conductors supported by timber poles (Plates 2 and 3).

Plates 2 and 3 – Aerial Powerlines (Source: MSEC, 2016)

A visual audit / site inspection of the 132 kV transmission line and towers within the Study area was conducted prior to commencement of secondary extraction of Longwall 301 to establish the condition of the structures. The inspection included:

- recording of existing structure conditions;
- two dimensional image records of the potentially affected structures; and
- condition of the access roads/tracks with specific attention to surface cracks.

A site inspection of the timber poles and powerlines within the Study area also occurred to record the existing structure conditions and access roads/tracks prior to commencement of secondary extraction of Longwall 301.

The audits / site inspections were conducted by representative(s) from Endeavour Energy and Metropolitan Coal.

6.1 KEY CONTACTS LIST

The list of key contacts for Peabody and Endeavour Energy during the development and implementation of this BFMP are provided in Table 5.

Table 5
List of Key Contacts

Company	Position	Name
Peabody (Metropolitan Coal)	Manager – Technical Services Jon Degotardi	Metropolitan Coal Control Room 24hr 02 4294 7333
Endeavour Energy	Operations Manager Substations – Southern Region Steve Dent Operations Manager Mains – Southern Region Brian Gray	Endeavour Energy 24hr Contact 131 003 General enquiry 133 718
Endeavour Energy	Transmission Asset Engineer – Southern Region Sally Bell	

7 MONITORING

A monitoring program will be implemented to monitor the impacts of the Project on the 132 kV transmission line and towers, high voltage powerlines and access roads/tracks as determined in consultation with Endeavour Energy. Table 6 summarises the BFMP-END monitoring components.

Table 6
BFMP-END Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Baseline	132 kV Towers (T8 to T12)	Survey	Adjacent subsidence line points at approximately 20 m spacing	Establish base conditions	Prior to LW301 extraction	Complete
			4 x ground points outside each leg for each tower	Establish base conditions	Prior to LW301 extraction	Complete
			4 x tower leg mounted prisms for each tower	Establish base condition	Prior to LW301 extraction	Complete
			Top of tower at fixed point	Establish base condition	Prior to LW301 extraction	Complete
		Condition Report (recording of existing structure conditions and two-dimensional image records of structures)		Establish base condition	Prior to LW301 extraction	Complete
	132 kV Transmission Line (between T8 to T12)	Survey	± 10 points either side of each tower	Establish base conditions (including clearance heights for roads, land and vegetation)	Prior to LW301 and LW304 extraction	Twice
	Timber Poles (11 kV)	Condition Report (recording of existing structure conditions and two dimensional image records of structures)		Establish base condition	Prior to LW301 and LW304 extraction	Twice
	High voltage powerlines (11 kV)	Visual inspection (including notes on clearance heights of powerlines)		Establish base condition	Prior to LW301 and LW304 extraction	Twice
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Establish base condition	Prior to LW301 and LW304 extraction	Twice
During Mining	132 kV Towers (T8 to T12)	Survey	Adjacent subsidence line points at approximately 20 m spacing	Monitor subsidence effects during mining (subsidence, tilt, strain)	At the completion of each longwall	Once per Longwall 301, 302, 303 and 304
			4 x ground points outside each leg for each tower	Monitor subsidence effects during mining (subsidence, tilt, strain, absolute horizontal translation)	At each tower within 400 m of the active longwall face until subsidence negligible	LW301-302 Weekly LW303-304 monthly during extraction
			4 x tower leg mounted prisms for each tower	Monitor subsidence effects during mining (differential leg movement)	At each tower within 400 m of the active longwall face until subsidence negligible	LW301-302 Weekly LW303-304 monthly during extraction

Table 6 (Continued)
BFMP-END Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
During Mining (Cont.)	132 kV Towers (T8 to T12) (Cont.)	Survey (Cont.)	Top of tower at fixed point	Monitor subsidence effects during mining (tilt, absolute horizontal translation)	At each tower within 400 m of the active longwall face until subsidence negligible	LW301-302 Weekly LW303-304 monthly during extraction
		Visual inspection	Field notes and observations recorded by surveyors	Monitor for evidence of subsidence effects on Towers including any observable surface deformations (e.g. degradation of foundations/footings) or other subsidence related effects (noted quantitatively in regards width, length, orientation)	At each tower within 400 m of the active longwall face until subsidence negligible	LW301-302 Weekly LW303-304 monthly during extraction
		Visual inspection (Endeavour Energy)	Inspection of structural integrity from the ground		As determined by Endeavour Energy	Annual (where coinciding)
			Fault and emergency patrols from either the air or ground		At any time in case of fault or emergency	
	132 kV Transmission Lines (between T8 to T12)	Survey	± 10 points either side of each tower	Monitor subsidence effects during mining (subsidence, tilt, absolute horizontal translation)	At each tower within 400 m of the active longwall face until subsidence negligible	Weekly within 400m zone
		Visual inspection	Field notes and observations recorded by surveyors	Monitor for evidence of subsidence effects on Transmission Lines including changes in clearance heights for roads, land and vegetation, or movement of insulator strings	At each tower within 400 m of the active longwall face until subsidence negligible	Weekly within 400m zone
		Visual inspection (Endeavour Energy)	Inspection of vegetation growth and electrical clearances from the air		As determined by Endeavour Energy	Annual (where coinciding)
			Fault and emergency patrols from either the air or ground		At any time in case of fault or emergency	

Table 6 (Continued)
BFMP-END Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
During Mining (Cont.)	Timber Poles (11 kV)	Visual inspection	Field notes and observations recorded by surveyors	Monitor for evidence of subsidence effects on Poles including any observable surface deformations (e.g. degradation of structure) or other subsidence related effects (e.g. movement of conductors)	Within 3 months of completion of extraction of each longwall	Once per Longwall
		Visual inspection (Endeavour Energy)	Inspection of structural integrity from the ground		As determined by Endeavour Energy	Four yearly (where coinciding)
			Fault and emergency patrols from either the air or ground		At any time in case of fault or emergency	
	High voltage powerlines	Visual inspection	Field notes and observations recorded by surveyors	Monitor for evidence of subsidence effects on powerlines including changes in clearance heights for roads, land and vegetation, or movement of insulator strings	Within 3 months of completion of extraction of each longwall	Once per Longwall
		Visual inspection (Endeavour Energy)	Inspection of vegetation growth and electrical clearances from the air		As determined by Endeavour Energy	Annual (where coinciding)
			Fault and emergency patrols from either the air or ground		At any time in case of fault or emergency	
	Access roads/tracks	Visual inspection	Field notes on general condition of access roads/tracks by surveyors	Monitor for surface cracks, buckling and general safety	At the completion of each longwall	Once per Longwall
					At each tower within 400 m of the active longwall face until subsidence negligible	LW301-302 Weekly LW303-304 monthly during extraction
					As per Longwall 304 LMP	
Post Mining	132 kV Towers (T8 to T12)	Survey	Adjacent subsidence line points at approximately 20 m spacing	Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 303 and 304	Twice
			4 x ground points outside each leg for each tower	Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 303 and 304	Twice
			4 x tower leg mounted prisms for each tower	Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 303 and 304	Twice

Table 6 (Continued)
BFMP-END Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Post Mining (Cont.)	132 kV Towers (T8 to T12) (Cont.)	Survey (Cont.)	Top of tower at fixed point	Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 303 and 304	Twice
		Condition Report (recording of structure conditions and two dimensional image records of structures)		Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 303 and 304	Twice
		Visual inspection (Endeavour Energy)	Ground inspection	Validation	Next scheduled post mining	Twice
			Climbing inspection	Validation	Next scheduled post mining	Twice
	132 kV Transmission Lines (between T8 to T12)	Survey	± 10 points either side of each tower	Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 303 and 304	Twice
		Visual inspection (Endeavour Energy)	Air inspection	Validation	Next scheduled post mining	Twice
			Climbing inspection	Validation	Next scheduled post mining	Twice
	Timber Poles (11 kV)	Condition Report (recording of structure conditions and two dimensional image records of structures)		Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 303 and 304	Twice
	High voltage powerlines	Visual inspection	Field notes and observations recorded by surveyors	Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 303 and 304	Twice
	Access roads/tracks	Visual inspection	Field notes on general condition of access roads/tracks by surveyors	Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 303 and 304	Twice
		Visual inspection (Endeavour Energy)	Ground inspection	Validation	Next scheduled post mining	Twice

Where relevant, inspections of subsidence impacts will include photographic record of the impacts for comparison with baseline photographic records.

Endeavour Energy or their delegates will conduct the various visual inspections. Metropolitan Coal will be notified of the timing of inspections and accompany Endeavour Energy or delegates if considered necessary. All personnel will complete necessary inductions or orientation relevant to the tasks required.

The frequency of monitoring will be reviewed either:

- in accordance with the Annual Review outlined in Section 12; or
- if triggered as a component of the Contingency Plan as outlined in Section 9 of this BFMP-END.

7.1 SUBSIDENCE PARAMETERS

Subsidence parameters (i.e. subsidence, tilt, tensile strain, compressive strain, absolute horizontal translation, and differential leg movement) associated with mining will be measured in accordance with the Longwall 304 Subsidence Monitoring Program (Figure 6).

In summary, surveys will be conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence movements (i.e. subsidence, tilt, tensile strain and compressive strain) will be measured along subsidence lines that have been positioned across the general landscape.

Monitoring of subsidence parameters specific to the Endeavour Energy 132 kV transmission line and towers will be measured by a single survey line along the transmission corridor occupied by the 132 kV transmission line, and by survey of Towers T8 to T12.

The survey line within the transmission line corridor consists of survey pegs or pins installed every 20 m (subject to terrain constraints) and measured by total station with a survey accuracy of ±5 mm.

7.2 SUBSIDENCE IMPACTS

7.2.1 132 kV Transmission Line and Towers

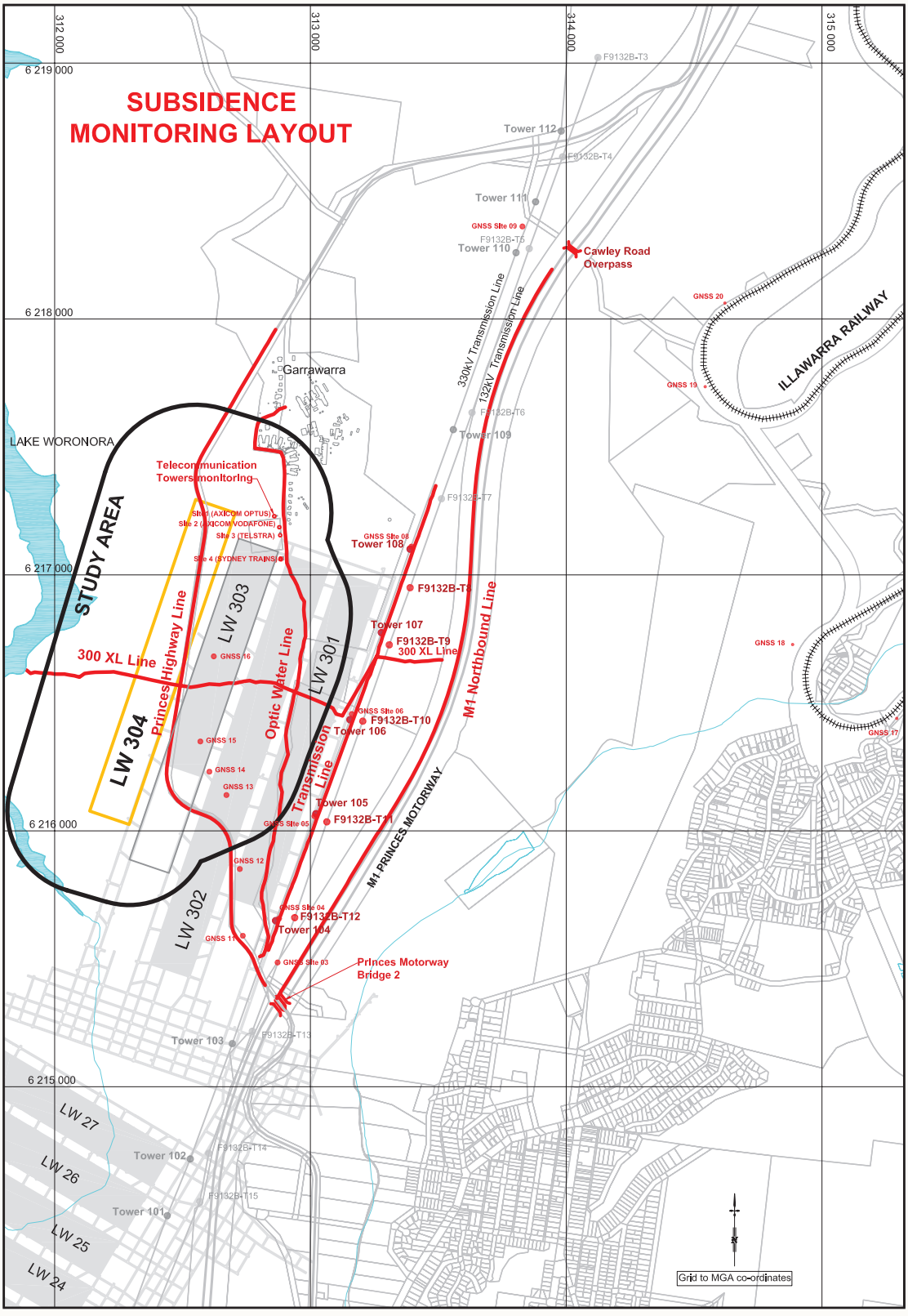
Visual inspections will be conducted of the 132 kV transmission line and towers between Tower T7 and T13 inclusive in accordance with the Endeavour Energy inspection program. This generally includes:

- annual inspection of the structural integrity of sites from the ground;
- annual inspection of vegetation growth and electrical clearances from the air;
- six yearly climbing inspections; and
- fault and emergency patrols from either the air or ground at any time.

A visual inspection was conducted prior to commencement of Longwall 301. More frequent (e.g. monthly) inspections will be conducted by Metropolitan Coal during the mining of Longwall 304. Additional observations of subsidence impacts will be conducted during routine works and recorded by surveyors during tower monitoring survey.

Specific details that will be noted and/or photographed include:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- assessment against the performance indicators and performance measure;
- whether any actions are required (e.g. initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.



MET-18-13_304 EP BFMP_017A

Source: MSEC (2019)

Peabody

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Subsidence Monitoring Layout

Figure 6

The information will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 3) and reported in accordance with the Project Approval conditions.

7.2.2 Timber Poles and High Voltage Powerlines (Aerial and Buried)

A visual inspection of the timber poles[2] and powerlines was conducted prior to commencement of Longwall 301. Additional observations of subsidence impacts will be conducted during routine works and sampling by Metropolitan Coal and its contractors.

Specific details that will be noted and/or photographed include:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- assessment against the performance indicators and performance measure;
- whether any actions are required (e.g. initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The information will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 3) and reported in accordance with the Project Approval conditions.

7.2.3 Access Roads/Tracks

Visual inspection of the access roads/tracks to the Endeavour Energy assets was conducted prior to the commencement of Longwall 301, and will be conducted following extraction of each longwall panel.

Visual observations of access roads/tracks would occur as part of routine works and inspections within 600 m of Longwalls 301-304 secondary extraction as described in the Metropolitan Coal Longwall 304 Land Management Plan (Longwall 304 LMP).

Specific details that will be noted and/or photographed that are relevant to the Endeavour Energy access roads/tracks include:

- the location, approximate dimensions (length, width and depth), and orientation of surface tension cracks;
- the location of the surface tension crack in relation to the access road/track to the Endeavour Energy asset;
- whether any actions are required (e.g. implementation of management measures as outlined in the Longwall 304 LMP, initiation of the Contingency Plan as outlined in the Longwall 304 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The date of the observation, details of the observer and the location of longwall extraction will also be documented.

[2] For example, where a timber pole lean of greater than 15 degrees from vertical is identified.

The information obtained will be recorded in the Longwall 304 LMP - Subsidence Impact Register and reported in accordance with the Project Approval conditions.

The information obtained will be used to assess the potential environmental consequences of the subsidence impact (described in the Longwall 304 LMP) and to identify required management measures. Management measures are discussed in the Longwall 304 LMP.

In the event the subsidence impacts are deemed to present a safety hazard (i.e. regardless of the nature or extent of the subsidence impact), actions will be implemented in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan.

7.3 ENVIRONMENTAL CONSEQUENCES

Metropolitan Coal and Endeavour Energy will compare the results of the subsidence impact monitoring against the built features performance measure and indicators. In the event the observed subsidence impacts exceed the performance measure or indicators, Metropolitan Coal and Endeavour Energy will assess the consequences of the exceedance in accordance with the Contingency Plan described in Section 9.

8 MANAGEMENT MEASURES

A number of potential management measures in relation to 132 kV towers and transmission lines, and other high voltage powerlines and poles are considered to be applicable. These include:

- alteration of conductor tensions;
- modification to attachment points such as placement of stringing sheaves to earth wires and/or phase conductors;
- strengthening of tower structures through installation of cruciform footings; and
- strengthening of timber poles footings.

The requirement for these management measures will be determined by Endeavour Energy and if required, constructed prior to mining within 600 m of the structure.

Where significant subsidence impacts on access roads/tracks are detected (e.g. those that affect the serviceability) or at any time Metropolitan Coal, Endeavour Energy or the landholder considers that the integrity of the access roads/tracks may be compromised, the following management measures will be implemented. Where significant cracks are detected, the cracks would be repaired as soon as practicable in consultation with the landholder. This may include the use of earthmoving equipment if considered the most appropriate means of repair. Appropriate sedimentation controls will be implemented during repair works. Management measures for access roads/tracks will be implemented in accordance with the Longwall 304 Land Management Plan.

Metropolitan Coal will assess the potential impacts to public safety and where appropriate, implement measures in accordance with the Longwall 304 Public Safety Management Plan.

Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.

Management measures will be reported in the Annual Review (Section 12).

9 CONTINGENCY PLAN

In the event the subsidence impacts observed exceed the performance measure or indicators detailed in Section 5 of this BFMP-END, Metropolitan Coal will implement the following Contingency Plan (Appendix 4):

- The observation will be reported to the Metropolitan Coal Manager - Technical Services within 24 hours.
- With the exception of access roads/tracks, the observation will be recorded in the Built Features Management Plan – Subsidence Impact Register (Appendix 3) consistent with the monitoring program described in Section 7 of this BFMP-END.
- If relating to an access road/track, the observation will be recorded in the Metropolitan Coal Longwall 304 Land Management Plan – Subsidence Impact Register.
- Metropolitan Coal will report any exceedance of the performance measure or indicators to the DP&E and Endeavour Energy as soon as practicable after Metropolitan Coal becomes aware of the exceedance.
- Metropolitan Coal will assess public safety and where appropriate implement safety measures in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan;
- Metropolitan Coal will conduct an investigation to evaluate the potential contributing factors. The investigation will:
  - include the re-survey of relevant subsidence monitoring lines;
  - compare and critically analyse measured versus predicted subsidence parameters;
  - review measured subsidence parameters against the observed impact; and
  - review the subsidence monitoring program and update the program where appropriate.
- The course of action with respect to the identified impact(s), in consultation with specialists and relevant agencies, will include:
  - a program to review the effectiveness of the contingency measures; and
  - consideration of adaptive management.

  Contingency measures are provided in Section 9.1.
- Metropolitan Coal will submit the proposed course of action to the DP&E for approval.
- Metropolitan Coal will implement the approved course of action to the satisfaction of the DP&E.

In accordance with Condition 6, Schedule 6 of the Project Approval, Metropolitan Coal will provide a suitable offset to compensate for the impact to the satisfaction of the Director-General (now Secretary) of DP&E if either the contingency measures implemented by Metropolitan Coal have failed to remediate the impact or the Director-General (now Secretary) determines that it is not reasonable or feasible to remediate the impact.

Metropolitan Coal will comply with the NSW *Coal Mine Subsidence Compensation Act, 2017* in the event that property damages occur as a result of mining Longwalls 301-304.

9.1 CONTINGENCY MEASURES

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of environmental consequences).

Contingency measures that could be considered in the event the performance measure for the 132 kV towers and transmission lines or the timber poles and high voltage powerlines is exceeded are summarised in Table 7. The decision tree for the contingency measures for the 132 kV towers and transmission lines are shown in Appendix 4.

Table 7
Contingency Measures

Environmental Consequence	Contingency Measures	
	Measure	**Description**
Impact on:		
Towers	Stabilisation techniques	Installation of tower supports such as cruciform elements.
	Rebuilding	Construction of new tower(s) or emergency structures.
Transmission Wires	Stabilisation techniques	Sheaving of conductors and/or earth wires.
	Rebuilding	Construction of new transmission lines.
Timber Poles	Stabilisation techniques	Installation of supports.
	Rebuilding	Construction of new pole(s) or emergency structures.
Powerline Wires	Stabilisation techniques	Sheaving of conductors and/or earth wires.
	Rebuilding	Construction of new powerlines.

10 TARP – MANAGEMENT TOOL

The framework for the various components of this BFMP-END are summarised in the BFMP-END TARP shown in Table 8. The BFMP-END TARP illustrates how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

The TARP comprises:

- baseline conditions;
- predicted subsidence impacts;
- trigger levels from monitoring to assess performance; and
- triggers that flag implementation of contingency measures.

The TARP system provides a simple and transparent snapshot of the monitoring of environmental performance and the implementation of management and/or contingency measures.

Table 8
BFMP-END Trigger Action Response Plan

ENDEAVOUR ENERGY – 132 kV Towers (T8 to T12)		
ENDEAVOUR ENERGY 132 kV Towers (T8 to T12)	*Risk: Subsidence effect on towers resulting in impact to structural integrity and reduced transmission line clearance.*	
	TRIGGER LEVEL	**RESPONSE**
	Level 1 - Normal **Expected subsidence conditions**	
	For LW 301-302 Subsidence • less than 80 mm Absolute Horizontal Movements • less than 140 mm at the base Tensile strain • less than 0.7 mm/m Compressive strain • less than 0.6 mm/m Differential tower leg movements • less than 4.0 mm For LW 303-304 • less than 125 mm Absolute Horizontal Movements • less than 140 mm at the base Tensile strain • less than 0.8 mm/m Compressive strain • less than 0.7 mm/m Differential tower leg movements • less than 4.0 mm	**<u>Normal Operations</u>** • Towers are safe and serviceable. • Negligible impact to towers. • Continue monitoring activities as planned.

Table 8 (Continued)
BFMP-END Trigger Action Response Plan

ENDEAVOUR ENERGY – 132 kV Towers (T8 to T12)		
ENDEAVOUR ENERGY 132 kV Towers (T8 to T12)	*Risk: Subsidence effect on towers resulting in impact to structural integrity and reduced transmission line clearance.*	
	TRIGGER LEVEL	**RESPONSE**
	Level 2 - Monitor **Subsidence elevated up to 20% of predicted but tower leg service condition normal**	
	Subsidence For LW 301-302 • between 80 and 100 mm Absolute Horizontal Movements • between 140 and 160 mm at the base Strain • between 0.7 and 1.0 mm/m Differential tower leg movements less than 4.0 mm For LW 303-304 • between 125 and 140 mm Absolute Horizontal Movements • between 140 and 160 mm at the base Strain • between 0.8 and 1.0 mm/m Differential tower leg movements • less than 4.0 mm	**Continue operations but report on subsidence anomaly** • Towers are safe and serviceable. • Negligible impact to towers. **Metropolitan Coal** • Resurvey subsidence line, ground points, tower leg mounted prisms and tower peak points in affected area to confirm results. • Engage subsidence expert to assess results. • Confirm results are consistent with other subsidence lines. • Compare and critically analyse measured versus predicted subsidence. • Inform and provide report to Endeavour Energy and NSW Principal Subsidence Engineer of subsidence results (notify within 24 hours of trigger). • Collaboratively share information with Endeavour Energy to monitor situation. **Endeavour Energy** • Assess information provided by Metropolitan Coal.

Table 8 (Continued)
BFMP-END Trigger Action Response Plan

ENDEAVOUR ENERGY – 132 kV Towers (T8 to T12)		
ENDEAVOUR ENERGY 132 kV Towers (T8 to T12)	*Risk: Subsidence effect on towers resulting in impact to structural integrity and reduced transmission line clearance.*	
	TRIGGER LEVEL	**RESPONSE**
	Level 3 - Cautionary **Anomalous differential leg movement , subsidence beyond 20% of predicted or surface cracking prohibiting vehicular movements**	
	Subsidence For LW 301-302 • greater than 100 mm Absolute Horizontal Movements • greater than 160 mm at the base Strain • greater than 1.0 mm/m Observable subsidence ground deformations at a tower Observable surface cracking on access road/tracks prohibiting vehicular movements Differential tower leg movements between 4.0 and 8.0 mm For LW 303-304 • greater than 140 mm Absolute Horizontal Movements • greater than 160 mm at the base Strain • greater than 1.0 mm/m Observable subsidence ground deformations at a tower Observable surface cracking on access road/tracks prohibiting vehicular movements Differential tower leg movements • between 4.0 and 8.0 mm	**Investigate & Resolve** • Towers are safe and serviceable. • Indication of impact to towers or reduced transmission line clearance. • Indication of surface cracking on access road/tracks prohibiting vehicular movements. **Metropolitan Coal** • Steps as per Level 2 event, plus: o Inform Endeavour Energy and NSW Principal Subsidence Engineer of subsidence results (immediately following awareness of trigger). o Increase frequency of monitoring and subsidence line surveys to weekly in affected area (if not already). o Report monitoring data to NSW Principal Subsidence Engineer within 48hrs following collection of data. o In conjunction with Endeavour Energy identify impact location and have Endeavour Energy assess condition of structure. o Review the subsidence monitoring program and update the program where appropriate. o Provide report on issue to both Endeavour Energy and DP&E. • For surface cracking on access road/tracks prohibiting vehicular movements: o Install track signage to alert patrol staff of any access restrictions or risks to vehicular movements. o Notify Endeavour Energy of any access limitations or restrictions with 24 hours and repair track within 72 hours to re-establish access. **Endeavour Energy** • In conjunction with Metropolitan Coal identify impact location, inspect tower, assess condition and determine appropriate response. (e.g. greater monitoring data or frequency, or schedule maintenance on the structure). • Make determination if other measures necessary to avoid further impact (e.g. deployment of emergency structures).

Table 8 (Continued)
BFMP-END Trigger Action Response Plan

ENDEAVOUR ENERGY – 132 kV Towers (T8 to T12)		
ENDEAVOUR ENERGY 132 kV Towers (T8 to T12)	*Risk: Subsidence effect on towers resulting in impact to structural integrity and reduced transmission line clearance.*	
	TRIGGER LEVEL	**RESPONSE**
	Level 4 – Restoration **Exceedance of nominated differential leg movement or fault occurs**	
	Fault Occurs Differential leg movement • Greater than 8.0 mm	**Implement Contingency Plan** • As per BFMP Section 9 and Appendix 4. **Metropolitan Coal** • As per Level 3 event, plus: o General Manager to be involved in all decision-making processes. o Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwall 304 Public Safety Management Plan. o Report exceedance of the performance measure or indicators to the DP&E and Endeavour Energy as soon as practicable. o Update the 'Built Features Management Plan – Subsidence Impact Register'. o Investigate circumstances of the fault and determine requirement for adaptive management of mining operations prior to future operations in vicinity of the towers and transmission lines. **Endeavour Energy** • As per Level 3 event, plus: o For fault – Endeavour Energy to enact fault / emergency response measures. o For greater than 8.0 mm differential leg movement – Endeavour Energy to determine timing of emergency restoration measure. o Complete restoration works. o Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.

11 FUTURE EXTRACTION PLANS

In accordance with Condition 7, Schedule 3 of the Project Approval, Metropolitan Coal will collect baseline data for the next Extraction Plan (i.e. Longwalls 305-310). However, for the 132 kV transmission lines and towers and other high voltage powerlines, the baseline (and post-mining) data collected for Longwalls 301-304 will be used as baseline for Longwalls 305 onward as longwall mining progressively moves further away from the Endeavour Energy assets.

In addition to the baseline data collection, consideration of the environmental performance and management measures in accordance with the review(s) conducted as part of this BFMP-END will inform the appropriate type and frequency of monitoring of the assets relevant to the next Extraction Plan.

12 ANNUAL REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

In accordance with Condition 3, Schedule 7 of the Project Approval, Metropolitan Coal will conduct an Annual Review of the environmental performance of the Project by the end of March each year.

The Annual Review will:

- describe the works carried out in the past year, and the works proposed to be carried out over the next year;
- include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the EA, Preferred Project Report and Extraction Plan;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

As described in Section 2, this BFMP will be reviewed within three months of the submission of an Annual Review, and revised where appropriate.

13 INCIDENTS

An incident is defined as a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval.

The reporting of incidents will be conducted in accordance with Condition 6, Schedule 7 of the Project Approval. Metropolitan Coal will notify the Director-General (now Secretary) of DP&E and any other relevant agencies of any incident associated with the Project as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of DP&E and any relevant agencies with a detailed report on the incident.

Endeavour Energy will be notified within 24 hours of any access limitations or restrictions.

14 COMPLAINTS

A protocol for the managing and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

The Environment & Community Superintendent is responsible for maintaining a system for recording complaints.

Metropolitan Coal will maintain public signage advertising the telephone number on which environmental complaints can be made. The Environment & Community Superintendent is responsible for ensuring that the currency and effectiveness of the service is maintained. Notifications of complaints received are to be provided as quickly as practicable to the Environment & Community Superintendent.

Complaints and enquiries do not have to be received via the telephone line and may be received in any other form. Any complaint or enquiry relating to environmental management or performance is to be relayed to the Environment & Community Superintendent as soon as practicable. All employees are responsible for ensuring the prompt relaying of complaints. All complaints will be recorded in a complaints register.

For each complaint, the following information will be recorded in the complaints register:

- date and time of complaint;
- method by which the complaint was made;
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- nature of the complaint;
- the action(s) taken by Metropolitan Coal in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken by Metropolitan Coal, the reason why no action was taken.

The Environment & Community Superintendent is responsible for ensuring that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary.

In accordance with Condition 10, Schedule 7 of the Project Approval, the complaints register will be made publicly available on the website and updated on a monthly basis. A summary of complaints received and actions taken will be presented to the Community Consultative Committee as part of the operational performance review.

15 NON-COMPLIANCES WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with Metropolitan Coal, and will be developed through promotion of Metropolitan Coal ownership under the direction of the General Manager.

The Manager - Technical Services and/or Environment & Community Superintendent will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 13, Metropolitan Coal will notify the Director-General (now Secretary) of the DP&E and any other relevant agencies of any incident associated with Metropolitan Coal as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of the DP&E and any relevant agencies with a detailed report on the incident.

A review of Metropolitan Coal's compliance with all conditions of the Project Approval, mining leases and all other approvals and licenses will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the Peabody website.

Additionally, in accordance with Condition 8, Schedule 7 of the Project Approval, an independent environmental audit was undertaken by the end of December 2011, and is undertaken a minimum of once every three years thereafter. A copy of the audit report will be submitted to the Director-General (now Secretary) of the DP&E and made publicly available on the Peabody website. The independent audit will be undertaken by an appropriately qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General (now Secretary) of the DP&E.

16 REFERENCES

Department of Planning & Environment and Division of Resources and Energy (2015) *Guidelines for the Preparation of Extraction Plans*.

Heggies (2008) *Metropolitan Coal Project Noise Impact Assessment.* Appendix J in the Metropolitan Coal Project Environmental Assessment.

Helensburgh Coal Pty Ltd [HCPL] (2008) *Metropolitan Coal Project Environmental Assessment*.

Helensburgh Coal Pty Ltd [HCPL] (2009) *Metropolitan Coal Project Preferred Project Report.*

Mine Subsidence Engineering Consultants (2008) *Subsidence Assessment Report on the Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Surface Infrastructure Resulting from the Proposed Extraction of Longwalls 20 to 44 at Metropolitan Colliery in Support of a Part 3A Application.*

Mine Subsidence Engineering Consultants (2016) *Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Endeavour Energy Infrastructure.*

Mine Subsidence Engineering Consultants (2019) *Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Endeavour Energy Infrastructure.*

APPENDIX 1

MSEC (2016) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 301 TO 303 - SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE ENDEAVOUR ENERGY INFRASTRUCTURE, DATED 7 SEPTEMBER 2016

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

7th September 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-01

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Endeavour Energy Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Endeavour Energy Infrastructure resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery.

The locations of the infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC844-01. The infrastructure includes a 132kV transmission line and low voltage powerlines located to the north and east of Longwalls 301 to 303. The 132kV transmission line therefore is located to the east and not proposed to be directly mined beneath. Parts of the low voltage powerline pass above the Longwalls 302 and 303. Predictions and impact assessments for the Endeavour Energy infrastructure are provided below

132 kV Transmission Line

The transmission towers and reference numbers are also shown in Drawing No. MSEC844-01. There are seven towers that are located within or immediately adjacent to the Study Area for Longwalls 301 to 303. The distances of these towers from the nearest longwall, being Longwall 301, are summarised in Table 1.

Table 1 Distances of the 132 kV Transmission Towers from Longwalls 301 to 303

Tower Number	Tower Type	Distance of the Transmission Towers Centrelines from the Longwalls (m)
F9132B-T13	Suspension	320
F9132B-T12	Suspension	100
F9132B-T11	Suspension	100
F9132B-T10	Suspension	110
F9132B-T9	Suspension	110
F9132B-T8	Suspension	120
F9132B-T7	Suspension	330

The transmission towers that are located within the Study Area are all suspension towers. The changes in alignment at the transmission towers are in the order of 1 to 2 degrees.

A photograph of one of the 132 kV transmission towers is provided in Figure 1.

Figure 1 Photograph of a 132 kV Transmission Tower

The predictions and impact assessments for the 132 kV transmission line are provided in the following sections.

Conventional Subsidence Parameters

The following provides summaries of the maximum predicted conventional movements for the 132 kV transmission line resulting from the extraction of Longwalls 301 to 303. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in the following section.

The predicted profiles of transient subsidence, tilt along and tilt across the alignment of the 132 kV transmission line, during the extraction of Longwall 301, are shown in the attached Fig. A.1. The profiles have been shown based on 50 metre advances of the longwall extraction face. The transmission line will initially experience subsidence adjacent to the northern end of Longwall 301 and then subsidence will progressively develop towards the southern end of the longwall during mining.

The predicted profiles of incremental and total conventional subsidence, tilt along and tilt across the alignment of the 132 kV transmission line, resulting from the extraction of Longwalls 301 to 303, are shown in the attached Fig. A.2. The black dashed lines are the incremental profiles that represent the additional movements due to each of the longwalls. The solid blue lines represent the total or accumulated movements after the completion of each longwall.

A summary of the maximum predicted values of incremental subsidence, tilt along and tilt across the alignment of the 132 kV transmission line, due to the extraction of each of the Longwalls 301 to 303, is provided in Table 2. The values are the maxima anywhere along the transmission line (i.e. not necessarily at the tower locations).

Table 2 Maximum Predicted Incremental Subsidence, Tilt Along and Tilt Across the Alignment of the 132 kV Transmission Line Resulting from the Extraction of Longwalls 301 to 303

Longwall	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Tilt Along Alignment (mm/m)	Maximum Predicted Incremental Tilt Across Alignment (mm/m)
Due To LW301	30	< 0.5	< 0.5
Due To LW302	60	< 0.5	< 0.5
Due To LW303	< 20	< 0.5	< 0.5

The maximum predicted incremental subsidence for the 132 kV transmission line, due to the extraction of each of the Longwalls 301 to 303, varies from less than 20 mm to 60 mm. It is noted, that the maximum predicted incremental subsidence due to Longwall 302 is greater than that due Longwall 301, as it is a second panel in the series and therefore results in higher magnitudes of subsidence above and outside of the mining area. The maximum predicted incremental tilts due to each of the longwalls are less than 0.5 mm/m (i.e. less than 0.05 %, or 1 in 2,000).

A summary of the maximum predicted values of total subsidence, tilt along the alignment and tilt across the alignment, resulting from the extraction of Longwalls 301 to 303, is provided in Table 3. The values are the maxima anywhere along the transmission line (i.e. not necessarily at the tower locations).

Table 3 Maximum Predicted Total Subsidence, Tilt Along and Tilt Across the Alignment of the 132 kV Transmission Line Resulting from the Extraction of Longwalls 301 to 303

Longwall	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt Along Alignment (mm/m)	Maximum Predicted Total Tilt Across Alignment (mm/m)
After LW301	30	< 0.5	< 0.5
After LW302	80	< 0.5	< 0.5
After LW303	90	< 0.5	0.5

The maximum predicted total subsidence for the 132 kV transmission line, resulting from the extraction of Longwalls 301 to 303, is 90 mm. The greatest subsidence occurs adjacent to the southern end of Longwall 301. The maximum predicted conventional tilt is 0.5 mm/m (i.e. 0.05 %, or 1 in 2,000) and is orientated across the alignment of the transmission line. The predicted conventional tilts along the alignment of the transmission line are less than 0.5 mm/m.

There are seven transmission towers that are located within or immediately adjacent to the Study Area, being Towers F9132B-T7 to F9132B-T13. A summary of the predicted values of total subsidence in the locations of the transmission towers, resulting from the extraction of Longwalls 301 to 303, is provided in Table 4

Table 4 Predicted Total Subsidence in the Locations of the Transmission Towers Resulting from the Extraction of Longwalls 301 to 303

Tower	Maximum Predicted Total Subsidence after LW301 (mm)	Maximum Predicted Total Subsidence after LW302 (mm)	Maximum Predicted Total Subsidence after LW303 (mm)
F9132B-T13	< 20	< 20	< 20
F9132B-T12	< 20	40	50
F9132B-T11	30	80	90
F9132B-T10	30	70	90
F9132B-T9	30	70	80
F9132B-T8	< 20	20	30
F9132B-T7	< 20	< 20	< 20

The transmission towers are predicted to experience vertical subsidence up to 90 mm resulting from the extraction of Longwalls 301 to 303. The highest subsidence is predicted to occur at Towers F9132B-T10 and F9132B-T10.

A summary of the maximum predicted values of total tilt at the bases of the transmission towers and total horizontal movements at the tops of the towers, resulting from the extraction of Longwalls 301 to 303, is provided in Table 5. The values are the maxima that occur at any time during or after the extraction of these longwalls. The horizontal movements have been based on an overall tower height of 40 metres.

Table 5 Maximum Predicted Total Tilts and Horizontal Movements at the Transmission Towers Resulting from the Extraction of Longwalls 301 to 303

Tower	Maximum Predicted Total Tilt Along Alignment at the Base of the Tower (mm, +ve towards north and -ve towards south)	Maximum Predicted Total Tilt Across Alignment at the Base of the Tower (mm, +ve towards east and -ve towards west)	Maximum Predicted Total Horizontal Movement Along Alignment at the Top of Tower (mm, +ve towards north and -ve towards south)	Maximum Predicted Total Horizontal Movement Across Alignment at the Top of the Tower (mm, +ve towards east and -ve towards west)
F9132B-T13	< ±0.5	< ±0.5	< ±20	< ±20
F9132B-T12	< ±0.5	< ±0.5	< ±20	< ±20
F9132B-T11	< ±0.5	< ±0.5	< ±20	-30
F9132B-T10	< ±0.5	< ±0.5	< ±20	-20
F9132B-T9	< ±0.5	< ±0.5	< ±20	-20
F9132B-T8	< ±0.5	< ±0.5	< ±20	< ±20
F9132B-T7	< ±0.5	< ±0.5	< ±20	< ±20

The maximum predicted conventional tilt in the locations of the transmission towers is less than 0.5 mm/m (i.e. less than 0.05 %, or 1 in 2,000). The maximum predicted horizontal movement at the tops of the towers is -30 mm orientated towards the west (i.e. towards the longwalls).

A summary of the maximum predicted values of total opening and closure between the tops of the transmission towers, resulting from predicted conventional subsidence movements due to the extraction of Longwalls 301 to 303, is provided in Table 6. The values are the maxima that occur at any time during or after the extraction of these longwalls.

Table 6 Maximum Predicted Total Opening and Total Closure between Transmission Towers Resulting from the Extraction of Longwalls 301 to 303

Span	Maximum Predicted Opening due to LW301 to LW303 (mm)	Maximum Predicted Closure due to LW301 to LW303 (mm)	Final Predicted Opening (+ve) or Closure (-ve) after LW303 (mm)
F9132B-T13 to F9132B-T12	< 20	< 20	< ±20
F9132B-T12 to F9132B-T11	< 20	< 20	< ±20
F9132B-T11 to F9132B-T10	< 20	< 20	< ±20
F9132B-T10 to F9132B-T9	< 20	< 20	< ±20
F9132B-T9 to F9132B-T8	< 20	< 20	< ±20
F9132B-T8 to F9132B-T7	< 20	< 20	< ±20

The maximum predicted opening and closure between the tops of the transmission towers are less than 20 mm.

The 132 kV transmission line is also likely to experience far-field horizontal movements orientated towards the mining area. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield.

The observed incremental far-field horizontal movements, resulting from the extraction of longwalls in the Southern Coalfield, are provided in Figure 2. The data is based on survey marks located outside of the mining area (i.e. above solid coal).

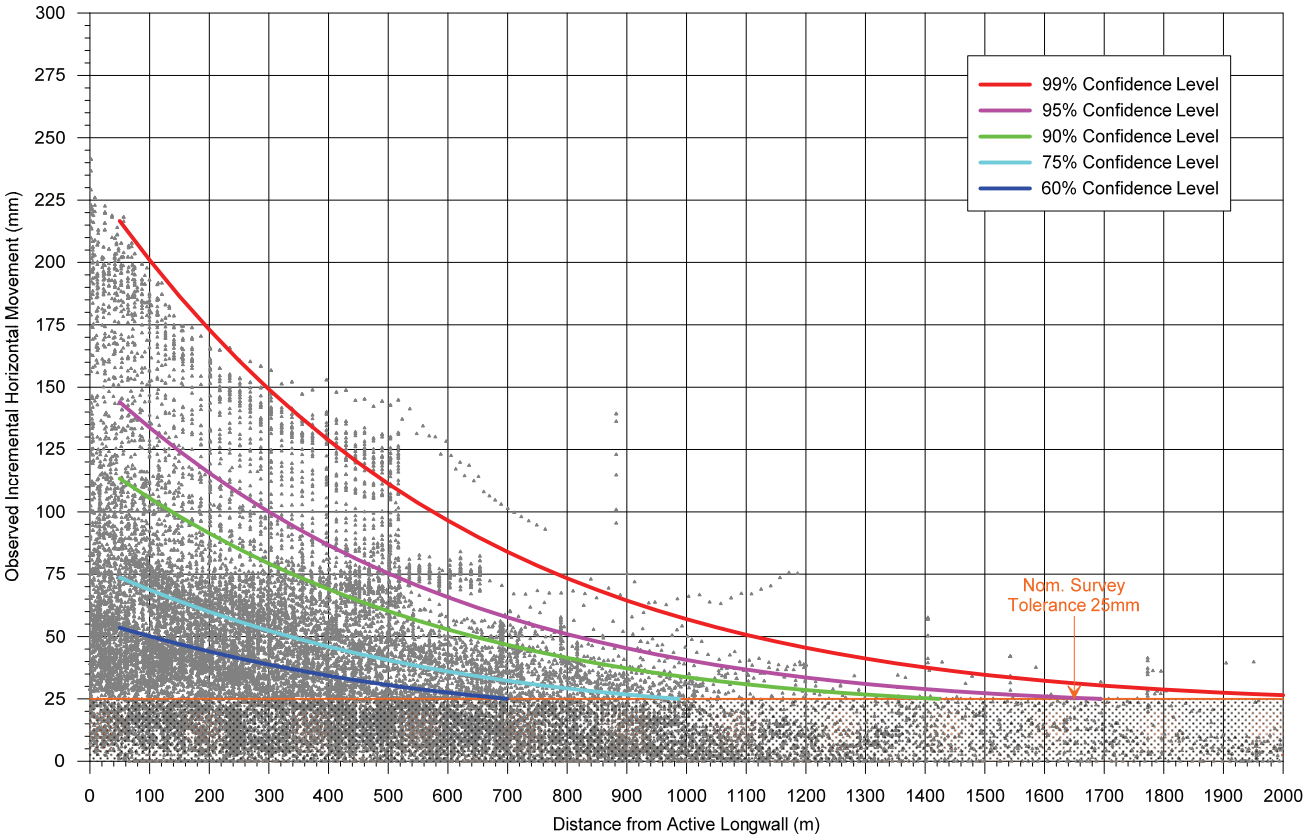

Figure 2 Observed Incremental Far-field Horizontal Movements from the Southern Coalfield (Solid Coal)

The transmission towers are located at distances between 100 and 330 metres from Longwalls 301 to 303. At these distances, the towers could experience absolute horizontal movements in the order of 100 mm to 140 mm based on the 95 % confidence level.

Far-field horizontal movements tend to be bodily movements orientated towards the mining area. The potential for impacts does not result from these absolute horizontal movements, but rather the differential horizontal movements.

These absolute far-field horizontal movements could result in small changes in the distances between the towers since the directions of these far-field horizontal movements are generally expected to be towards the extracted longwalls and the 132 kV transmission line is oriented approximately perpendicular to the longwalls. The greatest differences would therefore be expected to occur between towers that are located close to the longwalls and those located further from the longwalls, such as towers F9132B-T12 to F9132B-T13 and towers F9132B-T7 to F9132B-T8. A calculation of relative far field movements between towers based on potential far-field horizontal movements from Figure 2, for the 95% confidence level, indicates a potential maximum closure movement of 50 mm to 100 mm between the towers. With increasing distance from the extracted longwalls, the potential relative far-field movement between towers could result in an opening of less than 50 mm.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the 132 kV transmission line has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The transmission towers are located at distances of 100 metres or greater from the proposed longwalls. The database has therefore been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located outside and within 100 metres to 250 metres of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

A histogram of the maximum observed tensile and compressive strains measured in survey bays located above solid coal, for monitoring lines in the Southern Coalfield, is provided in Figure 3. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

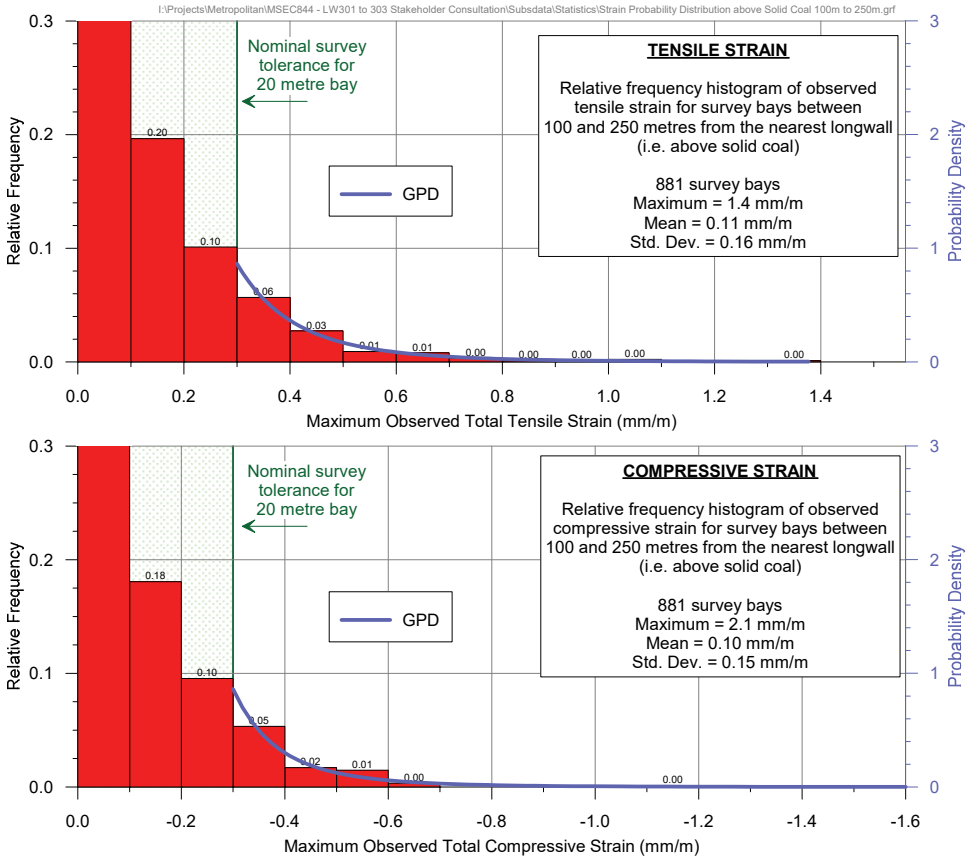

Figure 3 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Solid Coal (100 to 250 metres)

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above solid coal, based on the fitted GPDs, is provided in Table 7.

Table 7 Probabilities of Exceedance for Strain for Survey Bays Located above Solid Coal

Strain (mm/m)		Probability of Exceedance
Compression	-1.5	1 in 3,100
	-1.0	1 in 630
	-0.5	1 in 50
	-0.3	1 in 10
Tension	+0.3	1 in 10
	+0.5	1 in 35
	+1.0	1 in 400
	+1.5	1 in 2,200

The 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.4 mm/m tensile and compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.7 mm/m tensile and 0.6 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the mapped geological structures are shown in Drawing No. MSEC844-01. The Metropolitan Fault has a north west to south east strike and dips to the north east. This fault crosses the alignment of the 132 kV transmission line outside of the Study Area, at a distance of 0.5 kilometres north of Longwall 301. Faults also cross the alignment of the transmission line in the southern part of the Study Area, in close proximity to Tower F9132B-T13.

If these faults extend from the seam up to the surface, then localised and elevated compressive strains could develop at their surface expressions. It is also possible that localised and elevated strains could occur elsewhere due to unknown geological structures (i.e. anomalies).

If the surface expressions of the faults are located between the towers, then the predicted parameters for the towers do not change from those summarised in Table 4 to Table 7. However, if the surface expression of a fault is coincident with a tower, then it could experience a compressive strain greater than that predicted based on conventional ground movements.

It is difficult to predict the magnitudes of the non-conventional movements at known geological structures, especially in locations outside of mining. Experience from previous mining in close proximity of known geological structures can be used to provide a guide to the potential ground movements.

The greatest strain that has been measured at a known geological structure that was located outside of mining in the Southern Coalfield occurred in Appin Area 4. The surface expression of a low angle thrust fault was located at a distance of 190 metres from Longwall 407. The measured compressive strain at the surface expression due to mining of this longwall was 3.5 mm/m. The development of compressive strain versus the longwall face advance is illustrated in Figure 4. The rate of change of compressive strain per 10 metre longwall face advance is shown in Figure 5.

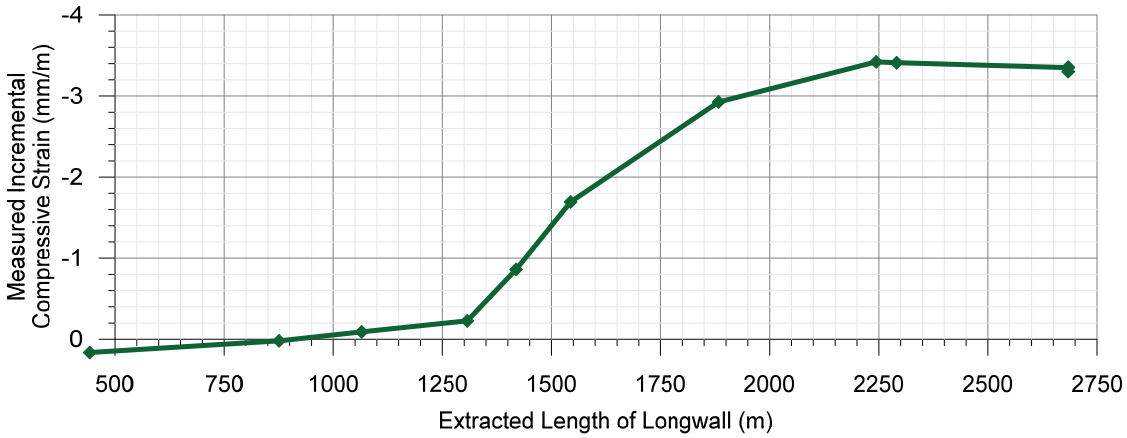

Figure 4 Development of Compressive Strain at the Surface Expression of the Low Angle Thrust Fault due to the Extraction of Appin Longwall 407

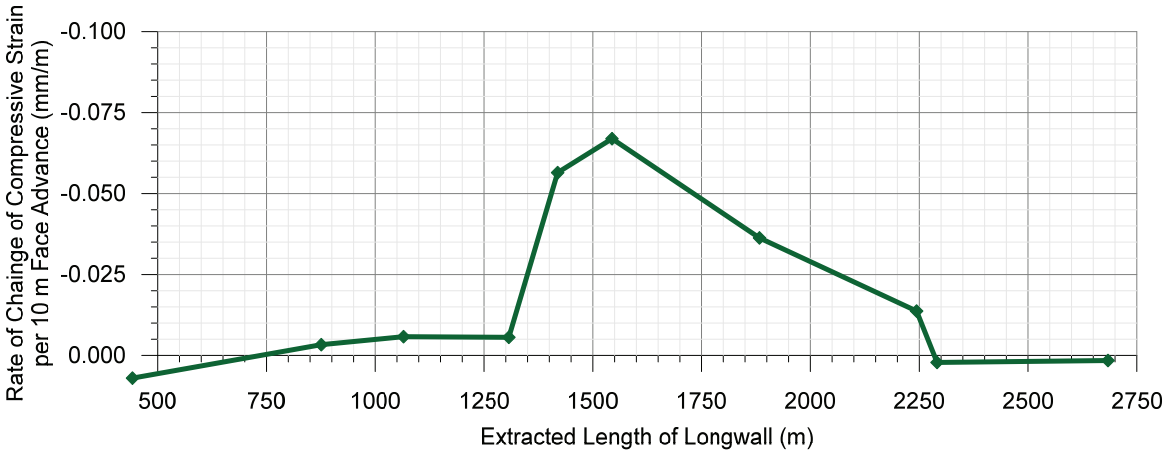

Figure 5 Rate of Change of Compressive Strain at the Surface Expression of the Low Angle Thrust Fault due to the Extraction of Appin Longwall 407

The maximum rate of change of compressive strain was 0.076 mm/m per 10 metre longwall face advance. Based on an average extraction rate of 50 metres per week, this equates to a maximum rate of 0.4 mm/m per week. The compressive strain developed over the period when the longwall had an extracted length between 1,300 and 2,200 metres. This equates to a period of approximately 18 weeks based on an average extraction rate of 50 metres per week.

The localised movements that developed at the surface expression of the low angled thrust fault in Appin Area 4 are an extreme case and greater than other known and measured cases in the Southern Coalfield. This case is likely to provide a conservative indication of potential non-conventional movements at surface expressions of geological structures outside of mining.

There are no major streams that cross the alignment of the 132 kV transmission line adjacent to Longwalls 301 to 303. The are some small tributaries along the alignment of the transmission line, which can be seen from the surface profile shown in Figs. A.1 and A.2. Localised and elevated compressive strains could develop in the bases of these small tributaries due to valley closure effects. However, the towers are located away from the bases of these small tributaries and, therefore, are unlikely to experience these valley closure strains.

Impact Assessments for the 132 kV Transmission Line

The cables along the 132 kV transmission line are not directly affected by ground strains, as they are supported by the towers above ground level. The cables can, however, be affected by the changes in distance between the towers, i.e. the distances between the towers at the level of the cables, which result from mining induced differential subsidence, horizontal ground movements and lateral movements at the tops of the towers due to differential tilting of the towers. The stability of the transmission towers can be affected by the mining induced tilts, curvatures and ground strains at the tower locations and by changes in the catenary profiles of the cables.

Potential Impacts due to the Predicted Conventional Movements

The transmission towers are predicted to experience vertical subsidence up to 90 mm resulting from the extraction of Longwalls 301 to 303. The transmission line is orientated parallel to the longwalls and therefore the low level vertical subsidence is predicted to be reasonably uniform along its alignment. It is unlikely, therefore, that these magnitudes of vertical subsidence would result in adverse impacts on the cable ground clearances.

The maximum predicted conventional tilt in the locations of the transmission towers is less than 0.5 mm/m (i.e. less than 0.1 %, or 1 in 2,000). The predicted mining induced tilts are very small and in the order of survey tolerance (i.e. not measurable). The mining induced tilts and horizontal movements due to conventional subsidence movements are predicted to result in opening and closures of less than 20 mm between adjacent towers. It is unlikely, therefore, that the conventional movements would result in adverse impacts on the transmission line.

Far-field horizontal movements could result in small changes in the distances between the towers, particularly those located near the ends of the longwalls. Potential maximum predicted shortening movement of 50 mm to 100 mm between the towers and opening of less than 50 mm could occur between towers, due to far-field horizontal movements.

The predicted strains at the locations of the transmission towers are 0.4 mm/m tensile and compressive based on the 95 % confidence level and are 0.7 mm/m tensile and 0.6 mm/m compressive based on the 99 % confidence level. It is recommended that Endeavour Energy review the structural integrity of the towers based on changes in the tower leg spacings (i.e. k-point distances) resulting from the predicted strains.

Potential Impacts due to Possible Non-Conventional Movements

Localised and elevated compressive strains can develop due to the presence of geological structures or valley related effects. There are no significant streams in the locations of the transmission towers and, therefore, it is unlikely that they will be adversely impacted by valley closure effects.

It is possible that the transmission towers could experience compressive strains greater than those predicted based on conventional movements if they were coincident with the surface expression of a fault. The potential for non-conventional movements in the locations of the towers is very low, due to their distances from the longwalls, however, the potential for these irregular movements cannot be discounted.

It is recommended that strategies are developed, in consultation with Endeavour Energy, to manage the potential for non-conventional movements at the transmission tower locations. The strategies should consider the magnitudes and rates of development of strain in locations of known geological structures adjacent to previous longwall mining. The observation at a low angled thrust fault in Appin Area 4 (refer to Figure 4 and Figure 5) is an extreme case and greater than other known and measured cases in the Southern Coalfield. This case is likely to provide a conservative indication of potential non-conventional movements at surface expressions of geological structures outside of mining.

The management strategies should include monitoring of the transmission towers during active subsidence to identify the early development of non-conventional ground movements. It is understood that survey marks are proposed to be installed on each of the transmission tower legs and in the ground.

It is recommended that a Trigger Action Response Plan (TARP) is developed outlining the actions required if non-conventional movements were identified at the transmission tower locations. The triggers and actions should be developed and agreed between Endeavour Energy and Peabody Energy.

It is also recommended that preventive measures are developed in case non-conventional movements are identified. The preventive measures could include: installation of timber poles to support the existing tower and/or the conductors; installation of additional bracing and/or strengthening members to the existing frame; or installation of a prefabricated steel frame to support the tower base.

The appropriate monitoring, management, preventive and remedial measures should be developed in consultation between Endeavour Energy and Peabody Energy.

Low Voltage Powerlines

The locations of the low voltage infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC844-01. Aerial and buried low voltage powerlines service the Garrawarra Complex in the northern part of the Study Area and above the northern ends of Longwalls 302 and 303. The feeder aerial powerline that runs between Helensburgh and the Garrawarra Complex is referred to as Powerline 1 and it is located north of the commencing ends of Longwalls 301 and 302.

Photographs of the aerial powerlines within the Study Area are provided in Figure 6. These powerlines comprise copper conductors supported by timber poles.

Figure 6 Aerial Powerlines

Conventional Subsidence Parameters

The following provides summaries of the maximum predicted conventional movements for the Endeavour Energy infrastructure resulting from the extraction of Longwalls 301 to 303. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

The predicted profiles of incremental and total conventional subsidence, tilt along and tilt across the alignment of Powerline 1, resulting from the extraction of Longwalls 301 to 303, are shown in the attached Fig. A.3. The black dashed lines are the incremental profiles that represent the additional movements due to each of the longwalls. The solid blue lines represent the total or accumulated movements after the completion of each longwall. The range of predicted curvatures in any direction at any time during or after the extraction of the longwalls is shown by the grey shading.

A summaries of the maximum predicted values of incremental subsidence and tilt for Powerline 1, due to the extraction of each of the Longwalls 301 to 303, is provided in Table 8. The values are the maxima anywhere along the powerline at any time during or after the extraction of each longwall.

Table 8 Maximum Predicted Incremental Subsidence and Tilt for Powerline 1 Resulting from the Extraction of Longwalls 301 to 303

Longwall	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Tilt Along Alignment (mm/m)	Maximum Predicted Incremental Tilt Across Alignment (mm/m)
Due To LW301	< 20	< 0.5	< 0.5
Due To LW302	30	< 0.5	< 0.5
Due To LW303	< 20	< 0.5	< 0.5

The maximum predicted incremental subsidence for Powerline 1, due to the extraction of each of the Longwalls 301 to 303, varies from less than 20 mm to 30 mm. Only low levels of vertical subsidence are predicted for this powerline since it is located outside the extents of the longwalls.

A summary of the maximum predicted values of total subsidence and tilt for Powerline 1, resulting from the extraction of Longwalls 301 to 303, is provided in Table 9. The values are the maxima anywhere along the cables at any time during or after the extraction of the longwalls.

Table 9 Maximum Predicted Total Subsidence and Tilt for Powerline 1 Resulting from the Extraction of Longwalls 301 to 303

Longwall	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt Along Alignment (mm/m)	Maximum Predicted Total Tilt Across Alignment (mm/m)
After LW301	< 20	< 0.5	< 0.5
After LW302	40	< 0.5	< 0.5
After LW303	50	< 0.5	0.5

The maximum predicted total subsidence for Powerline 1, resulting from the extraction of Longwalls 3301 to 303, is 50 mm after the completion of Longwall 303. The maximum predicted conventional tilts for this powerline are less than 0.5 mm/m (i.e. less than 0.05 %, or 1 in 2,000) along the alignment and 0.5 mm/m (i.e. 0.05 %, or 1 in 2,000) across the alignment (i.e. towards the longwalls).

The aerial powerlines that service the Garrawarra Complex are located above the northern ends of Longwalls 302 and 303. A summary of the maximum predicted values of total subsidence, tilt and curvature for these powerlines, resulting from the extraction of Longwalls 301 to 303, is provided in Table 10.

Table 10 Maximum Predicted Total Subsidence, Tilt and Curvature for the Aerial and Buried Powerlines on the Garrawarra Complex Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	30	< 0.5	< 0.01	< 0.01
After LW302	375	3.0	0.03	0.04
After LW303	500	4.0	0.03	0.05

The maximum predicted conventional tilt for the powerlines located directly above the longwalls is 4.0 mm/m (i.e. 0.4 %, or 1 in 250). The maximum predicted conventional curvatures are 0.03 km^{-1} hogging and 0.05 km^{-1} sagging, which equate to minimum radii of curvature of 33 kilometres and 20 kilometres, respectively.

Predicted Strains

The low voltage Powerlines are partially located above Longwalls 301 to 303. A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 7. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

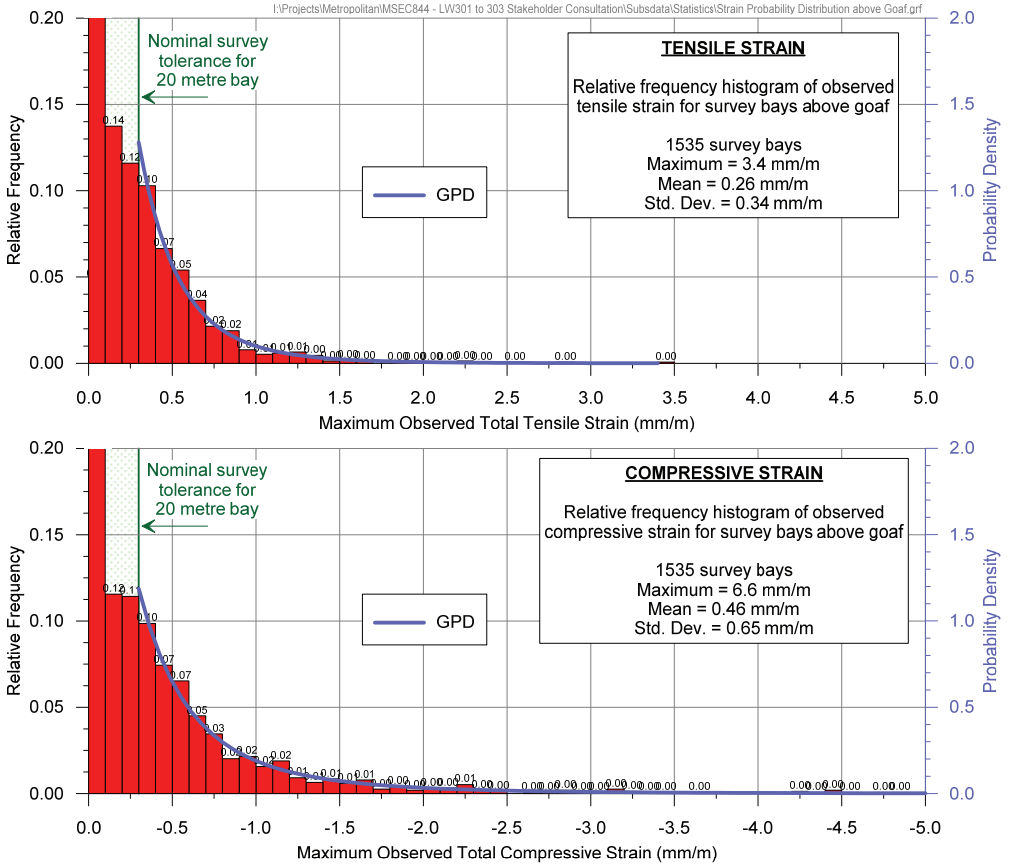

Figure 7 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based on the fitted GPDs, is provided in Table 11.

Table 11 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures and the streams are shown in Drawing No. MSEC844-01.

There are no mapped faults located within the extents of Longwalls 301 to 303. It is possible that the infrastructure located above the longwalls could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The powerlines do not cross any major streams within the Study Area. These cables, therefore, are not expected to experience any measurable valley closure effects.

Impact Assessments for the Powerlines

The feeder powerline (i.e. Powerline 1) is located outside the extents of Longwalls 301 to 303. The maximum predicted tilt for this powerline is 0.5 mm/m across its alignment (i.e. towards the longwalls). The maximum predicted tilt for the powerlines that are located directly above the longwalls is 4.0 mm/m.

The aerial conductors are supported by the timber poles above the ground and, therefore, are not expected to experience adverse impacts due to curvature and strain. The maximum predicted curvature is 0.05 km^{-1} sagging, which represents a minimum radius of curvature of 20 km. The maximum predicted strains are 0.9 mm/m tensile and 1.6 mm/m compressive based on the 95 % confidence level and 1.5 mm/m tensile and 3.2 mm/m compressive based on the 99 % confidence level.

Extensive experience of mining beneath aerial powerlines in the Southern Coalfield indicates that the potential impacts are rare and generally of a minor nature. Some remedial measures have been required, which include adjustments to cable catenaries, pole tilts and consumer cables which connect between the poles and building structures. The incidence of these impacts, however, was very low.

It is recommended that monitoring and management strategies are developed, in consultation with Endeavour Energy, to manage the potential impacts on the powerlines. It is expected that these cables can be maintained in serviceable condition with the implementation of the appropriate monitoring and management strategies.

Summary

The 132 kV transmission line is located to the east of the proposed Longwalls 301 to 303. The transmission towers are located at distances between 100 metres and 330 metres from the longwalls. At these distances, the transmission towers are predicted to experience low levels of vertical subsidence up to 90 mm. The predicted conventional tilts and differential horizontal movements between the towers are small and unlikely to result in adverse impacts.

However, it is possible that the transmission towers could experience localised and elevated compressive strains due to the presence of geological structures (known or unknown), if the surface expressions of these features are coincident with them.

The aerial low voltage powerlines are located in the northern part of the Study Area and above the northern ends of Longwalls 302 and 303. Experience of mining beneath these types of cables in the Southern Coalfield indicates that the potential impacts on these types of cables are rare and generally of a minor nature.

It is recommended that monitoring, management, preventive and remedial measures are developed, in consultation between Endeavour Energy and Peabody Energy, to manage the potential impacts for the Endeavour Energy infrastructure.

Yours sincerely

Peter DeBono
Mine Subsidence Engineering Consultants

Attachments:

Drawing No. MSEC844-01 – Longwalls 301 to 303 – Endeavour Energy 132 kV Transmission Line

Fig. A.1 Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the Alignment of the 132 kV Transmission Line during the Mining of Longwall 301
Fig. A.2 Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the Alignment of the 132 kV Transmission Line due to LW301 to LW303
Fig. A.3 Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the Alignment of Powerline 1 due to LW301 to LW303

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
ENDEAVOUR ENERGY

DATE:	SCALE:	DRAWING No:	Rev No
26 Aug 2016	1:12500	MSEC844-01	E

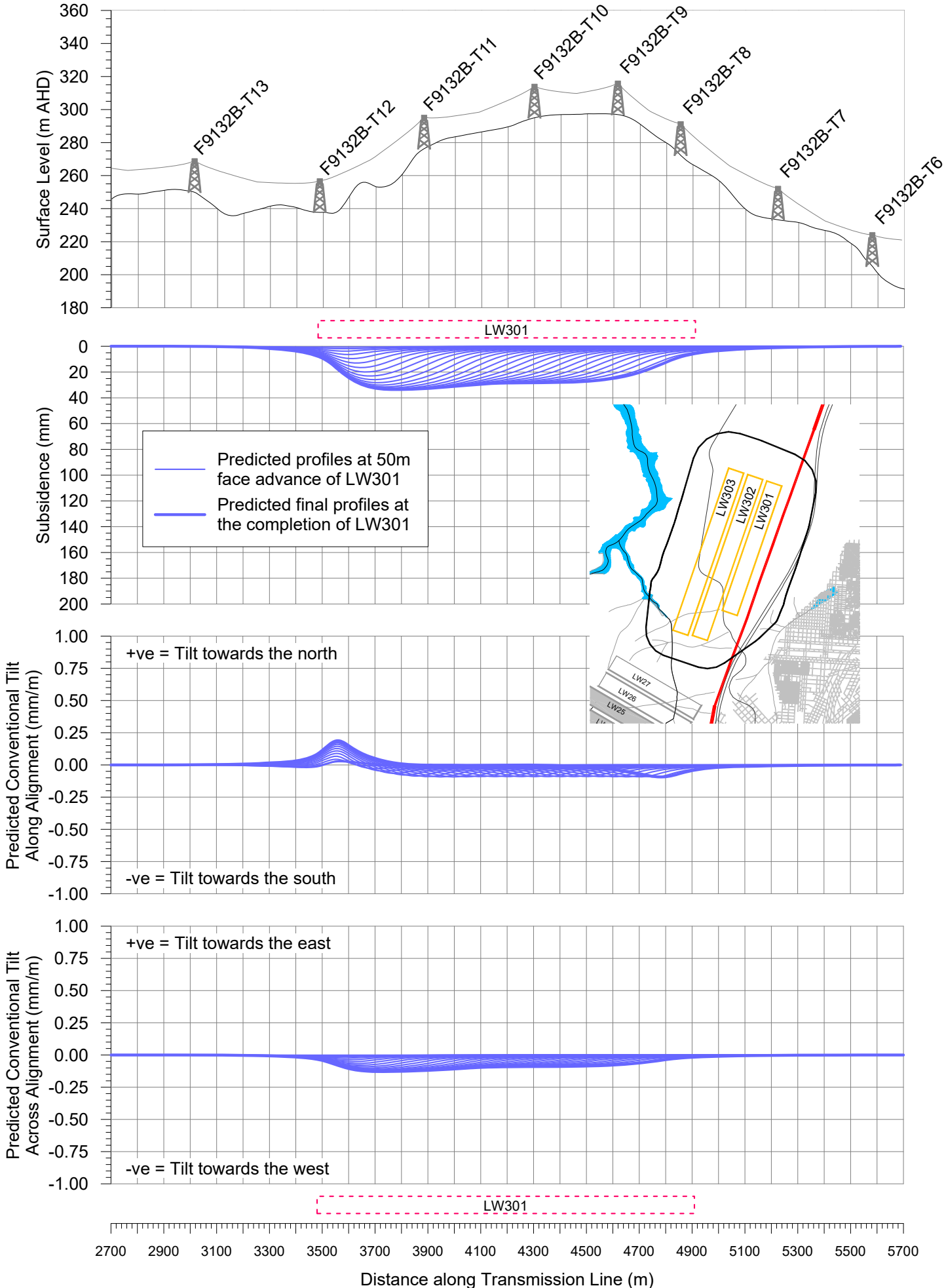
6 218 000
312 000
314 000
6 216 000
Grid to MGA co-ordinates

STUDY AREA
PREDICTED 20mm SUBSIDENCE CONTOUR
20
LW303
LW302
LW301
F9132B-T5
F9132B-T6
F9132B-T7
F9132B-T8
F9132B-T9
F9132B-T10
F9132B-T11
F9132B-T12
F9132B-T13
CAWLEY ROAD OVERPASS
CAWLEYS CK
330kV TRANSMISSION LINES
M1 PRINCES MOTORWAY
METROPOLITAN FAULT
POWERLINE 1
132kV TRANSMISSION LINE
WORONORA RESERVOIR
OLD PRINCES HWY
WILSONS CK
PRINCES HIGHWAY UNDERPASS 2
FAULT
MAIN WEST FAULT
POWELL FAULT

LEGEND
- 132 kV LINE & TOWERS
- POWERLINES
- POWER POLES

GEOLOGICAL STRUCTURES
- FAULTS
- DYKES

Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the Alignment of the 132 kV Transmission Line during the Mining of LW301



msec

Fig. A.1

Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the Alignment of the 132 kV Transmission Line due to LW301 to LW303

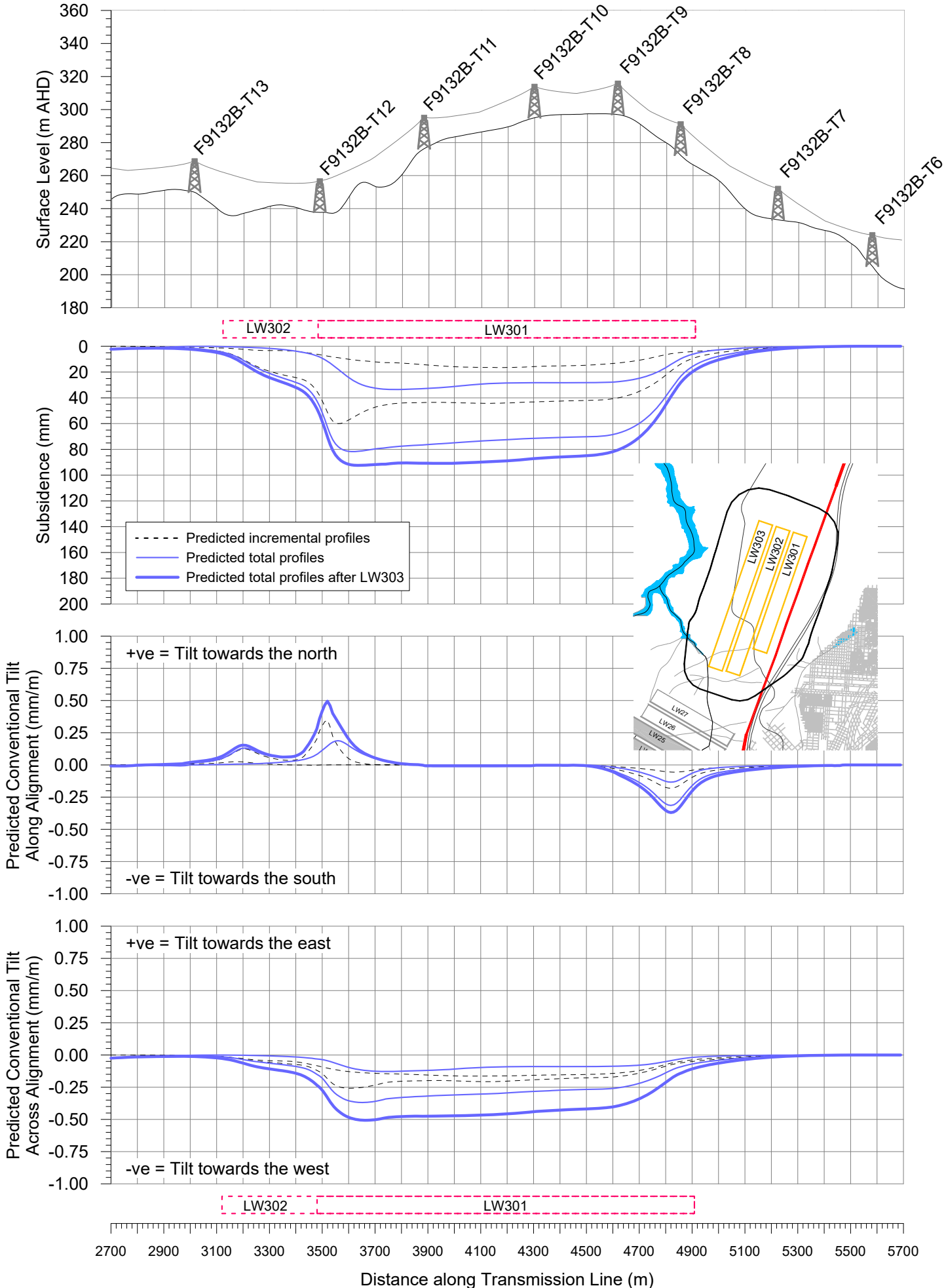


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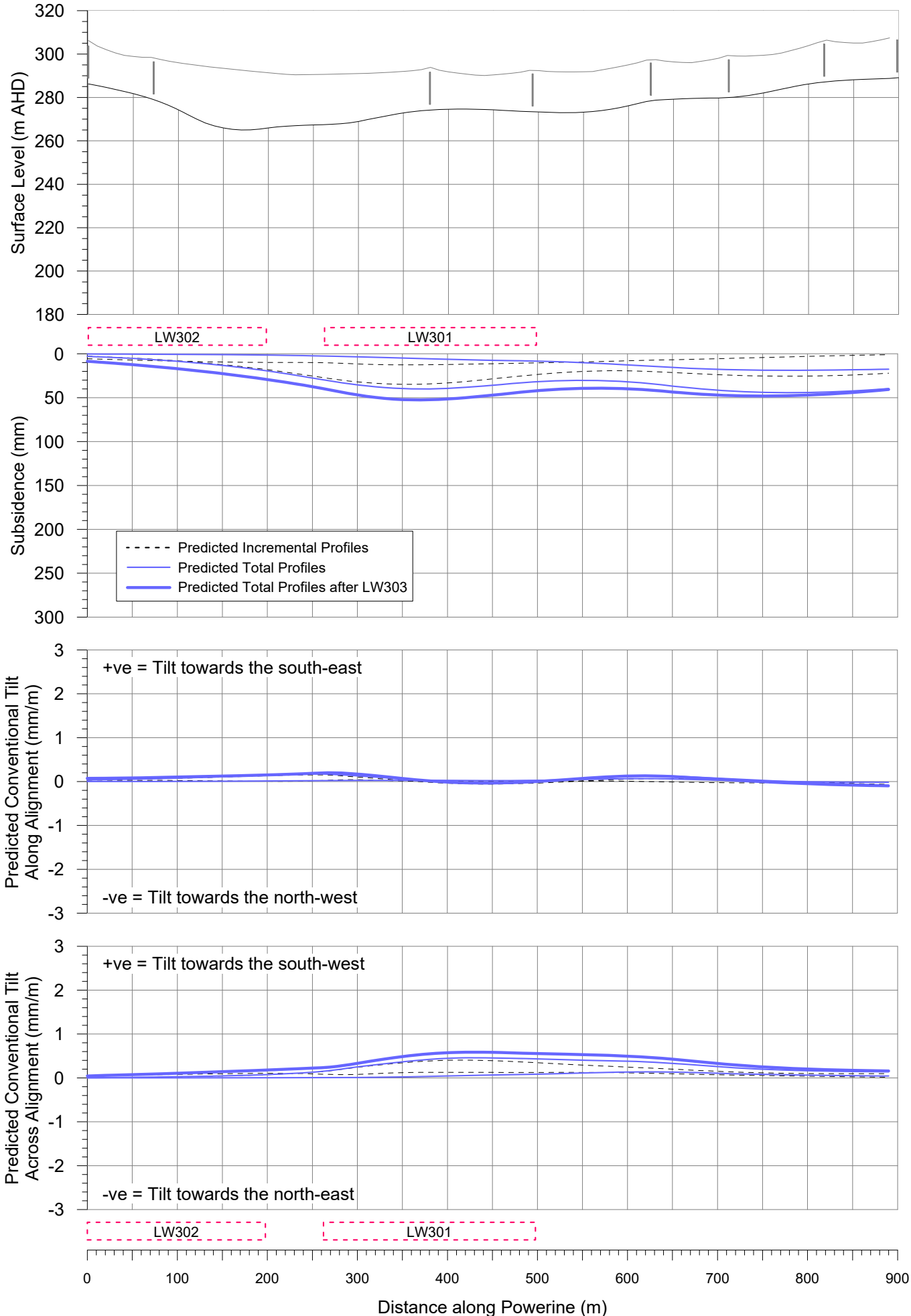
Fig. A.2

Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the Alignment of Powerline 1 due to LW301 to LW303



msec

Fig. A.3

APPENDIX 2

MSEC (2019) METROPOLITAN COLLIERY – PROPOSED LONGWALL 304 – SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE ENDEAVOUR ENERGY INFRASTRUCTURE

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

13th March 2019

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC1013-01

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Endeavour Energy Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Endeavour Energy Infrastructure resulting from the extraction of the proposed Longwall 304 at Metropolitan Colliery.

The locations of the infrastructure and the proposed longwall are shown in the attached Drawing No. MSEC1013-01. The infrastructure includes a 132kV transmission line and low voltage powerlines located to the north east of Longwall 304.

A Study Area is shown in Drawing No. MSEC1013-01 and is based on the outer limits of a 35° angle of draw line from Longwall 304 and the predicted 20mm subsidence contour for Longwall 304.

The 132kV transmission line is located is outside the Study Area for Longwall 304 and is 730 m from the longwall at its nearest point. The main low voltage distribution line runs between the township of Helensburgh and the Garrawarra Complex to the north east of the Study Area and is labelled Powerline 1 in Drawing No. MSEC1013-01. The low voltage powerlines within the Study Area service the Garrawarra Complex in the northern part of the Study Area. The powerlines comprise aerial conductors supported on timber poles. The nearest pole is approximately 150 m from Longwall 304. Underground powerlines are also present within the Garrawarra Complex and are understood to be private lines. There are no powerlines above Longwall 304.

Predictions and impact assessments for the Endeavour Energy infrastructure are provided below.

132 kV Transmission Line

The transmission towers and reference numbers are shown in Drawing No. MSEC1013-01. The transmission towers are all suspension towers. A photograph of one of the 132 kV transmission towers is provided in Figure 1.

Figure 1 Photograph of a 132 kV Transmission Tower

The predictions and impact assessments for the 132 kV transmission line are provided in the following sections.

Conventional Subsidence Parameters

The 132 kV transmission line is located 730 m from Longwall 304. At this distance, the transmission line is not expected to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwall 304. The transmission towers could experience low level far-field horizontal movement. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield, which tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain.

It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in the following section.

The observed incremental far-field horizontal movements, resulting from the extraction of longwalls in the Southern Coalfield, are provided in Figure 2. The data is based on survey marks located outside of the mining area (i.e. above solid coal).

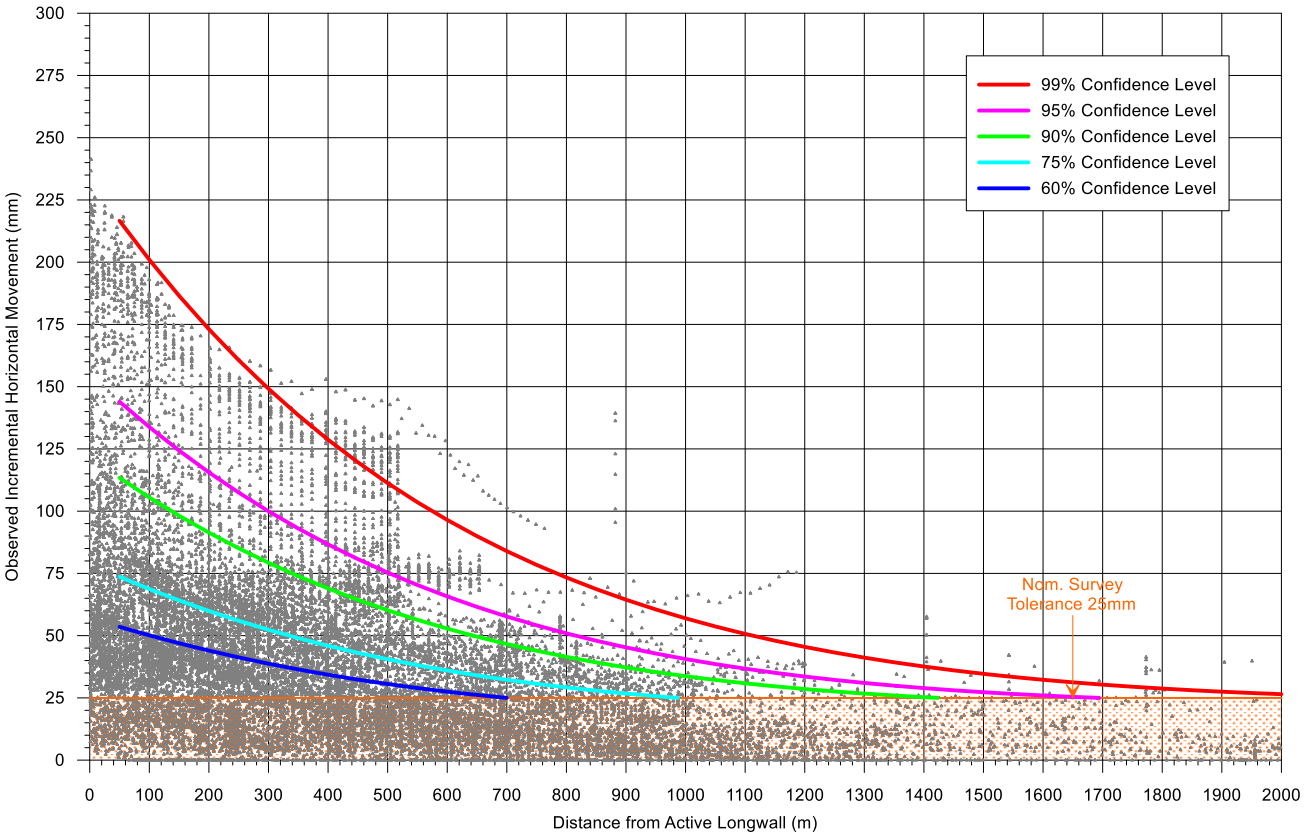


Figure 2 Observed Incremental Far-field Horizontal Movements from the Southern Coalfield (Solid Coal)

The absolute incremental horizontal movements measured at distances greater than 730 m from mining are in the order of 55 mm based on the 95% confidence level. Far-field horizontal movements tend to be bodily movements orientated towards the mining area. The strains associated with these low level horizontal movement are not expected to be measurable. The absolute far-field horizontal movements could result in minor changes in the distances between the towers since the directions of these far-field horizontal movements are generally expected to be towards the extracted longwalls. Monitoring of an adjacent transmission line approximately 50 m to the west of the 132 kV transmission line measured a maximum cumulative differential horizontal movement between towers of approximately 25 mm during the extraction of Longwalls 301 and 302.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of potential ground strains at the transmission towers was assessed statistically using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The transmission towers are located at distances of 100 m or greater from Longwall 301. The database has therefore been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located outside and within 100 m to 250 m of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

A histogram of the maximum observed tensile and compressive strains measured in survey bays located above solid coal, for monitoring lines in the Southern Coalfield, is provided in Figure 3 . The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

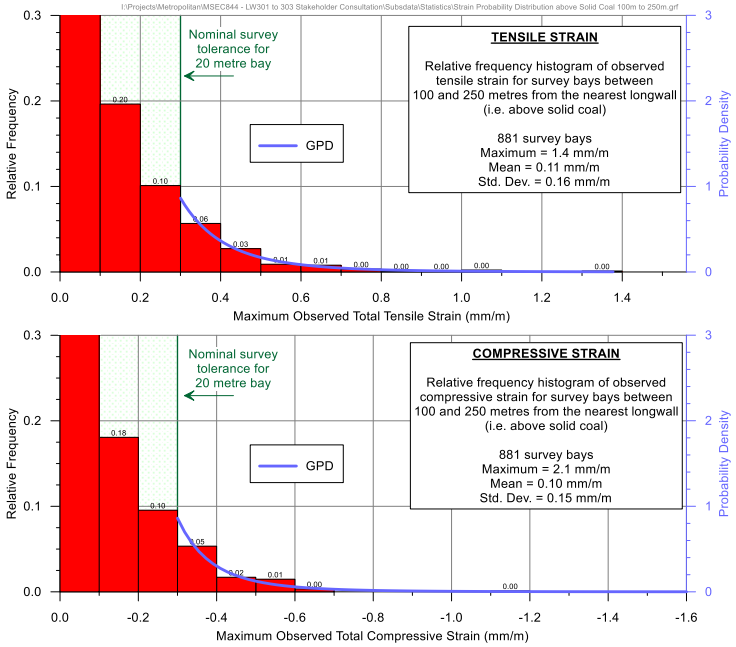


Figure 3 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Solid Coal (100 to 250 m)

The 95 % confidence levels for the maximum total strains that the individual survey bays above solid coal (100 to 250 m) experienced at any time during mining are 0.4 mm/m tensile and compressive. The 99 % confidence levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.7 mm/m tensile and 0.6 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures at seam level and the major streams are shown in Drawing No. MSEC1013-06. There are no mapped faults located within the Study Area that extend beneath the 132 kV transmission line. It is possible that the transmission line located adjacent to the Study Area could experience

localised and elevated strains due to unknown geological structures (i.e. anomalies). Non-conventional or anomalous movements have not been identified during the extraction of Longwalls 301 and 302. The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The transmission line does not cross any major streams within the Study Area and, therefore, is not expected to experience any measurable valley closure effects.

Impact Assessments for the 132 kV Transmission Line

The cables along the 132 kV transmission line are not directly affected by ground strains, as they are supported by the towers above ground level. The cables can, however, be affected by the changes in distance between the towers, i.e. the distances between the towers at the level of the cables, which result from mining induced differential subsidence, horizontal ground movements and lateral movements at the tops of the towers due to differential tilting of the towers. The stability of the transmission towers can be affected by the mining induced tilts, curvatures and ground strains at the tower locations and by changes in the catenary profiles of the cables.

Whilst the 132 kV transmission line could experience low level far-field horizontal movements, the associated tilts, curvatures or strains are not expected to be measurable. It is unlikely that the transmission lines would experience adverse impacts as a result of conventional subsidence movements due to the extraction of Longwall 304.

Far-field horizontal movements could result in small changes in the distances between the towers, particularly those located near the ends of the longwalls. Differential far-field horizontal movements between the transmission towers due to the extraction of Longwall 304 are expected to be less than 20 mm and are not expected to result in adverse impacts to the transmission line.

The predicted strains at the locations of the transmission towers are 0.4 mm/m tensile and compressive based on the 95 % confidence level and are 0.7 mm/m tensile and 0.6 mm/m compressive based on the 99 % confidence level. Tower leg spacings have been monitored since the commencement of Longwall 301 with observed changes in leg spacings generally within the level of accuracy of survey methods.

Localised and elevated compressive strains can develop due to the presence of geological structures. It is possible that the transmission towers could experience compressive strains greater than those predicted based on conventional movements if they were coincident with the surface expression of a fault. The potential for non-conventional movements in the locations of the towers is very low, due to their distances from the longwalls and observations to date, however, the potential for these irregular movements cannot be discounted.

A monitoring program, including a trigger action response plan, has been in place since the commencement of Longwall 301. Observed subsidence parameters have been within expected levels with no identified non-conventional movements. Based on these results the likelihood of non-conventional movements occurring as a result of the extraction of Longwall 304 is considered to be very low.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301 to 303 are updated and continued for Longwall 304, in consultation with Endeavour Energy, to manage the transmission line for potential non-conventional ground movements.

Low Voltage Powerlines

The locations of the low voltage infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC1013-01. Aerial and buried low voltage powerlines service the Garrawarra Complex in the north-eastern part of the Study Area. The feeder aerial powerline that runs between Helensburgh and the Garrawarra Complex is referred to as Powerline 1 and it is located to the east of the Study Area.

Photographs of the aerial powerlines within the Study Area are provided in Figure 4. These powerlines comprise copper conductors supported by timber poles.

Figure 4 Aerial Powerlines

Conventional Subsidence Parameters

The following provides summaries of the maximum predicted conventional movements for the Endeavour Energy infrastructure following the extraction of Longwall 303 and after extraction of Longwall 304. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

Powerline 1 is located over 460 m from Longwall 304 and is outside the Study Area. At this distance, Powerline 1 is not expected to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwall 304. The power poles could experience low level far-field horizontal movement. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield.

The observed incremental far-field horizontal movements, resulting from the extraction of longwalls in the Southern Coalfield, are provided in Figure 2. The absolute horizontal movements measured at distances greater than 460 m from mining are in the order of 85 mm based on the 95% confidence level. Far-field horizontal movements tend to be bodily movements orientated towards the mining area. The strains associated with these low level horizontal movement are not expected to be measurable.

The aerial powerlines and power poles within the Study Area that service the Garrawarra Complex are located to the north east of Longwall 304. A summary of the maximum predicted values of total subsidence, tilt and curvature for these powerlines, following the extraction of Longwall 303 and after extraction of Longwall 304, is provided in Table 1.

Table 1 Maximum Predicted Total Subsidence, Tilt and Curvature for the Aerial and Buried Powerlines on the Garrawarra Complex following the Extraction of Longwalls 303 and 304

Longwall	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})
Total after LW303	200	2.0	0.03	< 0.01
Total after LW304	300	3.0	0.03	< 0.01

The maximum predicted total subsidence is 300 mm. The maximum predicted conventional tilt is 3.0 mm/m (i.e. 0.3 %, or 1 in 330). The maximum predicted conventional curvatures are 0.03 km^{-1} hogging and < 0.01 sagging, which equate to minimum radii of curvature of 33 km and 100 km respectively.

Predicted Strains

Low voltage Powerlines are located within the Study Area to the east of Longwall 304. A histogram of the maximum tensile and compressive strains measured in survey bays above solid coal, for extracted longwalls in the Southern Coalfield is provided in Figure 5. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

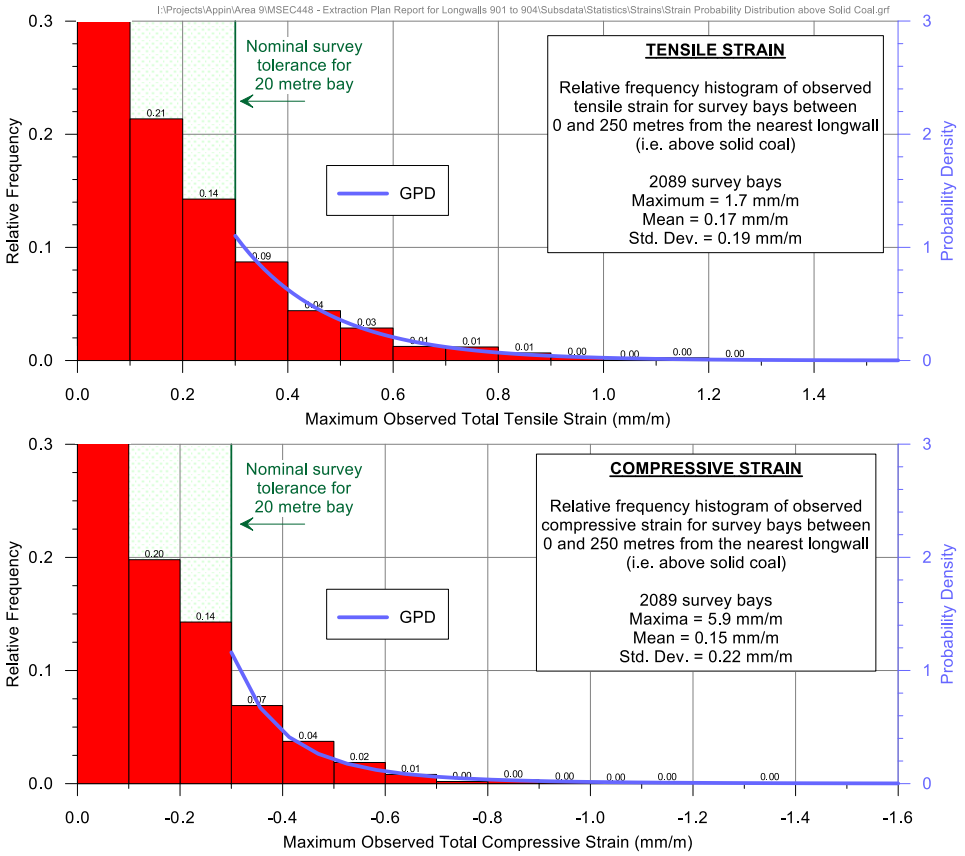


Figure 5 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield for Bays Located Above Solid Coal

The 95 % confidence levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining were 0.6 mm/m tensile and 0.5 mm/m compressive. The 99 % confidence levels for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining were 0.9 mm/m tensile and 0.8 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures at seam level and the major streams are shown in Drawing No. MSEC1013-06. There are no mapped faults located within the Study Area that extend beneath the low voltage powerlines. It is possible that the powerlines could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). Non-conventional or anomalous movements have not been identified during the extraction of Longwalls 301 and 302. The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The powerlines do not cross any major streams within the Study Area. These cables, therefore, are not expected to experience any measurable valley closure effects.

Impact Assessments for the Powerlines

The 11 kV powerlines comprise aerial conductors supported on timber poles and buried cables. Experience from the Southern Coalfield indicates that the potential impacts on these types of powerlines are rare and generally of a minor nature. Some remedial measures have been required, which include adjustments to cable catenaries, pole tilts and consumer cables which connect between the poles and building structures. The incidence of these impacts, however, was very low.

It is expected that the 11kV powerlines can be maintained in safe and serviceable conditions with the development of the appropriate monitoring and management plans.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301 to 303 are updated and continued for Longwall 304, in consultation with Endeavour Energy, to manage the low voltage powerlines for potential non-conventional ground movements.

Summary

The 132 kV transmission line is located to the east of the proposed Longwall 304 and is located outside the Study Area at distances of 730 m or more from Longwall 304. At this distance, the transmission line is not expected to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwall 304. The transmission towers could experience low level far-field horizontal movement. It is considered unlikely that the transmission lines would experience adverse impacts as a result of predicted movements due to the extraction of Longwall 304.

The aerial low voltage powerlines are located in the north-eastern part of the Study Area and are not directly above the proposed Longwall 304. Experience of mining beneath these types of cables in the Southern Coalfield indicates that the potential impacts on these types of cables are rare and generally of a minor nature.

It is possible that the transmission towers and power poles could experience localised and elevated strains due to the presence of geological structures (known or unknown), if the surface expressions of these features are coincident with them. Non-conventional subsidence movements have not been observed during the extraction of Longwalls 301 and 302 and the likelihood of non-conventional subsidence movements at the transmission towers and power poles due to Longwall 304 is considered to be very low.

It is expected that the potential impacts on the Endeavour Energy infrastructure can be managed with the implementation of the necessary monitoring and management strategies.

Yours sincerely

Peter DeBono
Mine Subsidence Engineering Consultants

Attachments:

Drawing No. MSEC1013-01 – Longwall 304 – Endeavour Energy 132 kV Transmission Line

I:\Projects\Metropolitan\MSEC1013 - LW304 Stakeholders Consultation\AcadData\MSEC1013-01 Endeavour Energy.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COLLIERY
LONGWALL 304
ENDEAVOUR ENERGY

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	as shown	MSEC1013-01	02

GEOLOGICAL STRUCTURES
- FAULTS
- DYKES

LEGEND
- 132 kV LINE & TOWERS
- POWERLINES
- POWER POLES

STUDY AREA
PREDICTED 20mm SUBSIDENCE CONTOUR
LW304
LW303
LW302
LW301
OLD PRINCES HWY
METROPOLITAN FAULT
CAWLEYS CK
WORONORA RESERVOIR
POWERLINE 1
132kV TRANSMISSION LINE
330kV TRANSMISSION LINES
WILSONS CK
PRINCES HIGHWAY UNDERPASS 2
F9132B-T6
F9132B-T7
F9132B-T8
F9132B-T9
F9132B-T10
F9132B-T11
F9132B-T12
F9132B-T13
6 218 000
6 216 000
312 000
Grid to MGA co-ordinates

APPENDIX 3

BUILT FEATURES MANAGEMENT PLAN – SUBSIDENCE IMPACT REGISTER

Built Features Management Plan - Subsidence Impact Register

Impact Register Number[1]	Built Feature[2]	Impact Description	Does Impact Exceed the Built Feature Performance Measure/Indicators? (Yes/No)	Management Measures Implemented	Were Management Measures Effective? (Yes/No)

Notes:

1: Fill out all details in the Assessment Form and record the register number here.

2: Built feature (e.g. transmission line, tower, etc.).

3: Impacts to access roads/tracks to be included in the Land Management Plan – Subsidence Impact Register.

Built Feature Management Plan – Subsidence Impact Register
Assessment Form

Date:	
Observer (Name and position):	
Register Number (i.e. Number 1, 2, etc.):	
Longwall Number and Chainage:	

Location of Observed Impact:

(Examples: location of tower, include GPS co-ordinates and a sketch)

Description of Observed Impact:

(Examples: nature and extent of impact - cracks in road etc any relevant information, attach photographs)

Person Notified:	Manager - Technical Services	☐

Description of Photographs:

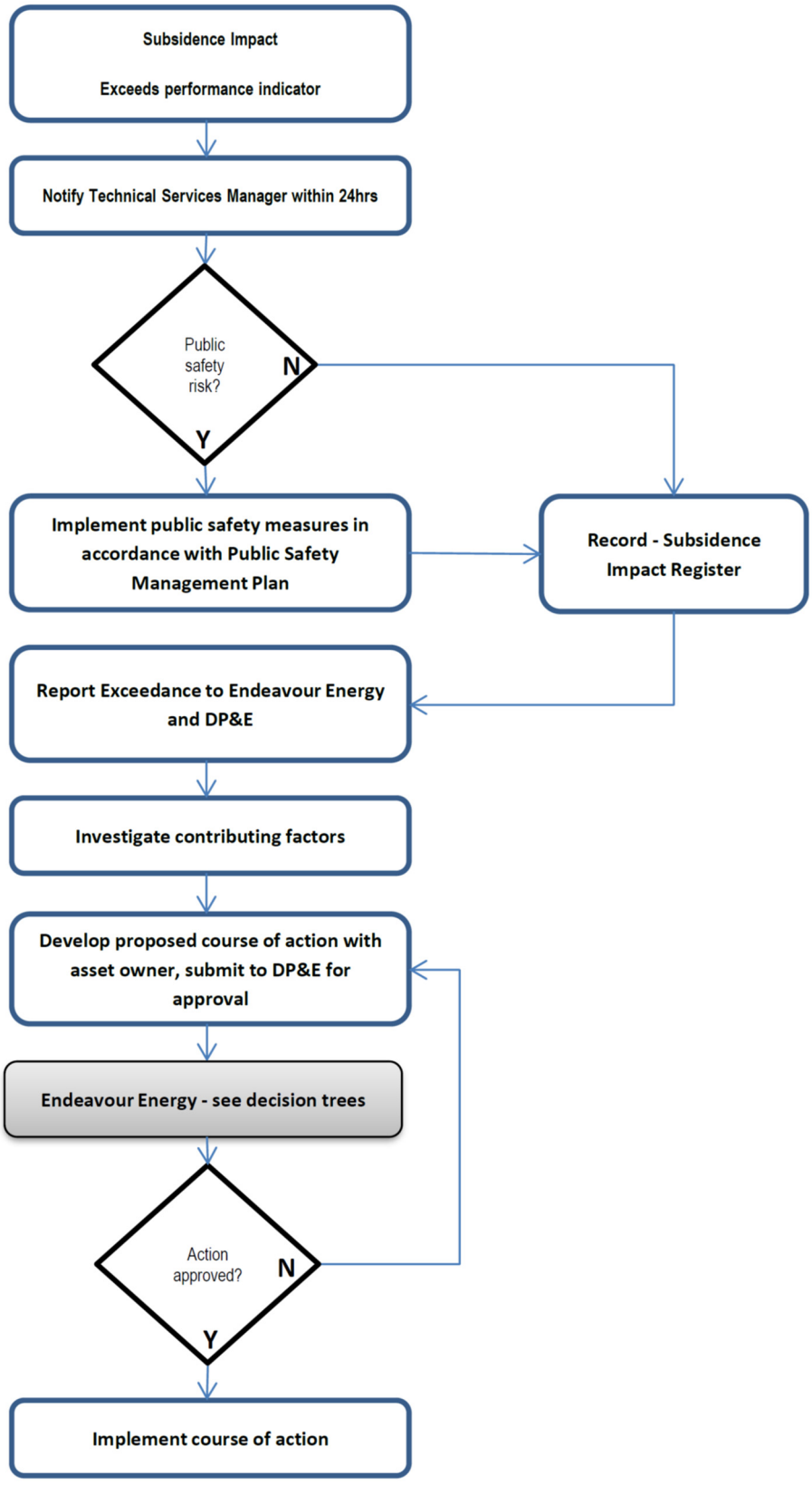
Actions Required:	Contingency Plan Initiated	☐
	Incident Notification	☐
	Safety Measures/Public Safety Management Plan Requirements	☐

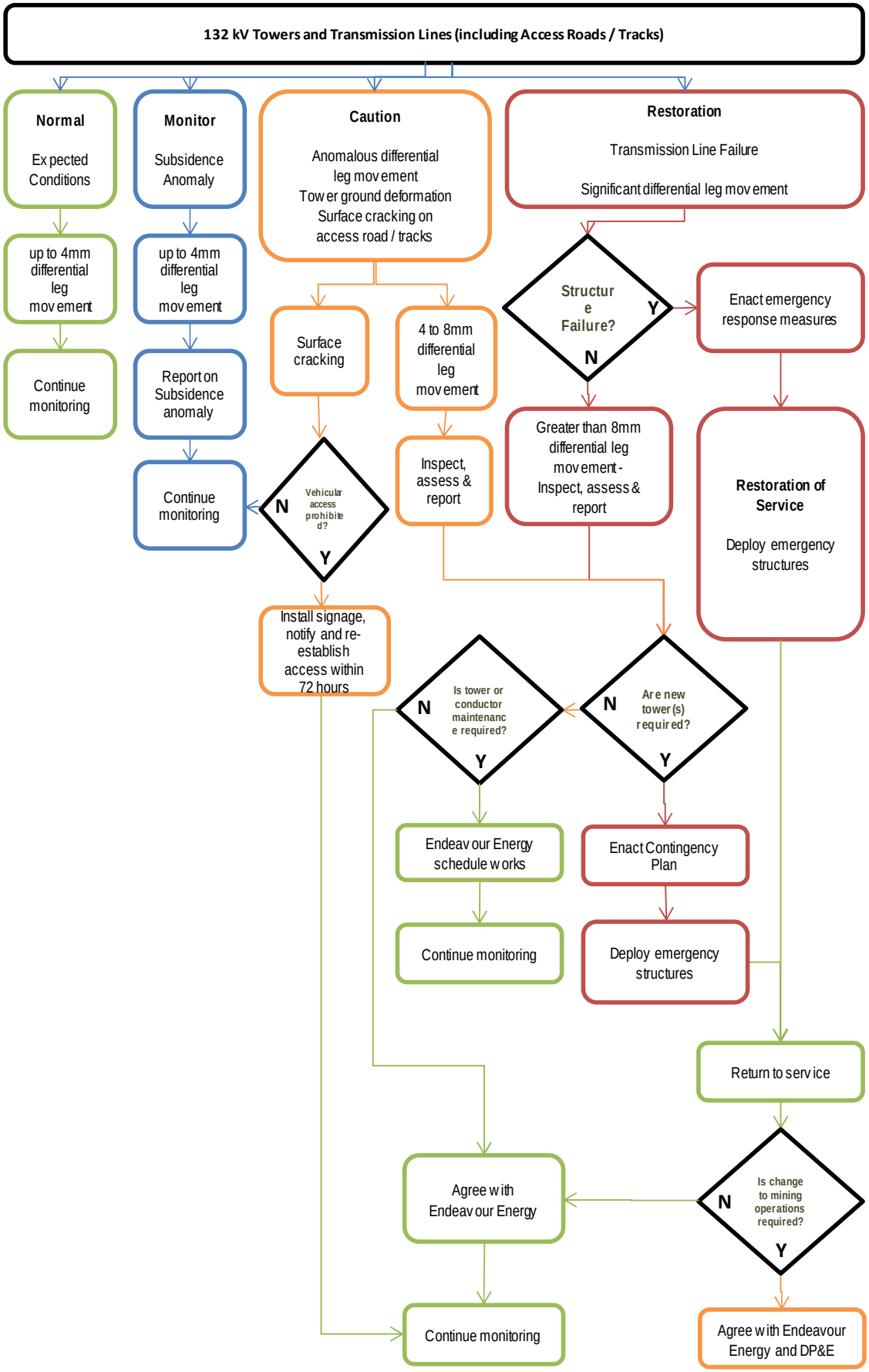
Management or Contingency Measures Implemented:

Effectiveness of Management or Contingency Measures:

APPENDIX 4

CONTINGENCY PLAN PROCEDURE AND DECISION TREE


Subsidence Impact
Exceeds performance indicator
Notify Technical Services Manager within 24hrs
Public safety risk?
N
Y
Implement public safety measures in accordance with Public Safety Management Plan
Record - Subsidence Impact Register
Report Exceedance to Endeavour Energy and DP&E
Investigate contributing factors
Develop proposed course of action with asset owner, submit to DP&E for approval
Endeavour Energy - see decision trees
Action approved?
N
Y
Implement course of action


132 kV Towers and Transmission Lines (including Access Roads / Tracks)
Normal
Expected Conditions
Monitor
Subsidence Anomaly
Caution
Anomalous differential leg movement
Tower ground deformation
Surface cracking on access road / tracks
Restoration
Transmission Line Failure
Significant differential leg movement
up to 4mm differential leg movement
up to 4mm differential leg movement
Continue monitoring
Report on Subsidence anomaly
Continue monitoring
Surface cracking
4 to 8mm differential leg movement
Structure Failure?
Y
N
Enact emergency response measures
Greater than 8mm differential leg movement - Inspect, assess & report
Restoration of Service
Deploy emergency structures
Inspect, assess & report
N
Vehicular access prohibited?
Y
Install signage, notify and re-establish access within 72 hours
N
Is tower or conductor maintenance required?
Y
N
Are new tower(s) required?
Y
Endeavour Energy schedule works
Continue monitoring
Enact Contingency Plan
Deploy emergency structures
Return to service
Agree with Endeavour Energy
N
Is change to mining operations required?
Y
Continue monitoring
Agree with Endeavour Energy and DP&E

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BUILT FEATURES MANAGEMENT PLAN
TRANSGRID

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&E Approval Date
All	LW301-303 BFMP_TRA-R01-A	Original – Draft for Consultation	TransGrid, DRG and DP&E	-
Sections 4.2.3, 7.2 & 9.1 and Tables 6, 9 & 10.	LW301-303 BFMP_TRA-R01-B	Revised – Incorporating Table 9 and updates	TransGrid	-
Sections 4.2.2 & 9.1, Table 6 and Figure 4	LW301-303 BFMP_TRA-R01-C	Revised – Incorporating TransGrid edits (email 2 Nov 16)	TransGrid, DRG and DP&E	11 May 2017*
Section 7.3.2, Tables 2, 8 & 12 and Appendix 3	LW301-303 BFMP_TRA-R01-D	Revised – Addressing DP&E and DRG requirements	TransGrid	-
Section 6.1 and Tables 8 & 11	LW301-303 BFMP_TRA-R01-E	Revised – Incorporating TransGrid edits (email 26 Jun 17)	TransGrid, DRG and DP&E	-
All	LW301-303 BFMP_TRA-R01-F	Revised TARP. Revised for LW 303	TransGrid and DRG	8 November 2018#
All	BFMP_TRA-R01-G	Inclusion of Longwall 304 into BFMP	TransGrid	-

* The approval allows for the extraction of Longwalls 301 and 302 only.

Approval for the extraction of Longwall 303.

April 2019

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Appendix 2 MSEC (2019) Metropolitan Colliery – Proposed Longwall 304 – Subsidence Predictions and Impact Assessments for the TransGrid 330 kV Transmission Line

Appendix 3 Built Features Management Plan – Subsidence Impact Register

Appendix 4 Contingency Plan Procedure and Decision Tree

1 INTRODUCTION

Metropolitan Coal is a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under section 75J of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com).

The Project comprises the continuation, upgrade and extension of underground coal mining operations (Longwalls 20-27 and Longwalls 301-317) and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1. Following the completion of Longwall 27 in 2017, Longwalls 301, 302, 303 and 304 define the next mining sub-domains within the Project underground mining area (Figures 1 to 3).

1.1 PURPOSE AND SCOPE

In accordance with Condition 6(f), Schedule 3 of the Project Approval, this Built Features Management Plan – TransGrid (BFMP-TRA) has been developed to manage the potential consequences of longwall extraction on the TransGrid assets.

The relationship of this BFMP-TRA to the Metropolitan Coal Environmental Management Structure and to the Metropolitan Coal Longwalls 301-304 Extraction Plan is shown on Figure 4.

In accordance with Condition 6, Schedule 3 of the Project Approval, the suitably qualified and experienced experts that have prepared this BFMP-TRA, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and Metropolitan Coal were endorsed by the Director-General (now Secretary) of the Department of Planning (DP&E). This BFMP-TRA has been prepared in consultation with TransGrid, including consideration of prior consultation during the development of the previously approved Built Features Management Plans.

1.2 STRUCTURE OF THE BFMP-TRA

The remainder of the BFMP-TRA is structured as follows:

Section 2: Describes the review and update of the BFMP-TRA.

Section 3: Outlines the statutory requirements applicable to the BFMP-TRA.

Section 4: Provides a revised assessment of the potential subsidence impacts and environmental consequences for Longwalls 301-304.

Section 5: Details the performance measures and indicators that will be used to assess the Project.

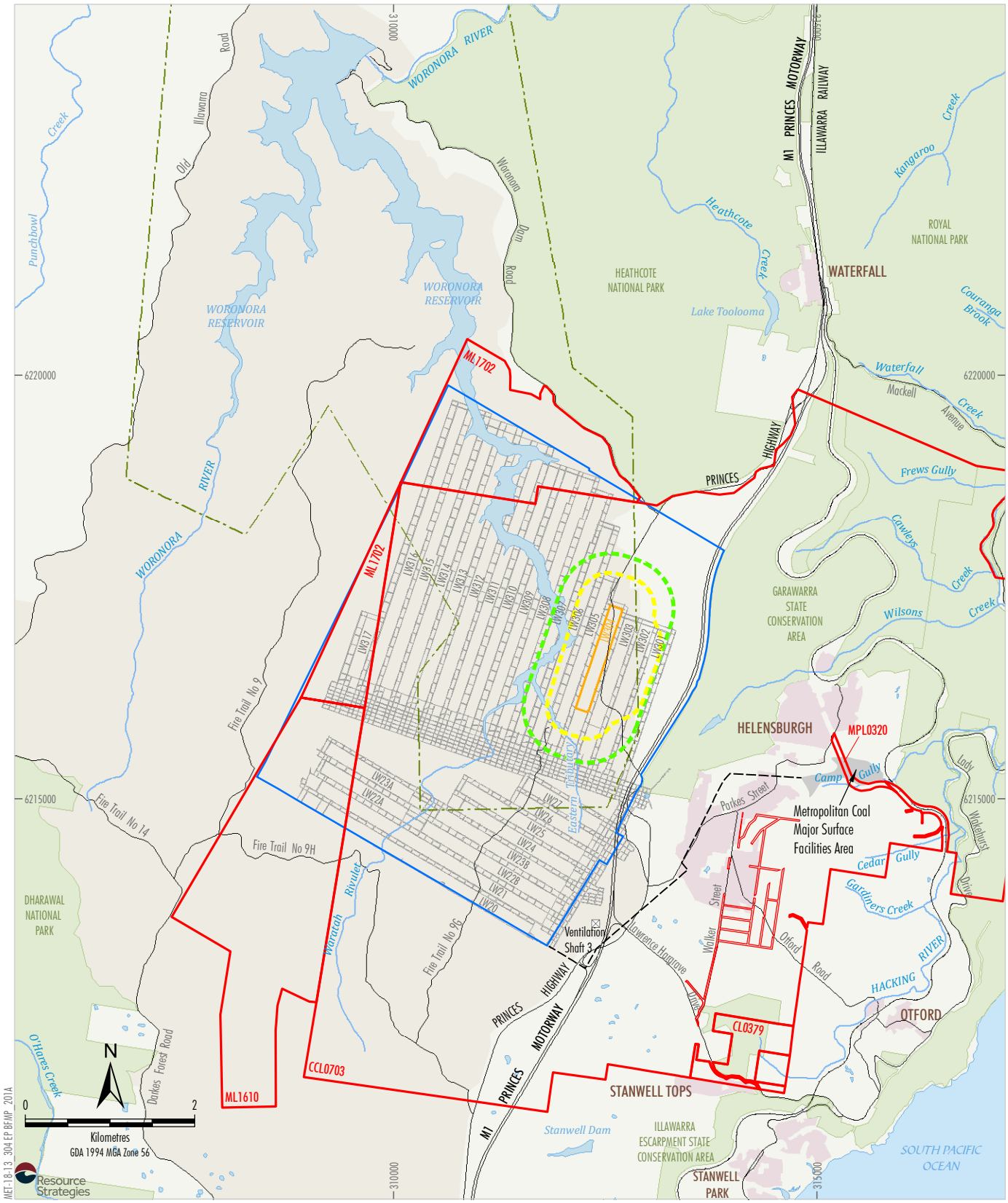
Section 6: Provides the detailed baseline data.

Section 7: Describes the monitoring program.

Section 8: Describes the management measures that will be implemented.

Section 9: Provides a contingency plan to manage any unpredicted impacts and their consequences.

Section 10: Describes the Trigger Action Response Plan (TARP) management tool.



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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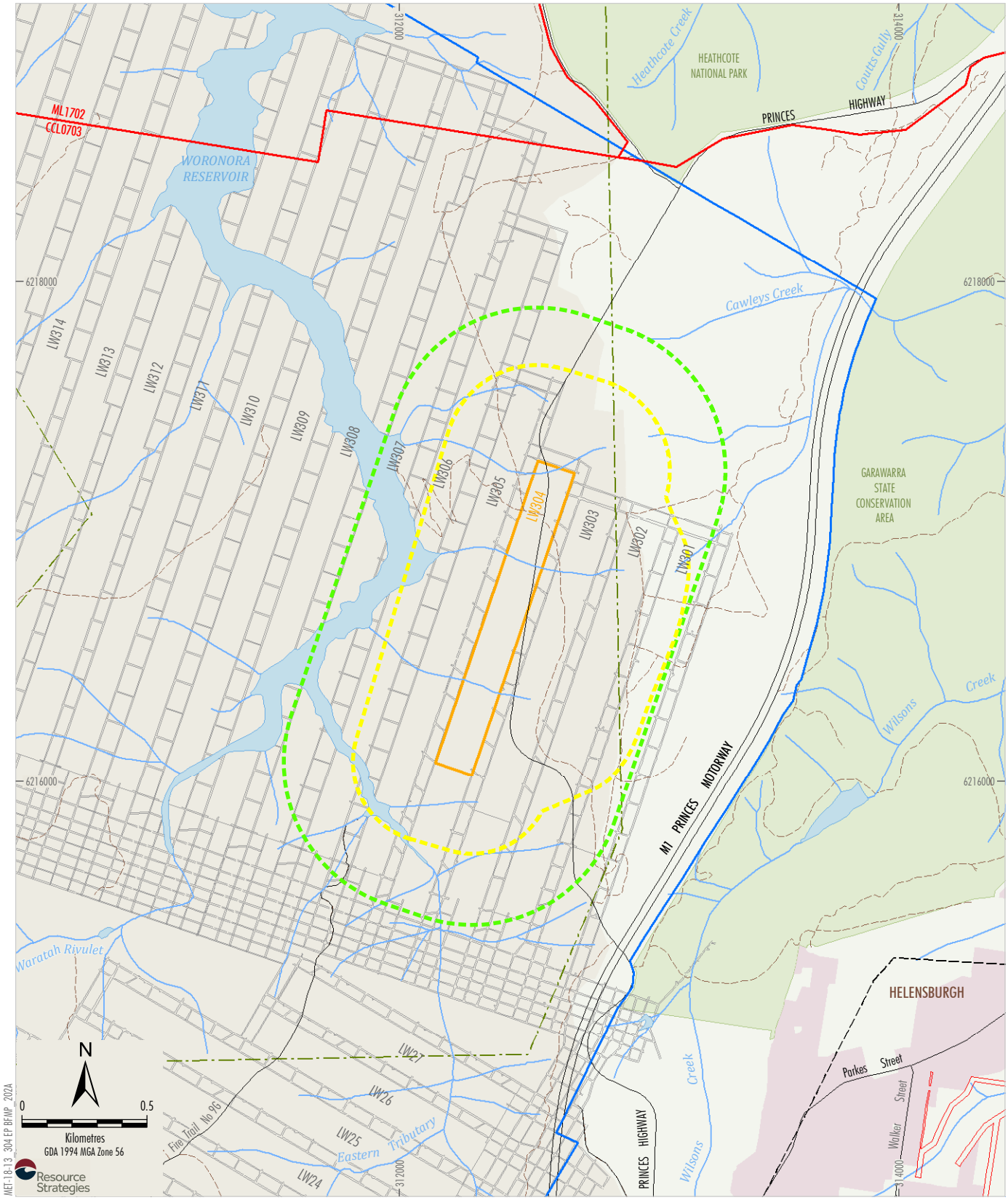
Longwalls 20-27 and Longwalls 301-317 Layout

Figure 1



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)
- Vehicular Track

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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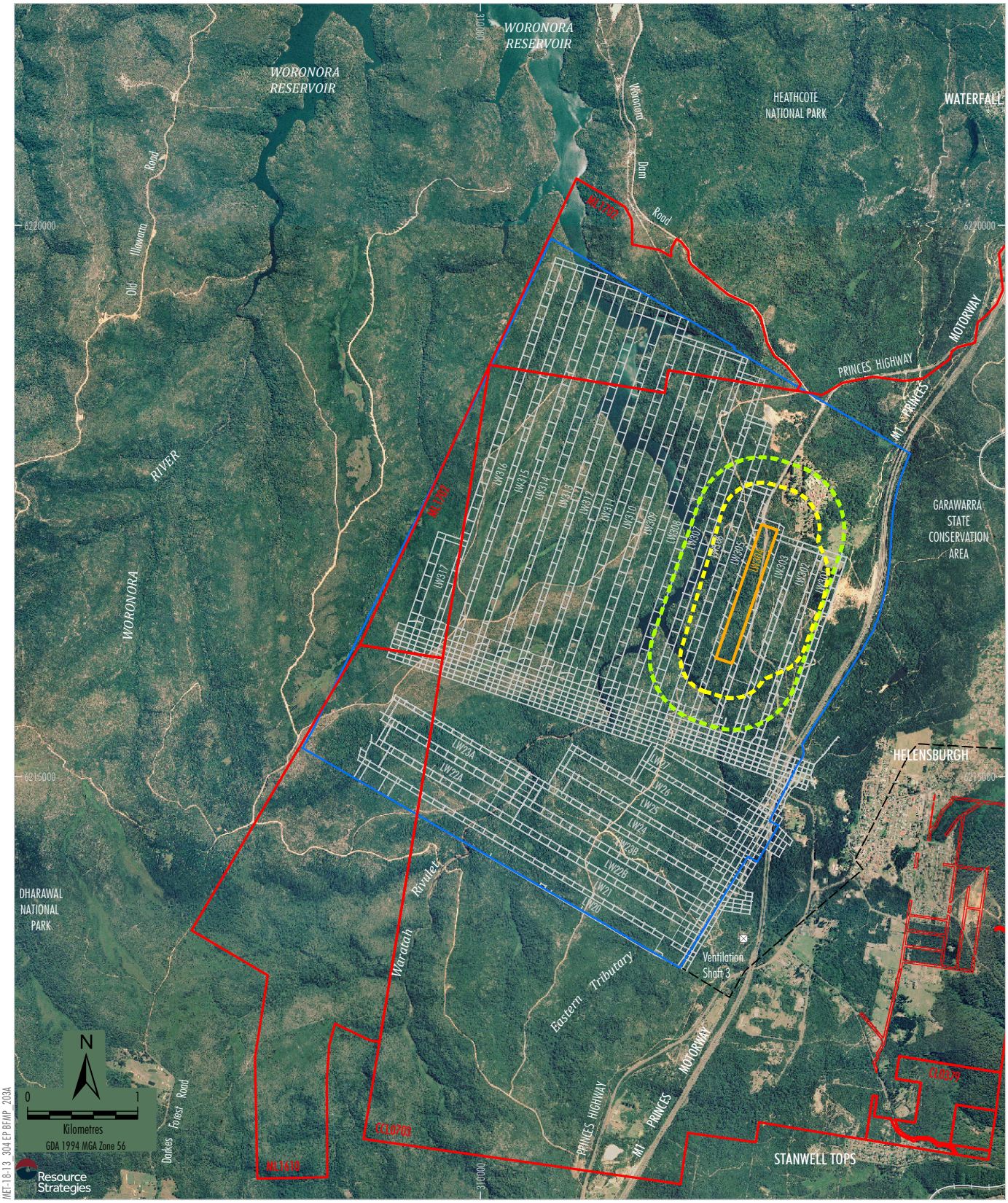
Longwalls 301-304 Layout

Figure 2



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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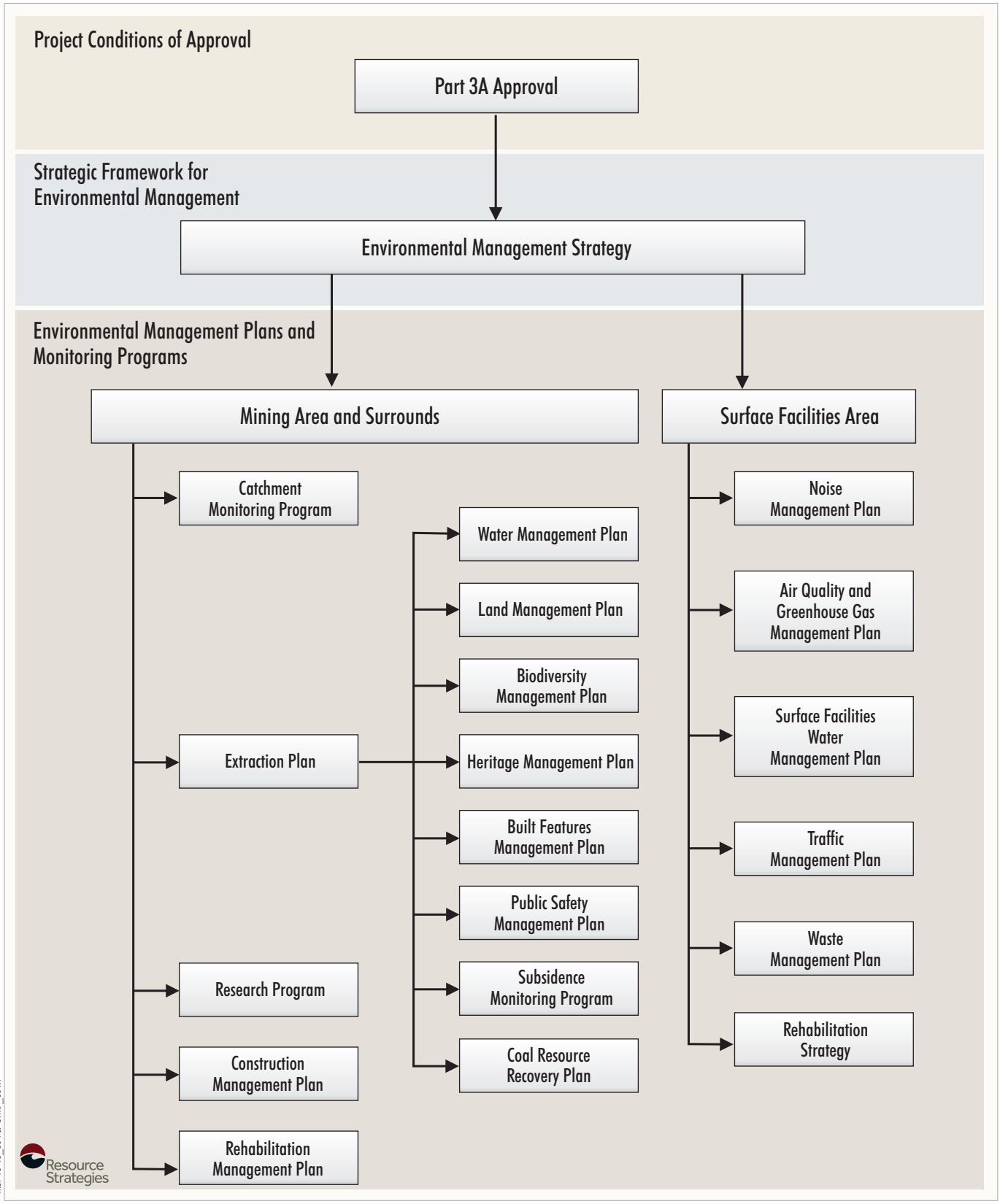
Longwalls 20-27 and Longwalls 301-317 Layout - Aerial Photograph

Figure 3



MET-18-13_304 EP BHMP_001A

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Environmental Management Structure

Figure 4

Section 11: Describes the program to collect sufficient baseline data for future Extraction Plans.

Section 12: Describes the annual review and improvement of environmental performance.

Section 13: Outlines the management and reporting of incidents.

Section 14: Outlines the management and reporting of complaints.

Section 15: Outlines the management and reporting of non-compliances with statutory requirements.

Section 16: Lists the references cited in this BFMP-TRA.

2 BFMP-TRA REVIEW AND UPDATE

In accordance with Condition 4, Schedule 7 of the Project Approval, the BFMP-TRA will be reviewed within three months of the submission of:

- an audit under Condition 8 of Schedule 7;
- an incident report under Condition 6 of Schedule 7;
- an annual review under Condition 3 of Schedule 7; and

if necessary, revised to the satisfaction of the Director-General (now Secretary) of the DP&E, to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

This BFMP will also be reviewed within three months of approval of any Project modification and if necessary, revised to the satisfaction of the DP&E.

The revision status of this plan is indicated on the title page of each copy of the BFMP-TRA. The distribution register for controlled copies of the BFMP-TRA is described in Section 2.1.

Revisions to any documents listed within this BFMP-TRA will not necessarily constitute a revision of this document.

2.1 DISTRIBUTION REGISTER

In accordance with Condition 10, Schedule 7 'Access to Information', Metropolitan Coal will make the BFMP-TRA publicly available on the Peabody website. A hard copy of the BFMP-TRA will also be maintained at the Metropolitan Coal site.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format. An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom the Metropolitan Coal plans and programs, such as the BFMP-TRA, will be distributed;
- the format (i.e. electronic or hard copy) of distribution; and
- the format of revision notification.

Metropolitan Coal will make the Distribution Register publicly available on the Peabody website.

Metropolitan Coal will be responsible for maintaining the Distribution Register and for ensuring that the notification of revisions is sent by email or post as appropriate.

In addition, Metropolitan Coal employees with local computer network access will be able to view the controlled electronic version of this BFMP-TRA on the Metropolitan Coal local area network. Metropolitan Coal will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on Metropolitan Coal's computer system and the Peabody website.

3 STATUTORY REQUIREMENTS

Metropolitan Coal's statutory obligations are contained in:

(i) the conditions of the Project Approval;

(ii) relevant licences and permits, including conditions attached to mining leases; and

(iii) other relevant legislation.

These are described below.

3.1 EP&A ACT APPROVAL

Condition 6(f), Schedule 3 of the Project Approval requires the preparation of a BFMP as a component of Extraction Plan(s) for second workings. Project Approval Condition 6(f), Schedule 3 states:

> ***SECOND WORKINGS***
>
> ***Extraction Plan***
>
> *6. The Proponent shall prepare and implement an Extraction Plan for all second workings in the mining area to the satisfaction of the Director-General. This plan must:*
>
> *…*
>
> *(f) include a:*
>
> *…*
>
> - *Built Features Management Plan, which has been prepared in consultation with the owner of the relevant feature, to manage the potential environmental consequences of the Extraction Plan on any built features;*

In addition, Condition 2, Schedule 7 and Condition 7, Schedule 3 of the Project Approval outline management plan requirements that are applicable to the preparation of the BFMP-TRA. Table 1 indicates where each component of the conditions is addressed within this BFMP-TRA.

Table 1
Management Plan Requirements

Project Approval Condition	BFMP-TRA Section
Condition 2 of Schedule 7	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Section 6
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 3
• any relevant limits or performance measures/criteria;	Section 5
• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 5
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Sections 7, 8, 9 and 10
d) a program to monitor and report on the:	Sections 7, 8 and 12
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 9 and Appendix 4
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Sections 7 and 12
g) a protocol for managing and reporting any;	
• incidents;	Section 13
• complaints;	Section 14
• non-compliances with statutory requirements; and	Section 15
• exceedances of the impact assessment criteria and/or performance criteria; and	Section 9 and Appendix 4
h) a protocol for periodic review of the plan.	Section 2
Condition 7 of Schedule 3	
7. In addition to the standard requirements for management plans (see condition 2 of schedule 7), the Proponent shall ensure that the management plans required under condition 6(f) above include:	
a) a program to collect sufficient baseline data for future Extraction Plans;	Section 11
b) a revised assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval;	Section 4
c) a detailed description of the measures that would be implemented to remediate predicted impacts; and	Section 8
d) a contingency plan that expressly provides for adaptive management.	Section 9 and Appendix 4

3.2 LICENCES, PERMITS AND LEASES

In addition to the Project Approval, all activities at or in association with the Metropolitan Coal Mine will be undertaken in accordance with the following licences, permits and leases which have been issued or are pending issue:

- The conditions of mining leases issued by the NSW Division of Resources and Geoscience (DRG), under the NSW *Mining Act, 1992* (e.g. Consolidated Coal Lease [CCL] 703, Mining Lease [ML] 1610, ML 1702, Coal Lease [CL] 379 and Mining Purpose Lease [MPL] 320).
- The Metropolitan Coal Mining Operations Plan 1 October 2012 to 30 September 2019 approved by the DRG.
- The conditions of Environment Protection Licence (EPL) No. 767 issued by the NSW Environment Protection Authority (EPA) under the NSW *Protection of the Environment Operations Act, 1997*. Revision of the EPL will be required prior to the commencement of Metropolitan Coal activities that differ from those currently licensed.
- The prescribed conditions of specific surface access leases within CCL 703 for the installation of surface facilities as required.
- Water Access Licences (WALs) issued by the NSW Department of Primary Industries – Water (now the Department of Industry – Water) under the NSW *Water Management Act, 2000*, including WAL 36475 under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* and WAL 25410 under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*.
- Mining and workplace health and safety related approvals granted by the NSW Resources Regulator and WorkCover NSW.
- Supplementary approvals obtained from WaterNSW for surface activities within the Woronora Special Area (e.g. fire road maintenance activities).

3.3 OTHER LEGISLATION

Metropolitan Coal will conduct the Project consistent with the Project Approval and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to the conduct of the Project (Helensburgh Coal Pty Ltd [HCPL], 2008)[1]:

- *Biodiversity Conservation Act, 2016;*
- *Biosecurity Act, 2015;*
- *Contaminated Land Management Act, 1997;*
- *Crown Land Management Act, 2016;*
- *Dams Safety Act, 2015;*
- *Dangerous Goods (Road and Rail Transport) Act, 2008;*
- *Energy and Utilities Administration Act, 1987;*
- *Fisheries Management Act, 1994;*

[1] The list of potentially applicable Acts has been updated to reflect changes to the Acts that were in force at the time of submission of the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008).

- *Mining Act, 1992;*
- *Protection of the Environment Operations Act, 1997;*
- *Rail Safety (Adoption of National Law) Act, 2012;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Water NSW Act, 2014;*
- *Work Health and Safety Act, 2011; and*
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

Relevant licences or approvals required under these Acts will be obtained as required.

4 REVISED ASSESSMENT OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

4.1 EXTRACTION LAYOUT

Longwalls 301-304 and the area of land within 600 metres (m) of Longwall 304 secondary extraction are shown on Figures 2 and 3. Longwall extraction occurs from north to south. The longwall layouts include 163 m panel widths (void) with 45 m pillars (solid).

The provisional extraction schedule for Longwalls 301-304 is provided in Table 2.

Table 2
Provisional Extraction Schedule

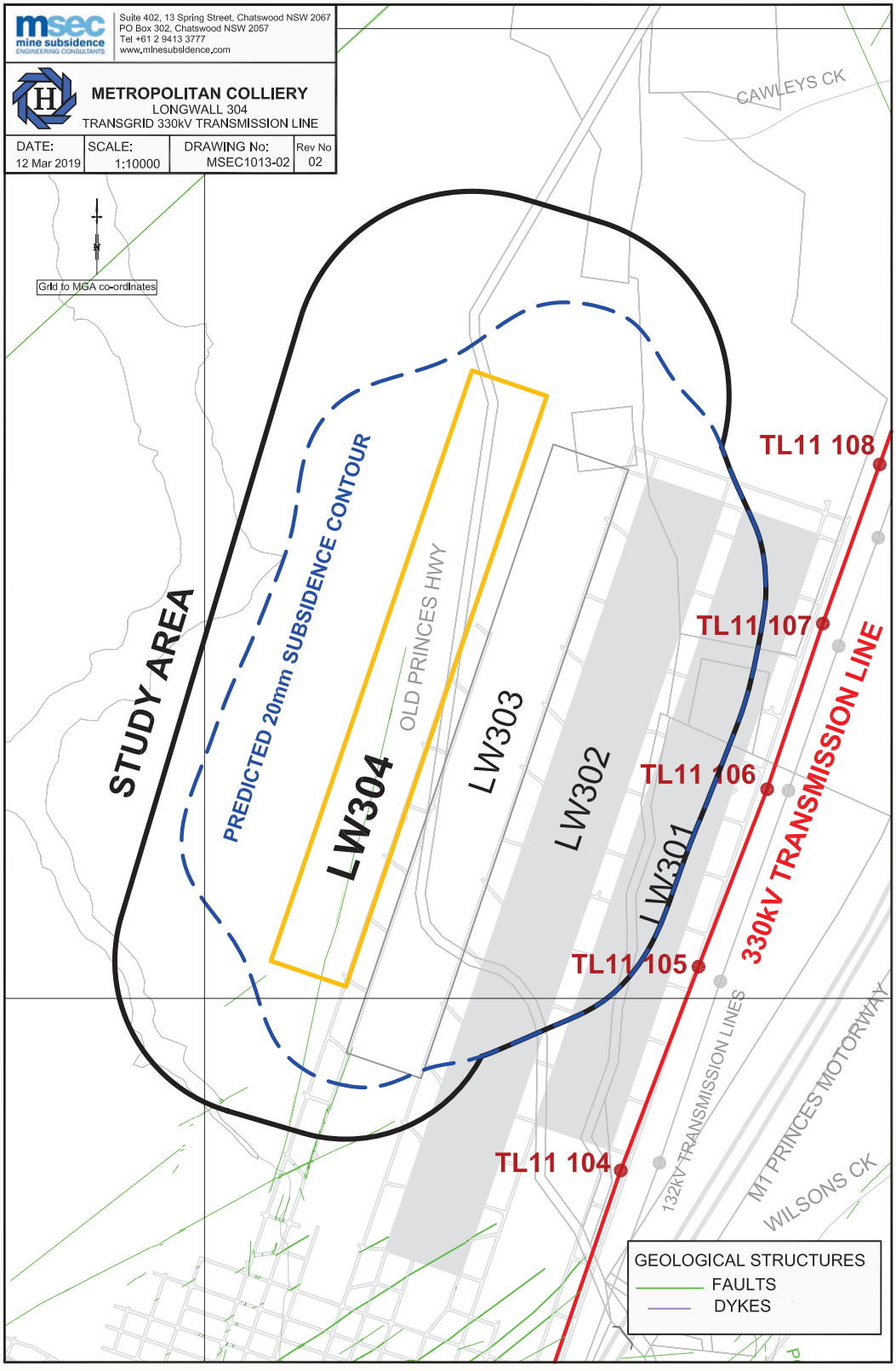
Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
301	June 2017	6 months	February 2018
302	March 2018	7 months	October 2018
303	November 2018	7 months	May 2019
304	July 2019	6 months	December 2019

The future Extraction Plans will consider the cumulative subsidence effects, subsidence impacts and/or environmental consequences. Note that the total cumulative predicted subsidence effects, subsidence impacts and/or environmental consequences at the completion of the Project are considered in the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008) and the Preferred Project Report (HCPL, 2009).

4.1.1 TransGrid Assets

Figure 5 illustrates the TransGrid 330 kilovolt (kV) transmission line and towers. The 330 kV transmission line is composed of:

- Transmission (suspension) towers (field numbers TL11-104 to TL11-108) located to the east of the study area for Longwall 304; and
- Dapto to Sydney South 330 kV Transmission Line (Feeder number 11).



MET-18-13_304 EP BHMP_006A

Source: MSEC (2019)

Figure 5

There are no tension towers within the Study area for Longwall 304. The transmission line is 670 m from Longwall 304 at its nearest point.

The 330 kV transmission line and towers are located to the east of Longwalls 301-304 and the longwall will not pass beneath these electrical services. There are five towers located near the 35 degree angle of draw and/or predicted 20 mm subsidence line around Longwall 304 as shown on Drawing No. MSEC1013-02 (Figure 5). The distances from the towers to the nearest longwalls are summarised in Table 3 below.

Table 3
Transmission Towers Distance to Longwalls 301-304

Tower Number	Tower Type	Approximate Distance to Longwall 301 (m)	Approximate Distance to Longwall 304 (m)
TL11-104	Suspension	50	680
TL11-105	Suspension	50	670
TL11-106	Suspension	70	680
TL11-107	Suspension	70	690
TL11-108	Suspension	195	700

4.2 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

4.2.1 Revised Subsidence Predictions

Subsidence predictions for Longwalls 20-44 in relation to the TransGrid assets was conducted by MSEC (2008) as part of the Metropolitan Coal Project EA. MSEC (2008) includes a table summarising the incremental systematic subsidence parameters for the extraction of each longwall from Longwalls 20-44. These include:

- maximum predicted incremental subsidence (vertical movement);
- maximum predicted incremental tilt along alignment;
- maximum predicted incremental tilt across alignment;
- maximum predicted incremental tensile strain; and
- maximum predicted incremental compressive strain.

Revised subsidence and impact predictions for the extraction of Longwalls 301-303 on TransGrid assets were conducted by MSEC and reported in MSEC (2016) (Appendix 1) and again for Longwall 304 MSEC (2019) (Appendix 2). The maximum predicted total systematic subsidence parameters in relation to the transmission lines for the extraction of Longwalls 301-304 is shown in Table 4. The maximum predicted total systematic subsidence parameters at the transmission towers for the extraction of Longwalls 301-304 is shown in Table 5.

Table 4
Total Subsidence Predictions for the Transmission Line After Longwalls 301-304

Longwall	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt along Alignment (mm/m)	Maximum Predicted Total Tilt across Alignment (mm/m)
After LW301	60	<0.5	0.5
After LW302	110	0.5	1.0
After LW303	140	0.5	1.0
After LW304[2]	140	0.5	1.0

Source: Table 3 in MSEC (2016) (Appendix 1) and MSEC (2019).
Mm = millimetres.
Mm/m = millimetres per metre.

Table 5
Total Subsidence Predictions for the Towers After Longwalls 301-304

Field Tower	Maximum Predicted Total Subsidence (mm)				Maximum Predicted Total Tilt Along Alignment at Base of the Tower (mm/m) [+ve north; -ve south]	Maximum Predicted Total Tilt Across Alignment at Base of the Tower (mm/m) [+ve east; -ve west]
	After LW301	After LW302	After LW303	After LW304[3]		
TL11-104	<20	40	50	50	<± 0.5	<± 0.5
TL11-105	40	100	125	125	<± 0.5	- 1.0
TL11-106	30	90	100	100	<± 0.5	- 0.5
TL11-107	30	90	100	100	<± 0.5	- 0.5
TL11-108	<20	30	50	50	<± 0.5	<± 0.5

Source: Tables 4 and 5 in MSEC (2016) (Appendix 1) and MSEC (2019).

The maximum predicted subsidence of 125 mm and total tilt of 1.0 mm/m both occur at Tower TL11-105 after the extraction of Longwall 303. The maximum predicted horizontal movement at the top of the towers (i.e. T11-105) is -60 mm orientated to the west (towards the longwalls).

Revised subsidence and impact predictions for the extraction of Longwall 304 on TransGrid assets were conducted by MSEC and reported in MSEC (2019) (Appendix 2). In summary:

- The transmission line is not expected to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwall 304.
- The transmission towers could experience low level far-field horizontal movement. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield, which tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain.
- It is considered unlikely that the transmission lines would experience adverse impacts as a result of predicted movements due to the extraction of Longwall 304.

[2] After Longwall 303 the transmission line is not expected to experience further measurable conventional subsidence, tilts or curvatures due to the extraction Longwall 304.

[3] After Longwall 303 the transmission towers are not expected to experience further measurable conventional subsidence, tilts or curvatures due to the extraction Longwall 304.

4.2.2 Risk Assessment Meeting

In accordance with the *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) a risk assessment meeting for Longwalls 301-303 was held on 26 August 2016. Attendees at the risk assessment meeting included representatives from Metropolitan Coal, TransGrid, MSEC, Resource Strategies and Axys Consulting (risk assessment facilitator).

The investigation and analysis methods used during the risk assessment included:

- preliminary identification of TransGrid assets;
- review of the revised subsidence predictions and potential impacts on TransGrid assets (including consideration of past experience in the Southern Coalfield); and
- development of a preliminary monitoring plan.

A number of risk control measures and procedures were identified and implemented during the risk assessment which considered the extraction of coal beneath the land within the Study area and in proximity to the TransGrid assets.

The risk control measures and procedures identified during the risk assessment for Longwalls 301-303 will be implemented and continued for the extraction of Longwall 304. The transmission line is not predicted to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwall 304.

Metropolitan Coal considers all risk control measures and procedures to be feasible to manage all identified risks.

The proposed risk control measures and procedures have been incorporated where relevant in this BFMP and the program for implementation is summarised in Table 6.

Table 6
Program for Implementation of Proposed Risk Control Measures and Procedures

	Risk Control Measure / Procedure	BFMP Section	Timing
Baseline Data / Validation			
1	Carry out a visual / baseline audit of the TransGrid assets (i.e. 330 kV transmission line and towers) in the Study area	Section 6	Complete
2	Conduct a visual inspection of the access roads/tracks to the TransGrid assets	Section 7.3.2	Complete
Management / Monitoring / Response Measures			
3	Establish key contacts list in the BFMP	Section 6.1	Complete
4	Include a schedule of times/frequency of communication with TransGrid for the status of mining of Longwalls 301-303 in the BFMP	Sections 7 and 10 / Table 2	Complete
5	Provide indicative timeframes in the BFMP between when the survey monitoring is carried out and information is provided to TransGrid	Section 7.3.1	Complete
6	Provide an indicative timeframe for the implementation of real-time monitoring for the towers	Section 7.3.1	Complete
7	Include in the BFMP, increased monitoring frequency to be implemented from the commencement of extraction of Longwall 301 with focus on the first tower(s) that may be affected (TL11-107 and TL11-108)	Section 7 / Table 8	Complete
8	Include in the TARP triggers for conditions that may need to be actioned by TransGrid	Section 10 / Table 11	Complete
9	Include in the BFMP relevant details regarding the potential for underground blast vibration impacts at the surface	Section 4.3	Complete

Table 6 (Continued)
Program for Implementation of Proposed Risk Control Measures and Procedures

	Risk Control Measure / Procedure	BFMP Section	Timing
10	TransGrid to confirm if any maintenance activities or capital works are scheduled for the towers within the Study area during the extraction of Longwall 301-303	Section 4.2.3	As required
Contingency Planning			
11	Undertake preliminary design works for contingency measures. This may include the opportunity to purchase/obtain emergency tower structures that could be used as a contingency	Section 9.1	Complete
12	TransGrid to determine where emergency towers could be installed in the Study area if required as a contingency	Section 9.1	Complete

4.2.3 TransGrid Impact Assessment

TransGrid carried out an assessment of the impacts of the predicted subsidence on the 330 kV transmission line and towers based on MSEC (2016) predictions. In summary:

- Cruciforms are not necessary.
- Conductor sheaves are not necessary.
- Earthwire sheaves are not necessary.
- Survey monitoring is necessary for towers legs.

TransGrid will inform Metropolitan Coal if any maintenance activities and/or capital works are scheduled for the towers within the Study area.

4.3 UNDERGROUND BLAST VIBRATION IMPACTS

Use of explosives is not required for existing or proposed general underground coal mining. Occasionally, geological structures (e.g. dykes) may be encountered underground that have to be broken up using very low mass explosives. This underground blasting would be undertaken at significant depth (e.g. greater than 400 m below the surface).

Ground vibration and airblast levels which cause human discomfort are generally lower than the recommended structural damage limits. Therefore, compliance with the lowest applicable human comfort criteria ensures that the potential to cause structural damage is minimal. Based on the assessment results presented in the Metropolitan Coal Project Noise Impact Assessment (Heggies, 2008), ground vibration levels are predicted to meet the most stringent night-time criteria of 1 mm/s at a distance of 500 m from the blast site. As blasting is conducted at least 400 m below the surface, vibration impacts are likely to be minimal (which is consistent with the existing Metropolitan Colliery blasting practices and experience).

5 PERFORMANCE MEASURES AND INDICATORS

The Project Approval requires Metropolitan Coal not to exceed the subsidence impact performance measures outlined in Table 1 of Condition 1, Schedule 3. The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

> *Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.*

The performance indicators proposed to ensure that the above performance measure is achieved include:

- the structural integrity of the transmission line and towers is maintained;
- the electrical clearance from vegetation is maintained; and
- the serviceability of the access roads/tracks is maintained.

Section 7 of this BFMP-TRA describes the monitoring that will be conducted to assess the Project against the above performance measure. Section 9 of this BFMP-TRA provides a Contingency Plan in the event the performance measure is exceeded.

6 BASELINE DATA

A photograph of a 330 kV transmission tower is shown in Plate 1.

Plate 1 – 330 kV Transmission Tower (Source: MSEC, 2016)

A site inspection of the 330 kV line was conducted prior to commencement of secondary extraction of Longwall 301 to establish the condition of the line. The inspection included:

- recording of existing structure conditions;
- two dimensional image records of the affected structures; and
- condition of the access road/tracks with specific attention to surface cracks.

6.1 KEY CONTACTS LIST

The list of key contacts for Peabody and TransGrid during the development and implementation of this BFMP are provided in Table 7.

Table 7
List of Key Contacts

Company	Position	Contact
Peabody (Metropolitan Coal)	Manager – Technical Services Jon Degotardi	Metropolitan 24hr Control Room 02 4294 7333
TransGrid	Proposal Manager John Psarologos	Transgrid 24hr Contact 1800 027 253 Transgrid General Enquiry 02 9284 3000

If an emergency situation arises and alternative supply is required, the following TransGrid stakeholders would be notified:

- TransGrid System Operation
  - phone: 02 9620 0102;
  - email: system.operator@transgrid.com.au
- TransGrid Maintenance Group
  - phone: 02 9620 0350;
  - email: TransmissionLinesandEasementsMaintenance@transgrid.com.au

7 MONITORING

A monitoring program has been implemented to monitor the impacts of the Project on the 330 kV transmission line and access roads/tracks as determined in consultation with TransGrid. Table 8 summarises the BFMP-TRA monitoring components.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts for comparison with baseline photographic records.

TransGrid or their delegates will conduct the various visual inspections. Metropolitan Coal will be notified of the timing of inspections and accompany TransGrid or delegates if considered necessary. All personnel will complete necessary inductions or orientation relevant to the tasks required.

The frequency of monitoring will be reviewed either:

- in accordance with the Annual Review outlined in Section 12; or
- if triggered as a component of the Contingency Plan as outlined in Section 9 of this BFMP-TRA.

Table 8
BFMP-TRA Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Baseline	Towers (TL11-104 to TL11-108)	Relative Survey	4 x ground points outside each leg for each tower	Establish base conditions	Prior to Longwalls 301 and 304 extraction	Twice
			4 x tower leg mounted prisms for each tower	Establish base condition	Prior to Longwalls 301 and 304 extraction	Twice
		Condition Report (recording of existing structure conditions and two-dimensional image records of structures)		Establish base condition	Prior to Longwalls 301 and 304 extraction	Twice
	Transmission Line (between TL11-104 to TL11-108)	Survey	Whole line between TL11-104 to TL11-108	Establish base conditions (including clearance heights for roads, land and vegetation)	Prior to Longwalls 301 and 304 extraction	Twice
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Establish base condition	Prior to Longwall 301 and 304 extraction	Twice
During Mining	Towers (TL11-104 to TL11-108)	Relative Survey	4 x Ground points outside each leg for each tower	Monitor subsidence effects during mining (subsidence, tilt, strain, absolute horizontal translation)	LW301-302 At each tower within 400 m of the active longwall face until subsidence negligible	LW301-302 Weekly
					LW303 - 304 (outside 400 m zone) at each tower monthly during extraction	LW303-304 Monthly
			4 x tower leg mounted prisms for each tower	Monitor subsidence effects during mining (differential leg movement)	LW301-302 At each tower within 400 m of the active longwall face until subsidence negligible	LW301-302 Weekly
					LW303 - 304 (outside 400 m zone) at each tower monthly during extraction	LW303-304 Monthly
			Earth wire peak point for each tower	Monitor subsidence effects during mining (tilt, absolute horizontal translation)	LW301-302 At each tower within 400 m of the active longwall face until subsidence negligible	LW301-302 Weekly
					LW303 - 304 (outside 400 m zone) at each tower monthly during extraction	LW303-304 Monthly

Table 8 (Continued)
BFMP-TRA Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
During Mining (Cont.)	Towers (TL11-104 to TL11-108) (Cont.)	Visual inspection	Field notes and observations recorded by surveyors	Monitor for evidence of subsidence effects on Towers including any observable surface deformations (e.g. degradation of foundations/ footings) or other subsidence related effects (noted quantitatively in regards width, length, orientation)	At each tower within 400 m of the active longwall face until subsidence negligible	Weekly
		Visual inspection (TransGrid)	Visual check by TransGrid of earth wire/ optical ground wire (OPGW), and for any conductor movement or impact on integrity and function of support clamps.		At any time in case of fault or emergency	
	Transmission Lines (between TL11-104 to TL11-108)	Survey	± 10 points either side of each tower	Monitor subsidence effects during mining (subsidence, tilt, absolute horizontal translation)	LW301-302 At each tower within 400 m of the active longwall face until subsidence negligible	LW301-302 Weekly
					LW303 - 304 outside 400 m zone at end of panel	LW303-304 End of panel
		Visual inspection	Field notes and observations recorded by surveyors	Monitor for evidence of subsidence effects on Transmission Lines including changes in clearance heights for roads, land and vegetation, or movement of insulator strings	At each tower within 400 m of the active longwall face until subsidence negligible	Weekly
		Visual inspection (TransGrid)	Visual check by TransGrid of earth wire/ OPGW, and for any conductor movement or impact on integrity and function of support clamps.		At any time in case of fault or emergency	
	Access roads/tracks	Visual inspection	Field notes on general condition of access roads/tracks by surveyors	Monitor for surface cracks, buckling and general safety	At the completion of each longwall	Twice (once per Longwall 301 & 302)
					LW301-302 At each tower within 400 m of the active longwall face until subsidence negligible	LW301-302 Weekly
					As per Longwall 304 LMP	

Table 8 (Continued)
BFMP-TRA Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Post Mining	Towers (TL11-104 to TL11-108)	Survey	4 x ground points outside each leg for each tower	Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 302, 303 and 304	Once per longwall
			4 x tower leg mounted prisms for each tower	Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 302, 303 and 304	Once per longwall
			Earth wire peak point for each tower	Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 302, 303 and 304	Once per longwall
		Condition Report (recording of structure conditions and two-dimensional image records of structures)		Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 302, 303 and 304	Once per longwall
		Visual inspection (TransGrid)	Ground inspection	Validation	Next scheduled post mining	Twice
			Climbing inspection	Validation	Next scheduled post mining	Twice
	Transmission Lines (between TL11-104 to TL11-108)	Survey	± 10 points either side of each tower	Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 302, 303 and 304	Once per longwall
		Visual inspection (TransGrid)	Ground inspection	Validation	Next scheduled post mining	Twice
			Climbing inspection	Validation	Next scheduled post mining	Twice
	Access roads/tracks	Visual inspection	Field notes on general condition of access roads/tracks by surveyors	Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 302, 303 and 304	Once per longwall
		Visual inspection (TransGrid)	Ground inspection	Validation	Next scheduled post mining	Once

7.1 SUBSIDENCE PARAMETERS

Subsidence parameters (i.e. subsidence, tilt, tensile strain, compressive strain, absolute horizontal translation, and differential leg movement) associated with mining will be measured in accordance with the Longwall 304 Subsidence Monitoring Program (Figure 6).

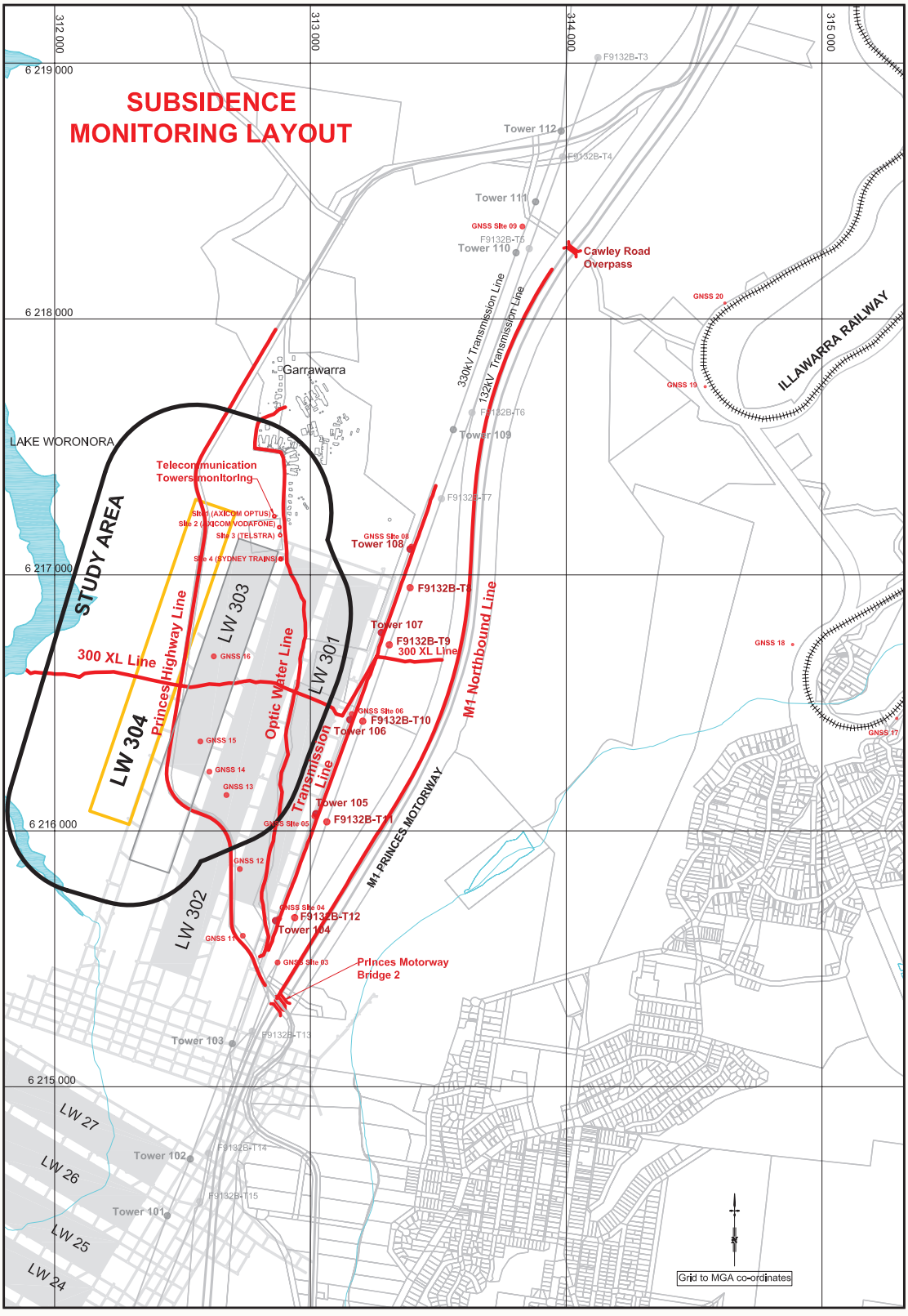
In summary, surveys will be conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence movements (i.e. subsidence, tilt, tensile strain and compressive strain) will be measured along subsidence lines that have been positioned across the general landscape.

Monitoring of subsidence parameters specific to the TransGrid 330 kV Transmission Line will be measured by a single survey line along the transmission corridor occupied by the transmission lines, and by survey of each tower (Towers TL11-104 to TL11-108).

The survey line within the transmission line corridor will consist of survey pegs or pins installed every 20 m (subject to terrain constraints) and measured by total station with a survey accuracy of ±20 mm.

7.2 SPECIFIC MONITORING FOR TOWERS TL11-104 TO TL11-108

The specific monitoring program developed in conjunction with TransGrid while mining near towers TL11-100 to TL11-102 has been extended to towers TL11-104 to TL11-108. This is detailed in Table 9.



MET-18-13_304 EP BFMP_017A

Source: MSEC (2019)

Peabody

METROPOLITAN COAL

Subsidence Monitoring Layout

Figure 6

Table 9
Monitoring Program Specific to Towers TL11-103 to TL11-108

Management Period	Monitoring	Trigger		Response
Baseline studies prior to mining	• Survey of monitoring lines/points. • Survey of Tower legs (TL11-104 to TL11-108). • Earth Peaks Monitoring.	• Documentation of base conditions.		• Document and report to: - TransGrid; and - Principal Subsidence Engineer – Department of Industries.
LW301-302 Mining within 400 m of towers: **TL11-104** **TL11-105** **TL11-106** **TL11-107** **TL11-108** **Minimum <u>weekly</u>** monitoring frequency unless trigger requires otherwise **LW303-304 Mining outside 400 m of towers:** **TL11-104** **TL11-105** **TL11-106** **TL11-107** **TL11-108** **Minimum <u>monthly</u>** monitoring frequency unless trigger requires otherwise	**Survey Monitoring** For each survey event at each tower carry out the following survey monitoring: • Survey 4 x ground monitoring points outside each leg. • Survey 4 x tower leg mounted prisms. • Survey the earth wire peak point. • For LW301-302 survey transmission line ± 10 points either side of the tower being monitored. **Visual Monitoring** For each survey event the surveyors will record on their field notes and provide in the weekly report the following: • Any observable surface deformations or other subsidence related effects at the tower being surveyed. • Any observable subsidence effects on the road accessing each tower. • Any observable effects will be noted quantitatively in regards width, length, orientation.	**GREEN**	• Less than <4 mm separation between tower leg; *and/or* • No observable surface deformations at a tower; *and/or* • Survey data within predictions.	• At monitoring frequency, document and report to: - TransGrid; and - NSW Principal Subsidence Engineer.
		ORANGE	• Separation between tower legs (4-8 mm); *and/or* • Observable surface deformations at a tower.	• Notify the following key stakeholders, as appropriate, within 24hrs of becoming aware of the trigger/s: - TransGrid; and - NSW Principal Subsidence Engineer. • Continue consultation with TransGrid. • Consult with TransGrid about increasing monitoring frequency.
		RED	• Separation between tower legs (>8mm); *and/or* • Observable surface deformations at a tower.	• Notify key stakeholders, as appropriate, immediately following awareness of the trigger/s being met: - TransGrid; and - NSW Principal Subsidence Engineer. • Undertake additional 3D survey and check against pre-mining monitoring data and review against predictions. • Consult with TransGrid about increasing monitoring frequency. • Undertake visual inspections accordingly. • Liaise with asset owner TransGrid regarding any remediation action/s plan. • Report monitoring data to NSW Principal Subsidence Engineer within 48hrs following collection of data. • Review mining options.
Post mining	• Survey of monitoring lines/points. • Survey of Tower legs (TL11-104 to TL11-108). • Earth Peaks Monitoring.	• Check against subsidence predictions and baseline survey.		• Undertake relative 3D survey and review against predictions. • Document actual subsidence against predictions. • Report monitoring data to TransGrid. • Report NSW Principal Subsidence Engineer.

7.3 SUBSIDENCE IMPACTS

7.3.1 Towers and Transmission Line

Visual inspections will be conducted of the towers and transmission line between Tower TL11-104 to TL11-108 inclusive in accordance with the TransGrid inspection program. This generally includes:

- annual inspection of the structure integrity sites from the ground;
- annual inspection of vegetation growth and electrical clearances from the air;
- six yearly climbing inspection; and
- fault and emergency patrols from either the air or ground at any time.

Audit / baseline inspections will occur prior to commencement of Longwall 301 and Longwall 304, and within three months of the completion of Longwalls 301-303 and Longwall 304. Weekly survey inspections will be conducted at each tower when the active longwall face is within 400 m of the tower until subsidence is negligible[4]. Monthly survey inspections will be conducted during extraction when greater than 400 m from the active longwall face. Additional observations of subsidence impacts will be conducted during routine works and recorded by surveyors during tower monitoring survey.

Specific details that will be noted and/or photographed include:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- assessment against the performance indicators and performance measure;
- whether any actions are required (e.g. initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The information will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 3) and reported in accordance with the Project Approval conditions.

Real-Time Monitoring Trial

In addition to the above monitoring, Metropolitan Coal is currently trialling the use of real-time survey monitoring at the towers as an additional management tool. Upon completion of the trial and subject to review of the trial outcomes (e.g. survey accuracy, trigger development, etc.), Metropolitan Coal will review and consider the continued use of real-time monitoring during the extraction of Longwalls 301-304.

7.3.2 Access Roads/Tracks

Visual inspection of the access roads/tracks to the TransGrid assets was undertaken prior to the commencement of Longwall 301, and will be conducted following extraction of each longwall panel (i.e. Longwalls 302-304).

Visual observations of access roads/tracks would occur as part of routine works and inspections within 600 m of Longwalls 301-304 secondary extraction as described in the Metropolitan Coal Longwall 304 Land Management Plan (Longwall 304 LMP).

[4] Survey information will be provided to TransGrid as soon as possible following completion of the weekly survey/ inspection, and allowing for data entry/download and review (e.g. 24 hours) or as otherwise indicated in Table 9.

Specific details that will be noted and/or photographed that are relevant to the TransGrid access roads/tracks include:

- the location, approximate dimensions (length, width and depth), and orientation of surface tension cracks;
- the location of the surface tension crack in relation to the access road/track to the TransGrid asset;
- whether any actions are required (e.g. implementation of management measures as outlined in the Longwall 304 LMP, initiation of the Contingency Plan as outlined in the Longwall 304 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The date of the observation, details of the observer and the location of longwall extraction will also be documented.

The information obtained will be recorded in the Longwall 304 LMP - Subsidence Impact Register and reported in accordance with the Project Approval conditions.

The information obtained will be used to assess the potential environmental consequences of the subsidence impact (described in the Longwall 304 LMP) and to identify required management measures. Management measures are discussed in the Longwall 304 LMP.

In the event the subsidence impacts are deemed to present a safety hazard (i.e. regardless of the nature or extent of the subsidence impact), actions will be implemented in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan.

7.4 ENVIRONMENTAL CONSEQUENCES

Metropolitan Coal and TransGrid will compare the results of the subsidence impact monitoring against the built features performance measure and indicators. In the event the observed subsidence impacts exceed the performance measure or indicators, Metropolitan Coal and TransGrid will assess the consequences of the exceedance in accordance with the Contingency Plan described in Section 9.

8 MANAGEMENT MEASURES

A number of potential management measures in relation to towers and transmission lines are considered to be applicable. These include:

- alteration of conductor tensions;
- install temporary structures;
- modification to attachment points such as placement of stringing sheaves to earth wires and/or phase conductors; and
- strengthening of tower structures (e.g. through installation of cruciform footings).

The requirement for these management measures will be determined by TransGrid (Section 4.2.3) and if required, constructed prior to mining within 600 m of the towers.

Where significant subsidence impacts on access roads/tracks are detected (e.g. those that affect the serviceability) or at any time Metropolitan Coal, TransGrid or the landholder considers that the integrity of the access roads/tracks may be compromised, the following management measures would be applied. Where significant cracks are detected, the cracks would be repaired as soon as practicable in consultation with the landholder. This may include the use of earthmoving equipment if considered the most appropriate means of repair. Appropriate sedimentation controls will be implemented during repair works. Management measures for access roads/tracks will be implemented in accordance with the Longwall 304 Land Management Plan.

Metropolitan Coal will assess the potential impacts to public safety and where appropriate, implement measures in accordance with the Longwall 304 Public Safety Management Plan.

Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.

Management measures will be reported in the Annual Review (Section 12).

9 CONTINGENCY PLAN

In the event the subsidence impacts observed exceed the performance measure or indicators detailed in Section 5 of this BFMP-TRA, Metropolitan Coal will implement the following Contingency Plan (Appendix 4):

- The observation will be reported to the Metropolitan Coal Manager - Technical Services within 24 hours.
- With the exception of access roads/tracks, the observation will be recorded in the Built Features Management Plan – Subsidence Impact Register (Appendix 3) consistent with the monitoring program described in Section 7 of this BFMP-TRA.
- If relating to an access road/track, the observation will be recorded in the Metropolitan Coal Longwall 304 Land Management Plan – Subsidence Impact Register.
- Metropolitan Coal will report any exceedance of the performance measure or indicators to the DP&E and TransGrid as soon as practicable after Metropolitan Coal becomes aware of the exceedance.
- Metropolitan Coal will assess public safety and where appropriate implement safety measures in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan;
- Metropolitan Coal will conduct an investigation to evaluate the potential contributing factors. The investigation will:
  - include the re-survey of relevant subsidence monitoring lines;
  - compare and critically analyse measured versus predicted subsidence parameters;
  - review measured subsidence parameters against the observed impact; and
  - review the subsidence monitoring program and update the program where appropriate.
- The course of action with respect to the identified impact(s), in consultation with specialists and relevant agencies, will include:
  - a program to review the effectiveness of the contingency measures; and
  - consideration of adaptive management.

  Contingency measures are provided in Section 9.1.

- Metropolitan Coal will submit the proposed course of action to the DP&E for approval.
- Metropolitan Coal will implement the approved course of action to the satisfaction of the DP&E.

In accordance with Condition 6, Schedule 6 of the Project Approval, Metropolitan Coal will provide a suitable offset to compensate for the impact to the satisfaction of the Director-General (now Secretary) of DP&E if either the contingency measures implemented by Metropolitan Coal have failed to remediate the impact or the Director-General (now Secretary) determines that it is not reasonable or feasible to remediate the impact.

Metropolitan Coal will comply with the NSW *Coal Mine Subsidence Compensation Act, 2017* in the event that property damages occur as a result of mining Longwalls 301-304.

9.1 CONTINGENCY MEASURES

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of environmental consequences).

TransGrid designs its network with full redundancy provision (i.e. n-1 capability). In the unlikely event that TL11 became unserviceable due to a subsidence impact, TransGrid can potentially switch around TL11 for a period of time to effect emergency works, continuing to provide power to its customers (unless there are planned outages/faults in other connected parts of the transmission network).

Contingency measures that could be considered in the event the performance measure for the towers and transmission line is exceeded are summarised in Table 10. The decision tree for the contingency measures is shown in Appendix 4.

Preliminary design works for contingency measures (e.g. temporary structures for use in an emergency) has been completed in consultation with TransGrid, including proposed locations for temporary pole towers if required.

Table 10
Contingency Measures – Towers and Transmission Lines

Environmental Consequence	Contingency Measures	
	Measure	**Description**
Impact on Towers	Temporary replacement	• Temporary switching of power to alternate transmission lines to effect repairs to TL11. • Installation of temporary emergency tower structures as designed by TransGrid. • Emergency structures can be deployed to re-establish line operations within 72hrs (depending on the amount of towers requiring replacement).
	Rebuilding	• Construction of new tower(s) while temporary towers are in operation.
Impact on Transmission Wires	Stabilisation techniques	• Sheaving of conductors and/or earth wires.
	Rebuilding	• Construction of new transmission lines.

In the event that contingency measures in Table 10 are still expected to exceed performance measures, adaptive management will be implemented. This includes:

- reduction in extraction height;
- modification to layout; or
- stop mining the longwall.

10 TARP – MANAGEMENT TOOL

The framework for the various components of the BFMP-TRA are summarised in the BFMP-TRA TARP shown in Table 11. The BFMP-TRA TARP illustrates how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

The TARP comprises:

- baseline conditions;
- predicted subsidence impacts;
- trigger levels from monitoring to assess performance; and
- triggers that flag implementation of contingency measures.

The TARP system provides a simple and transparent snapshot of the monitoring of environmental performance and the implementation of management and/or contingency measures.

Table 11
BFMP-TRA Trigger Action Response Plan

TRANSGRID – Towers (T11-104 to T11-108)		
TRANSGRID Towers	*Risk: Subsidence effect on towers resulting in impact to structural integrity and reduced transmission line clearance.*	
	TRIGGER LEVEL	**RESPONSE**
	Level 1 - Normal **Expected subsidence conditions**	
	Subsidence • less than 100 mm for LW 301 - 302 • less than 125 mm for LW 303 - 304 Absolute Horizontal Movements • less than 80 mm at the base Tensile strain • less than 0.6 mm/m Compressive strain • less than 0.6 mm/m Differential tower leg movements • less than 4.0 mm	**Normal Operations** • Towers are safe and serviceable. • Negligible impact to towers. • Continue monitoring activities as planned.
	Level 2 - Monitor **Subsidence elevated up to +15% of predicted but tower leg service condition normal**	
	Subsidence • between 100 and 115 mm for LW 301-302 • between 125 and 145 mm for LW 303-304 Absolute Horizontal Movements • between 80 and 100 mm at the base Strain • between 0.6 and 0.8 mm/m Differential tower leg movements • less than 4.0 mm	**Continue operations but report on subsidence anomaly** • Towers are safe and serviceable. • Negligible impact to towers. **Metropolitan Coal** • Resurvey subsidence line, ground points, tower leg mounted prisms and earth wire peak points in affected area to confirm results. • Engage subsidence expert to assess results. • Confirm results are consistent with other subsidence lines. • Compare and critically analyse measured versus predicted subsidence. • Inform and provide report to TransGrid and NSW Principal Subsidence Engineer of subsidence results (notify within 24 hours of trigger). • Collaboratively share information with TransGrid to monitor situation. **TransGrid** • Assess information provided by Metropolitan Coal.

Table 11 (Continued)
BFMP-TRA Trigger Action Response Plan

TRANSGRID – Towers (T11-104 to T11-108)		
TRANSGRID Towers	*Risk: Subsidence effect on towers resulting in impact to structural integrity and reduced transmission line clearance.*	
	TRIGGER LEVEL	**RESPONSE**
	Level 3 - Cautionary **Anomalous differential leg movement or subsidence beyond +15% of predicted**	
	Subsidence • greater than 115 mm for LW 301-302 • greater than 145 mm for LW 303-304 Absolute Horizontal Movements • greater than 100 mm at the base Strain • greater than 0.8 mm/m Observable subsidence ground deformations at a tower Differential tower leg movements • between 4.0 and 8.0 mm	**Investigate & Resolve** • Towers are safe and serviceable. • Indication of impact to towers or reduced transmission line clearance. **Metropolitan Coal** • Steps as per Level 2 event, plus: – Inform TransGrid and NSW Principal Subsidence Engineer of subsidence results (immediately following awareness of trigger). – Increase frequency of monitoring and subsidence line surveys to weekly in affected area (if not already). – Report monitoring data to NSW Principal Subsidence Engineer within 48hrs following collection of data. – In conjunction with TransGrid identify impact location and have TransGrid assess tower condition and/or conductor performance. – Review the subsidence monitoring program and update the program where appropriate. – Provide report on issue to both TransGrid and DP&E. **TransGrid** • In conjunction with Metropolitan Coal identify impact location, inspect tower, assess condition and determine appropriate response. (e.g. greater monitoring data or frequency, or schedule maintenance on the structure). • Make determination if other measures necessary to avoid further impact (e.g. deployment of emergency structures).

Table 11 (Continued)
BFMP-TRA Trigger Action Response Plan

TRANSGRID – Towers (T11-104 to T11-108)		
TRANSGRID Towers	*Risk: Subsidence effect on towers resulting in impact to structural integrity and reduced transmission line clearance.*	
	TRIGGER LEVEL	**RESPONSE**
	Level 4 – Restoration **Exceedance of nominated differential leg movement or fault occurs**	
	Fault Occurs, or Differential leg movement • Greater than 8.0 mm	**Implement Contingency Plan** • As per BFMP Section 9 and Appendix 4. **Metropolitan Coal** • As per Level 3 event, plus: – General Manager to be involved in all decision-making processes. – Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwall 304 Public Safety Management Plan. – Report exceedance of the performance measure or indicators to the DP&E and TransGrid as soon as practicable. – Update the 'Built Features Management Plan – Subsidence Impact Register'. – Investigate circumstances of the fault and determine requirement for adaptive management of mining operations prior to future operations in vicinity of the towers and transmission lines. **TransGrid** • As per Level 3 event, plus: – For fault - TransGrid to enact fault / emergency response measures including switching around TL11 while service is restored. – For greater than 8.0 mm differential leg movement - TransGrid to determine timing of emergency restoration measure. – Complete restoration works. – Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.

11 FUTURE EXTRACTION PLANS

In accordance with Condition 7, Schedule 3 of the Project Approval, Metropolitan Coal will collect baseline data for the next Extraction Plan (i.e. Longwalls 305-310). The baseline (and post-mining) data collected for Longwalls 301-304 will be used as baseline for Longwalls 305 onward as longwall mining progressively moves further away from the TransGrid assets.

In addition to the baseline data collection, consideration of the environmental performance and management measures in accordance with the review(s) conducted as part of this BFMP-TRA will inform the appropriate type and frequency of monitoring of the assets relevant to the next Extraction Plan.

12 ANNUAL REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

In accordance with Condition 3, Schedule 7 of the Project Approval, Metropolitan Coal will conduct an Annual Review of the environmental performance of the Project by the end of March each year.

The Annual Review will:

- describe the works carried out in the past year, and the works proposed to be carried out over the next year;
- include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the EA, Preferred Project Report and Extraction Plan;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

As described in Section 2, this BFMP will be reviewed within three months of the submission of an Annual Review, and revised where appropriate.

13 INCIDENTS

An incident is defined as a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval.

The reporting of incidents will be conducted in accordance with Condition 6, Schedule 7 of the Project Approval. Metropolitan Coal will notify the Director-General (now Secretary) of DP&E and any other relevant agencies of any incident associated with the Project as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of DP&E and any relevant agencies with a detailed report on the incident.

TransGrid will be notified within 24 hours of any access limitations or restrictions.

14 COMPLAINTS

A protocol for the managing and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

The Environment & Community Superintendent is responsible for maintaining a system for recording complaints.

Metropolitan Coal will maintain public signage advertising the telephone number on which environmental complaints can be made. The Environment & Community Superintendent is responsible for ensuring that the currency and effectiveness of the service is maintained. Notifications of complaints received are to be provided as quickly as practicable to the Environment & Community Superintendent.

Complaints and enquiries do not have to be received via the telephone line and may be received in any other form. Any complaint or enquiry relating to environmental management or performance is to be relayed to the Environment & Community Superintendent as soon as practicable. All employees are responsible for ensuring the prompt relaying of complaints. All complaints will be recorded in a complaints register.

For each complaint, the following information will be recorded in the complaints register:

- date and time of complaint;
- method by which the complaint was made;
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- nature of the complaint;
- the action(s) taken by Metropolitan Coal in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken by Metropolitan Coal, the reason why no action was taken.

The Environment & Community Superintendent is responsible for ensuring that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary.

In accordance with Condition 10, Schedule 7 of the Project Approval, the complaints register will be made publicly available on the website and updated on a monthly basis. A summary of complaints received and actions taken will be presented to the Community Consultative Committee as part of the operational performance review.

15 NON-COMPLIANCES WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with Metropolitan Coal, and will be developed through promotion of Metropolitan Coal ownership under the direction of the General Manager.

The Manager - Technical Services and/or Environment & Community Superintendent will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 13, Metropolitan Coal will notify the Director-General (now Secretary) of the DP&E and any other relevant agencies of any incident associated with Metropolitan Coal as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of the DP&E and any relevant agencies with a detailed report on the incident.

A review of Metropolitan Coal's compliance with all conditions of the Project Approval, mining leases and all other approvals and licenses will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the Peabody website.

Additionally, in accordance with Condition 8, Schedule 7 of the Project Approval, an independent environmental audit was undertaken by the end of December 2011, and is undertaken a minimum of once every three years thereafter. A copy of the audit report will be submitted to the Director-General (now Secretary) of the DP&E and made publicly available on the Peabody website. The independent audit will be undertaken by an appropriately qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General (now Secretary) of the DP&E.

16 REFERENCES

Department of Planning & Environment and Division of Resources and Energy (2015) *Guidelines for the Preparation of Extraction Plans*.

Heggies (2008) *Metropolitan Coal Project Noise Impact Assessment.* Appendix J in the Metropolitan Coal Project Environmental Assessment.

Helensburgh Coal Pty Ltd [HCPL] (2008) *Metropolitan Coal Project Environmental Assessment*.

Helensburgh Coal Pty Ltd [HCPL] (2009) *Metropolitan Coal Project Preferred Project Report.*

Mine Subsidence Engineering Consultants (2008) *Subsidence Assessment Report on the Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Surface Infrastructure Resulting from the Proposed Extraction of Longwalls 20 to 44 at Metropolitan Colliery in Support of a Part 3A Application.*

Mine Subsidence Engineering Consultants (2016) *Metropolitan Colliery – Proposed Longwalls 301-303 - Subsidence Predictions and Impact Assessments for the TransGrid 330 kV Transmission Line, dated 7 September 2016.*

Mine Subsidence Engineering Consultants (2019) *Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the TransGrid 330 kV Transmission Line.*

APPENDIX 1

MSEC (2016) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 301 TO 303 - SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE TRANSGRID 330 KV TRANSMISSION LINE, DATED 7 SEPTEMBER 2016

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

7th September 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-02

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the TransGrid 330 kV Transmission Line

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the TransGrid 330 kV transmission line resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery.

The locations of the 330 kV transmission line and the proposed longwalls are shown in the attached Drawing No. MSEC844-02. The transmission line is located to the east of Longwalls 301 to 303 and therefore is not proposed to be directly mined beneath.

The transmission towers and reference numbers are also shown in Drawing No. MSEC844-02. There are six towers that are located within or immediately adjacent to the Study Area for Longwalls 301 to 303. The distances of these towers from the nearest longwall, being Longwall 301, are summarised in Table 1.

Table 1 Distances of the 330 kV Transmission Towers from Longwalls 301 to 303

Tower Number	Tower Type	Distance of the Transmission Towers Centrelines from the Longwalls (m)
TL11 103	Suspension	310
TL11 104	Suspension	50
TL11 105	Suspension	50
TL11 106	Suspension	70
TL11 107	Suspension	70
TL11 108	Suspension	110

The transmission towers that are located within the Study Area are all suspension towers. The changes in alignment at the transmission towers are in the order of 1 to 3 degrees.

A photograph of one of the 330 kV transmission towers is provided in Figure 1.

Figure 1 Photograph of a 330 kV Transmission Tower

The predictions and impact assessments for the 330 kV transmission line are provided in the following sections.

Predictions of Conventional Subsidence Parameters

The following provides summaries of the maximum predicted conventional movements for the 330 kV transmission line resulting from the extraction of Longwalls 301 to 303. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in the following section.

The predicted profiles of transient subsidence, tilt along and tilt across the alignment of the 330 kV transmission line, during the extraction of Longwall 301, are shown in the attached Fig. A.1. The profiles have been shown based on 50 metre advances of the longwall extraction face. The transmission line will initially experience subsidence adjacent to the northern end of Longwall 301 and then subsidence will progressively develop towards the southern end of the longwall during mining.

The predicted profiles of incremental and total conventional subsidence, tilt along and tilt across the alignment of the 330 kV transmission line, resulting from the extraction of Longwalls 301 to 303, are shown in the attached Fig. A.2. The black dashed lines are the incremental profiles that represent the additional movements due to each of the longwalls. The solid blue lines represent the total or accumulated movements after the completion of each longwall.

A summary of the maximum predicted values of incremental subsidence, tilt along and tilt across the alignment of the 330 kV transmission line, due to the extraction of each of the Longwalls 301 to 303, is provided in Table 2. The values are the maxima anywhere along the transmission line (i.e. not necessarily at the tower locations).

Table 2 Maximum Predicted Incremental Subsidence, Tilt Along and Tilt Across the Alignment of the 330 kV Transmission Line Resulting from the Extraction of Longwalls 301 to 303

Longwall	Maximum Predicted Incremental Subsidence (mm)	Maximum Predicted Incremental Tilt Along Alignment (mm/m)	Maximum Predicted Incremental Tilt Across Alignment (mm/m)
Due To LW301	40	< 0.5	< 0.5
Due To LW302	80	< 0.5	0.5
Due To LW303	30	< 0.5	< 0.5

The maximum predicted incremental subsidence for the 330 kV transmission line, due to the extraction of each of the Longwalls 301 to 303, varies between 30 mm and 80 mm. It is noted, that the maximum predicted incremental subsidence due to Longwall 302 is greater than that due Longwall 301, as it is a second panel in the series and therefore results in higher magnitudes of subsidence above and outside of the mining area. The maximum predicted incremental tilt due to each of the longwalls is 0.5 mm/m (i.e. 0.05 %, or 1 in 2,000) across the alignment.

A summary of the maximum predicted values of total subsidence, tilt along the alignment and tilt across the alignment, resulting from the extraction of Longwalls 301 to 303, is provided in Table 3. The values are the maxima anywhere along the transmission line (i.e. not necessarily at the tower locations).

Table 3 Maximum Predicted Total Subsidence, Tilt Along and Tilt Across the Alignment of the 330 kV Transmission Line Resulting from the Extraction of Longwalls 301 to 303

Longwall	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Tilt Along Alignment (mm/m)	Maximum Predicted Total Tilt Across Alignment (mm/m)
After LW301	60	< 0.5	0.5
After LW302	110	0.5	1.0
After LW303	140	0.5	1.0

The maximum predicted total subsidence for the 330 kV transmission line, resulting from the extraction of Longwalls 301 to 303, is 140 mm. The greatest subsidence occurs adjacent to the southern end of Longwall 301. The maximum predicted conventional tilt is 1.0 mm/m (i.e. 0.1 %, or 1 in 1,000) and is orientated across the alignment of the transmission line. The maximum predicted conventional tilt along the alignment of the transmission line is 0.5 mm/m (i.e. 0.05 %, or 1 in 2,000).

There are six transmission towers that are located within or immediately adjacent to the Study Area, being Towers TL11 103 to TL11 108. A summary of the predicted values of total subsidence in the locations of the transmission towers, resulting from the extraction of Longwalls 301 to 303, is provided in Table 4.

Table 4 Predicted Total Subsidence in the Locations of the Transmission Towers Resulting from the Extraction of Longwalls 301 to 303

Tower	Maximum Predicted Total Subsidence after LW301 (mm)	Maximum Predicted Total Subsidence after LW302 (mm)	Maximum Predicted Total Subsidence after LW303 (mm)
TL11 103	< 20	< 20	< 20
TL11 104	< 20	40	50
TL11 105	40	100	125
TL11 106	30	90	100
TL11 107	30	80	100
TL11 108	< 20	< 20	<20

The transmission towers are predicted to experience vertical subsidence up to 125 mm resulting from the extraction of Longwalls 301 to 303. The highest subsidence is predicted to occur at Tower TL11 105.

A summary of the maximum predicted values of total tilt at the bases of the transmission towers and total horizontal movements at the tops of the towers, resulting from the extraction of Longwalls 301 to 303, is provided in Table 5. The values are the maxima that occur at any time during or after the extraction of these longwalls. The horizontal movements have been based on an overall tower height of 50 metres.

Table 5 Maximum Predicted Total Tilts and Horizontal Movements at the Transmission Towers Resulting from the Extraction of Longwalls 301 to 303

Tower	Maximum Predicted Total Tilt Along Alignment at the Base of the Tower (mm, +ve towards north and -ve towards south)	Maximum Predicted Total Tilt Across Alignment at the Base of the Tower (mm, +ve towards east and -ve towards west)	Maximum Predicted Total Horizontal Movement Along Alignment at the Top of Tower (mm, +ve towards north and -ve towards south)	Maximum Predicted Total Horizontal Movement Across Alignment at the Top of the Tower (mm, +ve towards east and -ve towards west)
TL11 103	< ±0.5	< ±0.5	< ±20	< ±20
TL11 104	< ±0.5	< ±0.5	< ±20	< ±20
TL11 105	< ±0.5	-1.0	< ±20	-60
TL11 106	< ±0.5	-0.5	< ±20	-50
TL11 107	< ±0.5	-0.5	< ±20	-50
TL11 108	< ±0.5	< ±0.5	< ±20	< ±20

The maximum predicted conventional tilt in the locations of the transmission towers is -1.0 mm/m (i.e. 0.1 %, or 1 in 1,000). The maximum predicted horizontal movement at the tops of the towers is -60 mm. The maximum tilt and horizontal movement both occur at Tower TL11 105 and are orientated towards the west (i.e. towards the longwalls).

A summary of the maximum predicted values of total opening and closure between the tops of the transmission towers, resulting from predicted conventional subsidence movements due to the extraction of Longwalls 301 to 303, is provided in Table 6. The values are the maxima that occur at any time during or after the extraction of these longwalls.

Table 6 Maximum Predicted Total Opening and Total Closure between Transmission Towers Resulting from the Extraction of Longwalls 301 to 303

Span	Maximum Predicted Opening due to LW301 to LW303 (mm)	Maximum Predicted Closure due to LW301 to LW303 (mm)	Final Predicted Opening (+ve) or Closure (-ve) after LW303 (mm)
TL11 103 to TL11 104	< 20	< 20	< ±20
TL11 104 to TL11 105	< 20	< 20	< ±20
TL11 105 to TL11 106	< 20	< 20	< ±20
TL11 106 to TL11 107	< 20	< 20	< ±20
TL11 107 to TL11 108	< 20	< 20	< ±20

The maximum predicted closure and opening between the tops of the transmission towers due to conventional subsidence movement is less than 20 mm.

The 330 kV transmission line is also likely to experience far-field horizontal movements orientated towards the mining area. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield.

The observed incremental far-field horizontal movements, resulting from the extraction of longwalls in the Southern Coalfield, are provided in Figure 2. The data is based on survey marks located outside of the mining area (i.e. above solid coal).

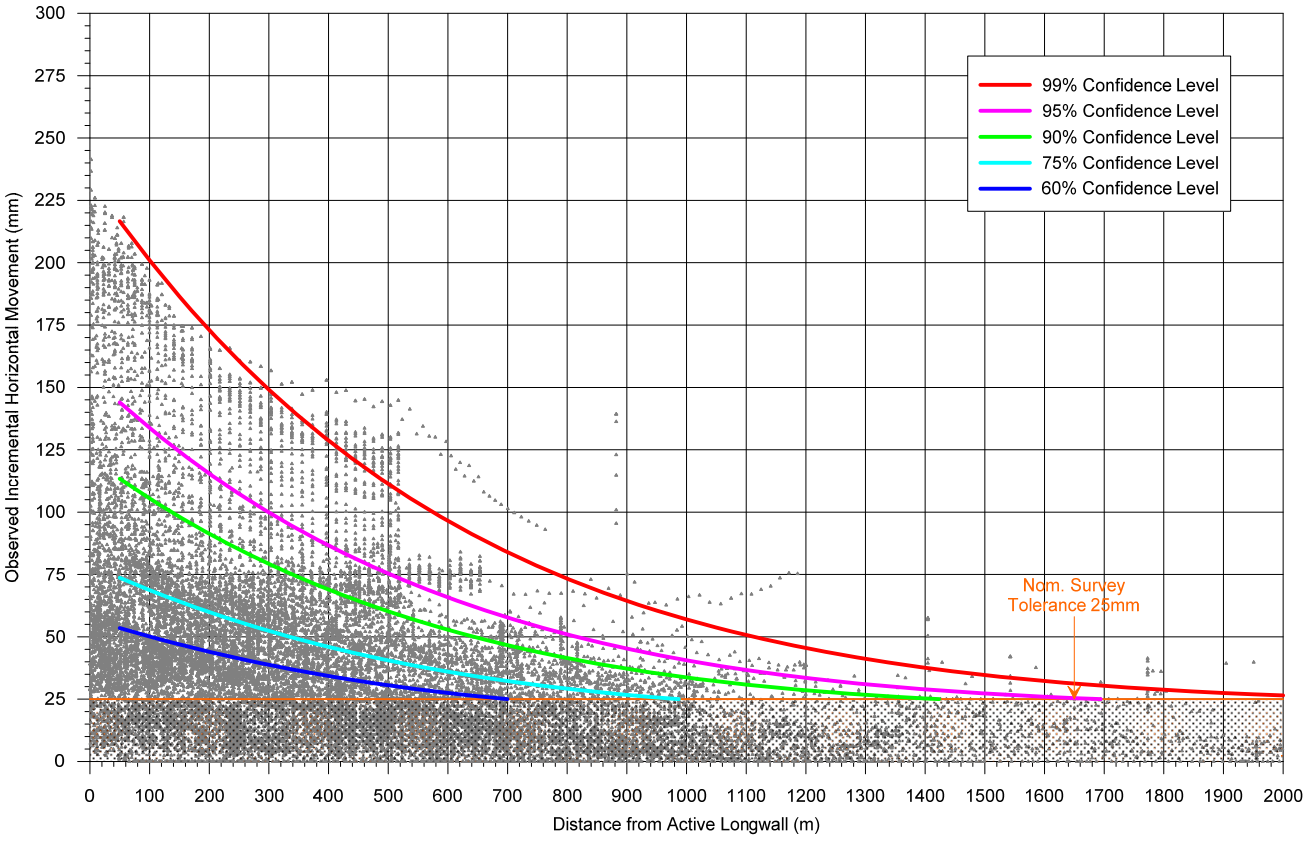


Figure 2 Observed Incremental Far-field Horizontal Movements from the Southern Coalfield (Solid Coal)

The transmission towers are located at distances between 50 and 310 metres from Longwalls 301 to 303. At these distances, the towers could experience absolute horizontal movements in the order of 100 mm to 140 mm based on the 95 % confidence level.

Far-field horizontal movements tend to be bodily movements orientated towards the mining area. The potential for impacts does not result from these absolute horizontal movements, but rather the differential horizontal movements.

These absolute far-field horizontal movements could result in small changes in the distances between the towers since the directions of these far-field horizontal movements are generally expected to be towards the extracted longwalls and the 330 kV transmission line is oriented approximately perpendicular to the longwalls. The greatest differences would therefore be expected to occur between towers that are located close to the longwalls and those located further from the longwalls, such as towers TL11 103 to TL11 104 and towers TL11 108 to TL11 109. A calculation of relative far field movements between towers based on potential far-field horizontal movements from Figure 2, for the 95% confidence level, indicates a potential maximum closure movement of less than 50 mm between the towers. With increasing distance from the extracted longwalls, the potential relative far-field movement between towers could result in an opening of less than 50 mm.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the 330 kV transmission line has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The transmission towers are located at distances of 50 metres or greater from the proposed longwalls. The database has therefore been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located outside between zero and 100 metres of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

A histogram of the maximum observed tensile and compressive strains measured in survey bays located above solid coal, for monitoring lines in the Southern Coalfield, is provided in Figure 3. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

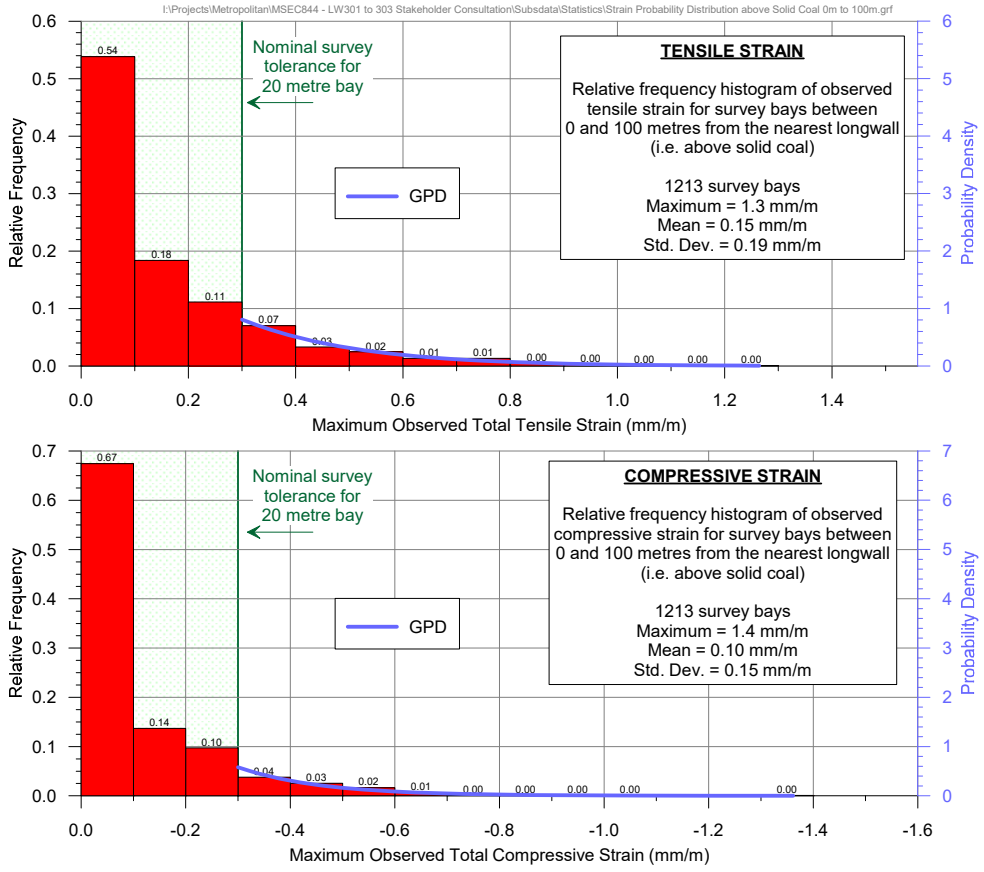


Figure 3 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Solid Coal (0 to 100 metres)

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above solid coal, based on the fitted GPDs, is provided in Table 7.

Table 7 Probabilities of Exceedance for Strain for Survey Bays Located above Solid Coal

Strain (mm/m)		Probability of Exceedance
Compression	-1.5	1 in 3,100
	-1.0	1 in 630
	-0.5	1 in 40
	-0.3	1 in 10
Tension	+0.3	1 in 6
	+0.5	1 in 15
	+1.0	1 in 250
	+1.5	1 in 2,200

The 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.5 mm/m tensile and 0.4 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.8 mm/m tensile and 0.7 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures are shown in Drawing No. MSEC844-02. The Metropolitan Fault has a north west to south east strike and dips to the north east. This fault crosses the alignment of the 330 kV transmission line outside of the Study Area, in close proximity to Tower TL11 109, at a distance of 0.5 kilometres north of Longwall 301. Faults also cross the alignment of the transmission line in the southern part of the Study Area, in close proximity to Tower TL11 103.

If these faults extend from the seam up to the surface, then localised and elevated compressive strains could develop at their surface expressions. It is also possible that localised and elevated strains could occur elsewhere due to unknown geological structures (i.e. anomalies).

If the surface expressions of the faults are located between the towers, then the predicted parameters for the towers do not change from those summarised in Table 4 to Table 7. However, if the surface expression of a fault is coincident with a tower, then it could experience a compressive strain greater than that predicted based on conventional ground movements.

It is difficult to predict the magnitudes of the non-conventional movements at known geological structures, especially in locations outside of mining. Experience from previous mining in close proximity of known geological structures can be used to provide a guide to the potential ground movements.

The greatest strain that has been measured at a known geological structure that was located outside of mining in the Southern Coalfield occurred in Appin Area 4. The surface expression of a low angle thrust fault was located at a distance of 190 metres from Longwall 407. The measured compressive strain at the surface expression due to mining of this longwall was 3.5 mm/m. The development of compressive strain versus the longwall face advance is illustrated in Figure 4. The rate of change of compressive strain per 10 metre longwall face advance is shown in Figure 5.

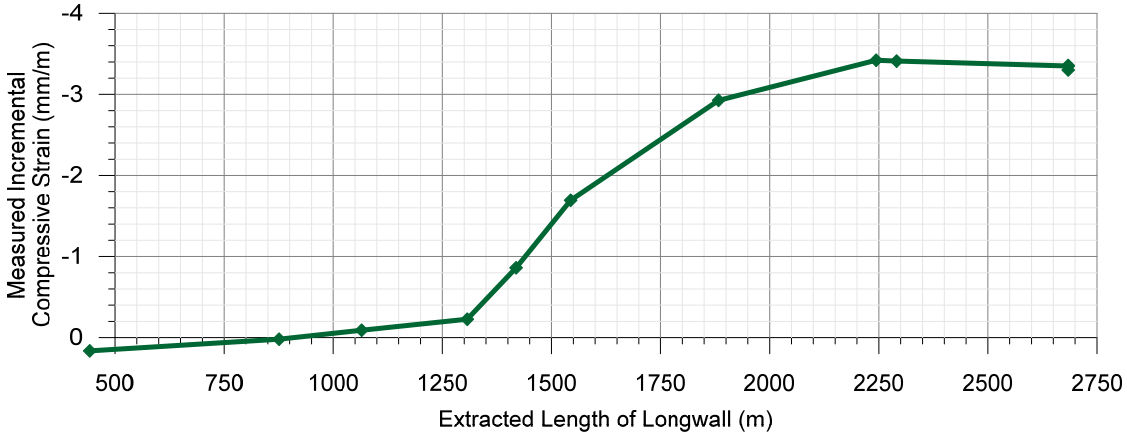


Figure 4 Development of Compressive Strain at the Surface Expression of the Low Angle Thrust Fault due to the Extraction of Appin Longwall 407

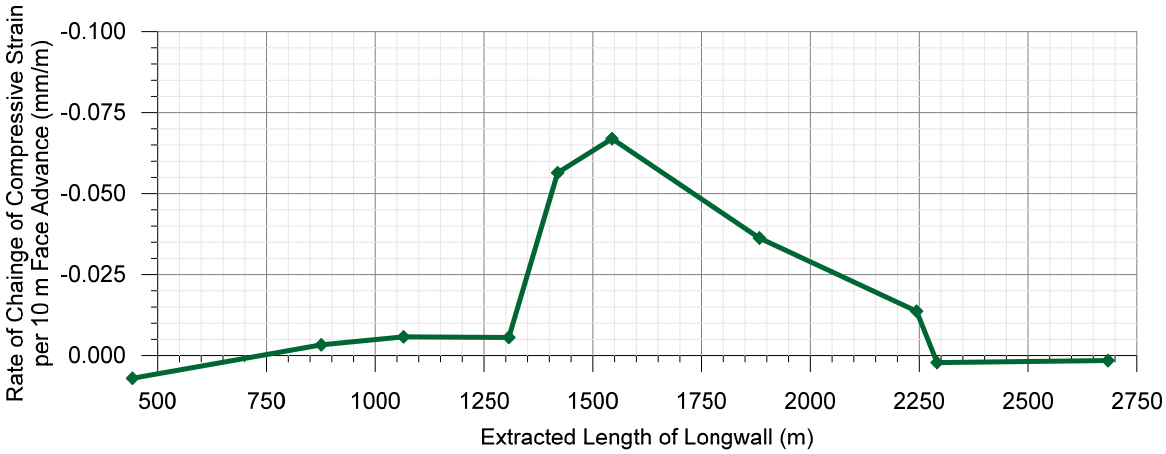


Figure 5 Rate of Change of Compressive Strain at the Surface Expression of the Low Angle Thrust Fault due to the Extraction of Appin Longwall 407

The maximum rate of change of compressive strain was 0.076 mm/m per 10 metre longwall face advance. Based on an average extraction rate of 50 metres per week, this equates to a maximum rate of 0.4 mm/m per week. The compressive strain developed over the period when the longwall had an extracted length between 1,300 and 2,200 metres. This equates to a period of approximately 18 weeks based on an average extraction rate of 50 metres per week.

The localised movements that developed at the surface expression of the low angled thrust fault in Appin Area 4 are an extreme case and greater than other known and measured cases in the Southern Coalfield. This case is likely to provide a conservative indication of potential non-conventional movements at surface expressions of geological structures outside of mining.

There are no major streams that cross the alignment of the 330 kV transmission line adjacent to Longwalls 301 to 303. The are some small tributaries along the alignment of the transmission line, which can be seen from the surface profile shown in Figs. A.1 and A.2. Localised and elevated compressive strains could develop in the bases of these small tributaries due to valley closure effects. However, the towers are located away from the bases of these small tributaries and, therefore, are unlikely to experience these valley closure strains.

Impact Assessments for the 330 kV Transmission Line

The cables along the 330 kV transmission line are not directly affected by ground strains, as they are supported by the towers above ground level. The cables can, however, be affected by the changes in bay lengths, i.e. the distances between the towers at the level of the cables, which result from mining induced differential subsidence, horizontal ground movements and lateral movements at the tops of the towers due to differential tilting of the towers. The stability of the transmission towers can be affected by the mining induced tilts, curvatures and ground strains at the tower locations and by changes in the catenary profiles of the cables.

Potential Impacts due to the Predicted Conventional Movements

The transmission towers are predicted to experience vertical subsidence up to 125 mm resulting from the extraction of Longwalls 301 to 303. The transmission line is orientated parallel to the longwalls and therefore the low level vertical subsidence is predicted to be reasonably uniform along its alignment. It is unlikely, therefore, that these magnitudes of vertical subsidence would result in adverse impacts on the cable ground clearances.

The maximum predicted conventional tilt in the locations of the transmission towers is 1.0 mm/m (i.e. 0.1 %, or 1 in 1,000) orientated across the alignment. The predicted mining induced tilts are very small and generally similar to the order of survey tolerance. The mining induced tilts and horizontal movements along the alignment of the transmission line are predicted to result in opening and closure of less than 20 mm between adjacent towers. It is unlikely, therefore, that the conventional movements would result in adverse impacts on the transmission line.

Far-field horizontal movements could result in small changes in the distances between the towers, particularly those located near the ends of the longwalls. Potential maximum predicted shortening movement of 50 mm between the towers and opening of less than 50 mm could occur between towers, due to far-field horizontal movements.

The predicted strains at the locations of the transmission towers are 0.5 mm/m tensile and 0.4 mm/m compressive based on the 95 % confidence level and are 0.8 mm/m tensile and 0.7 mm/m compressive based on the 99 % confidence level. It is recommended that TransGrid review the structural integrity of the towers based on changes in the tower leg spacings (i.e. k-point distances) resulting from the predicted strains.

Potential Impacts due to Possible Non-Conventional Movements

Localised and elevated compressive strains can develop due to the presence of geological structures or valley related effects. There are no significant streams in the locations of the transmission towers and, therefore, it is unlikely that they will be adversely impacted by valley closure effects.

It is possible that the transmission towers could experience compressive strains greater than those predicted based on conventional movements if they were coincident with the surface expression of a fault. The potential for non-conventional movements in the locations of the towers is very low, due to their distances from the longwalls, however, the potential for these irregular movements cannot be discounted.

It is recommended that strategies are developed, in consultation with TransGrid, to manage the potential for non-conventional movements at the transmission tower locations. The strategies should consider the magnitudes and rates of development of strain in locations of known geological structures adjacent to previous longwall mining. The observation at a low angled thrust fault in Appin Area 4 (refer to Figure 4 and Figure 5) is an extreme case and greater than other known and measured cases in the Southern Coalfield. This case is likely to provide a conservative indication of potential non-conventional movements at surface expressions of geological structures outside of mining.

The management strategies should include monitoring of the transmission towers during active subsidence to identify the early development of non-conventional ground movements. It is understood that survey marks have been installed on each of the transmission tower legs and in the ground.

It is recommended that a Trigger Action Response Plan (TARP) is developed outlining the actions required if non-conventional movements were identified at the transmission tower locations. The triggers and actions should be developed and agreed between TransGrid and Peabody Energy.

It is also recommended that preventive measures are developed in case non-conventional movements are identified. The preventive measures could include: installation of timber poles to support the existing tower and/or

the conductors; installation of additional bracing and/or strengthening members to the existing frame; or installation of a prefabricated steel frame to support the tower base.

The appropriate monitoring, management, preventive and remedial measures should be developed in consultation between TransGrid and Peabody Energy.

Summary

The 330 kV transmission line is located to the east of the proposed Longwalls 301 to 303. The transmission towers are located at distances between 50 metres and 310 metres from the longwalls. At these distances, the transmission towers are predicted to experience low levels of vertical subsidence up to 125 mm. The predicted conventional tilts and differential horizontal movements between the towers are very small and unlikely to result in adverse impacts.

However, it is possible that the transmission towers could experience localised and elevated compressive strains due to the presence of geological structures (known or unknown), if the surface expressions of these features are coincident with them. It is recommended that monitoring, management, preventive and remedial measures are developed, in consultation between TransGrid and Peabody Energy, to manage the potential for these irregular movements.

Yours sincerely

Peter DeBono
Mine Subsidence Engineering Consultants

Attachments:

Drawing No. MSEC844-02 – Longwalls 301 to 303 – TransGrid 330 kV Transmission Line

Fig. A.1 Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the Alignment of the 330 kV Transmission Line during the Mining of Longwall 301

Fig. A.2 Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the Alignment of the 330 kV Transmission Line due to LW301 to LW303

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
TRANSGRID 330kV TRANSMISSION LINE

DATE:	SCALE:	DRAWING No:	Rev No
26 Aug 2016	1:12500	MSEC844-02	D

Grid to MGA co-ordinates

6 218 000
6 216 000
312 000
314 000

TL11 110
TL11 109
TL11 108
TL11 107
TL11 106
TL11 105
TL11 104
TL11 103

CAWLEY ROAD OVERPASS
CAWLEYS CK
STUDY AREA
METROPOLITAN FAULT
WORONORA RESERVOIR
PREDICTED 20mm SUBSIDENCE CONTOUR
20
OLD PRINCES HWY
LW303
LW302
LW301
330kV TRANSMISSION LINE
132kV TRANSMISSION LINES
M1 PRINCES MOTORWAY
WILSONS CK
PRINCES HIGHWAY UNDERPASS 2
FAULT
MAIN WEST FAULT
POWELL FAULT

GEOLOGICAL STRUCTURES
FAULTS
DYKES

Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the Alignment of the 330 kV Transmission Line during the Mining of LW301

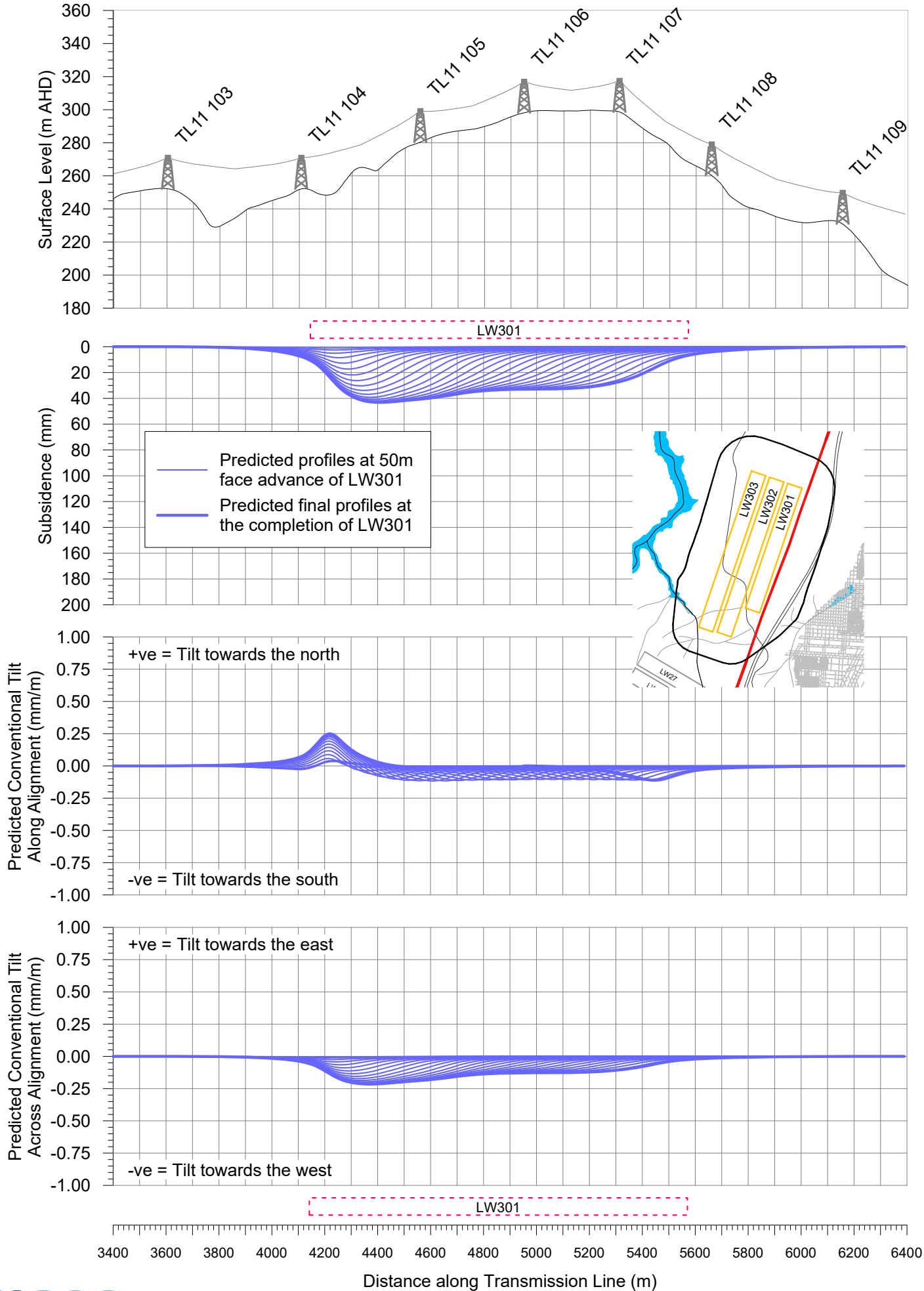

Fig. A.1

Predicted Profiles of Conventional Subsidence, Tilt Along and Tilt Across the Alignment of the 330 kV Transmission Line due to LW301 to LW303

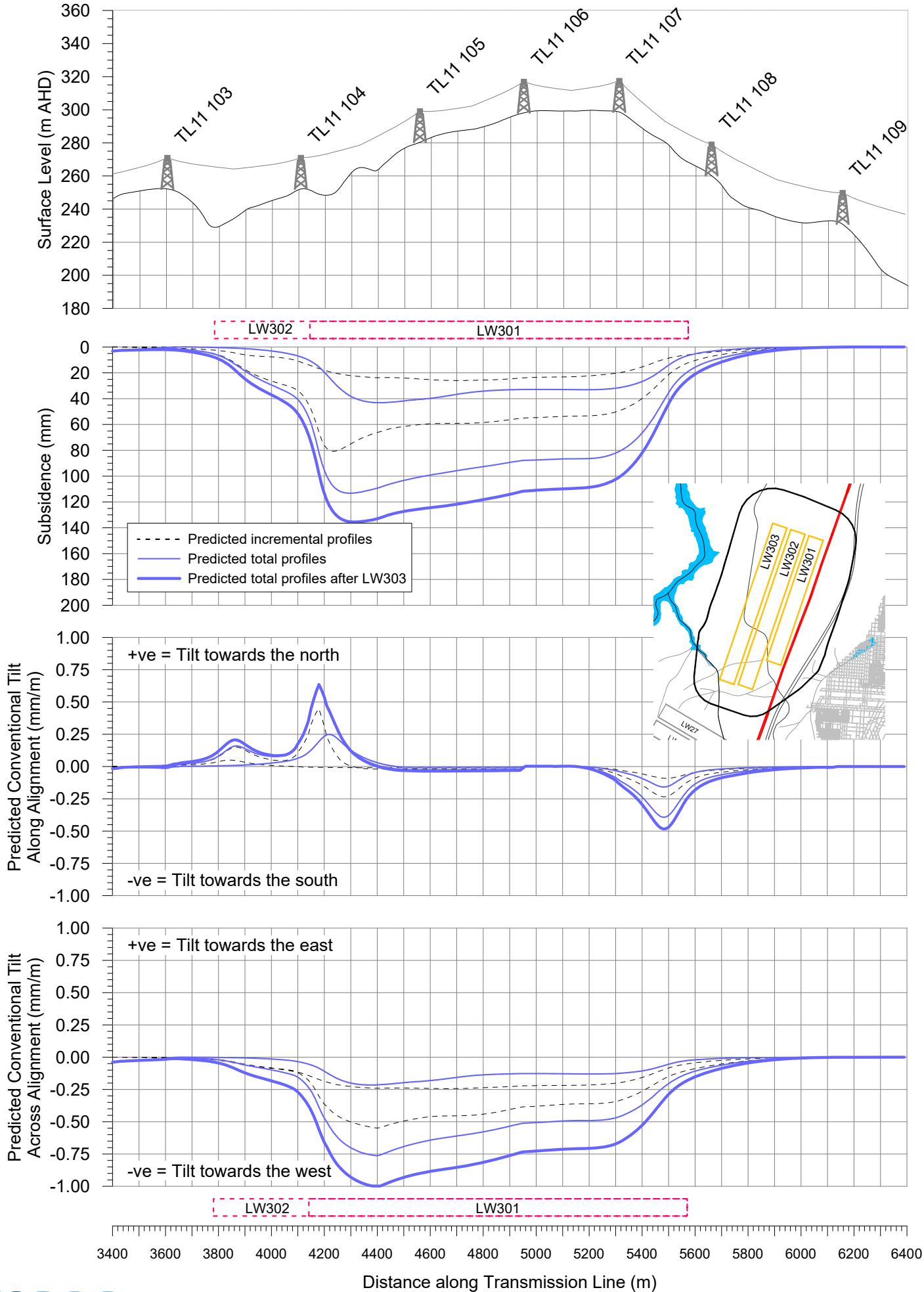

Fig. A.2

APPENDIX 2

MSEC (2019) METROPOLITAN COLLIERY – PROPOSED LONGWALL 304 – SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE TRANSGRID 330 KV TRANSMISSION LINE

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

13th March 2019

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC1013-02

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the TransGrid 330 kV Transmission Line

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the TransGrid 330 kV transmission line resulting from the extraction of the proposed Longwall 304 at Metropolitan Colliery.

The locations of the 330 kV transmission line and the proposed longwall are shown in the attached Drawing No. MSEC1013-02.

A Study Area is shown in Drawing No. MSEC1013-02 and is based on the outer limits of a 35° angle of draw line from Longwall 304 and the predicted 20mm subsidence contour for Longwall 304.

The 330kV transmission line is located is outside the Study Area for Longwall 304 and is 670 m from the longwall at its nearest point. Predictions and impact assessments for the TransGrid 330 kV transmission line are provided below.

The transmission towers and reference numbers are also shown in Drawing No. MSEC1013-02. There are five towers that are located immediately adjacent to the Study Area for Longwall 304. The transmission towers that are located adjacent to the Study Area are all suspension towers. The changes in alignment at the transmission towers are in the order of 1 to 3 degrees. A photograph of one of the 330 kV transmission towers is provided in Figure 1.

Figure 1 Photograph of a 330 kV Transmission Tower

Predictions of Conventional Subsidence Parameters

The 330 kV transmission line is located 670 m from Longwall 304. At this distance, the transmission line is not expected to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwall 304. The transmission towers could experience low level far-field horizontal movement. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield, which tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain.

It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in the following section.

The observed incremental far-field horizontal movements, resulting from the extraction of longwalls in the Southern Coalfield, are provided in Figure 2. The data is based on survey marks located outside of the mining area (i.e. above solid coal).

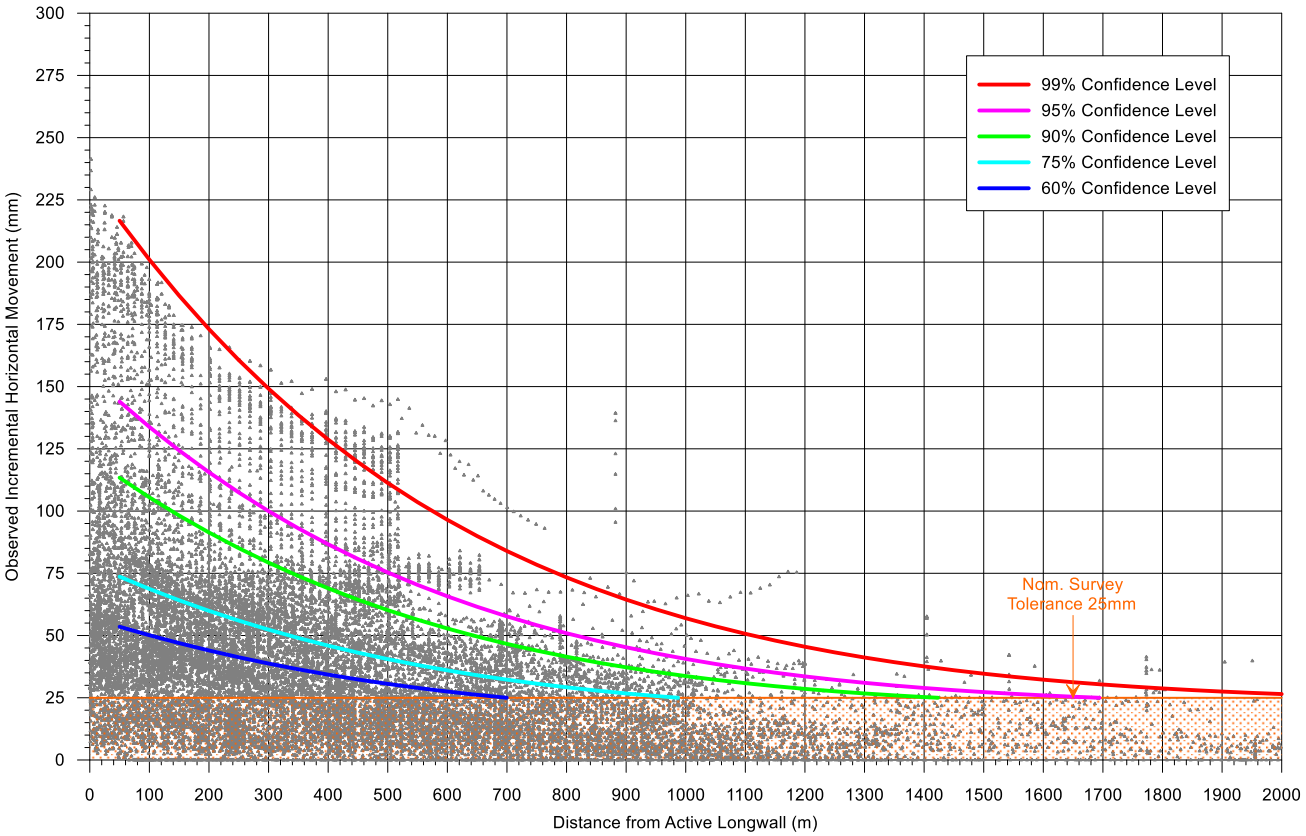

Figure 2 Observed Incremental Far-field Horizontal Movements from the Southern Coalfield (Solid Coal)

The absolute incremental horizontal movements measured at distances greater than 670 m from mining are in the order of 60 mm based on the 95% confidence level. Far-field horizontal movements tend to be bodily movements orientated towards the mining area. The strains associated with these low level horizontal movement are not expected to be measurable. The absolute far-field horizontal movements could result in minor changes in the distances between the towers since the directions of these far-field horizontal movements are generally expected to be towards the extracted longwalls. Monitoring of the transmission towers measured a maximum cumulative differential horizontal movement between towers of approximately 25 mm during the extraction of Longwalls 301 and 302.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the 330 kV transmission line has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The transmission towers are located at distances of 50 metres or greater from the existing and proposed longwalls. The database has therefore been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located outside between zero and 100 metres of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

A histogram of the maximum observed tensile and compressive strains measured in survey bays located above solid coal, for monitoring lines in the Southern Coalfield, is provided in Figure 3. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

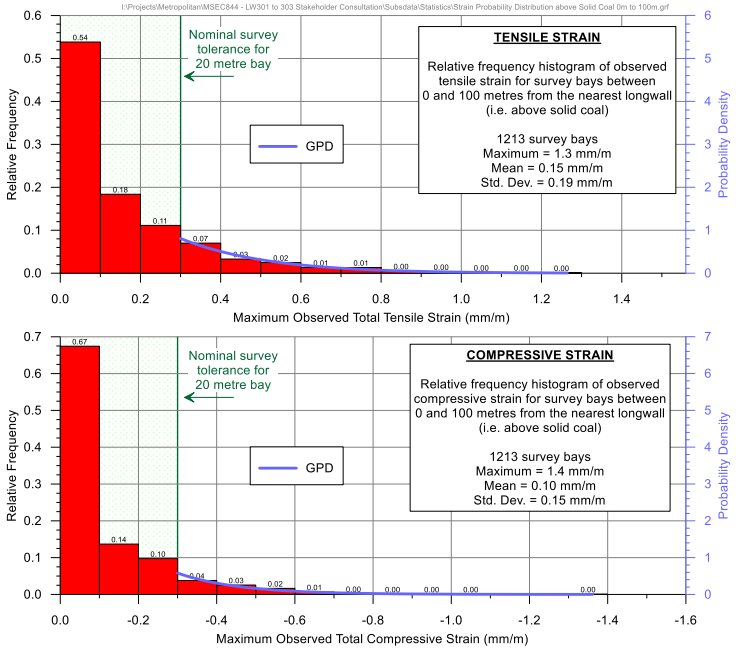

Figure 3 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Solid Coal (0 to 100 metres)

The 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.5 mm/m tensile and 0.4 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.8 mm/m tensile and 0.7 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures at seam level and the major streams are shown in Drawing No. MSEC1013-02. There are no mapped faults located within the Study Area that extend beneath the 330 kV transmission line. It is possible that the transmission line could experience localised and elevated strains due to

unknown geological structures (i.e. anomalies). Non-conventional or anomalous movements have not been identified during the extraction of Longwalls 301 and 302. The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The transmission line does not cross any major streams within the Study Area and, therefore, is not expected to experience any measurable valley closure effects.

Impact Assessments for the 330 kV Transmission Line

The cables along the 330 kV transmission line are not directly affected by ground strains, as they are supported by the towers above ground level. The cables can, however, be affected by the changes in bay lengths, i.e. the distances between the towers at the level of the cables, which result from mining induced differential subsidence, horizontal ground movements and lateral movements at the tops of the towers due to differential tilting of the towers. The stability of the transmission towers can be affected by the mining induced tilts, curvatures and ground strains at the tower locations and by changes in the catenary profiles of the cables.

Whilst the 330 kV transmission line could experience low level far-field horizontal movements, the associated tilts, curvatures or strains are not expected to be measurable. It is unlikely that the transmission lines would experience adverse impacts as a result of conventional subsidence movements due to the extraction of Longwall 304.

Far-field horizontal movements could result in small changes in the distances between the towers, particularly those located near the ends of the longwalls. Differential far-field horizontal movements between the transmission towers due to the extraction of Longwall 304 are expected to be less than 20 mm and are not expected to result in adverse impacts to the transmission line.

The predicted strains at the locations of the transmission towers are 0.5 mm/m tensile and 0.4 mm/m compressive based on the 95 % confidence level and are 0.8 mm/m tensile and 0.7 mm/m compressive based on the 99 % confidence level. Tower leg spacings have been monitored since the commencement of Longwall 301 with observed changes in leg spacings generally within the level of accuracy of survey methods.

Localised and elevated compressive strains can develop due to the presence of geological structures. It is possible that the transmission towers could experience compressive strains greater than those predicted based on conventional movements if they were coincident with the surface expression of a fault. The potential for non-conventional movements in the locations of the towers is very low, due to their distances from the longwalls and observations to date, however, the potential for these irregular movements cannot be discounted.

A monitoring program, including a trigger action response plan, has been in place since the commencement of Longwall 301. Observed subsidence parameters have been within expected levels with no identified non-conventional movements. Based on these results the likelihood of non-conventional movements occurring as a result of the extraction of Longwall 304 is considered to be very low.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301 to 303 are updated and continued for Longwall 304, in consultation with Endeavour Energy, to manage the transmission line for potential non-conventional ground movements.

Summary

The 330 kV transmission line is located to the east of the proposed Longwall 304 and is located outside the Study Area at distances of 670 m or more from Longwall 304. At this distance, the transmission line is not expected to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwall 304. The transmission towers could experience low level far-field horizontal movement. It is considered unlikely that the transmission lines would experience adverse impacts as a result of predicted movements due to the extraction of Longwall 304.

It is possible that the transmission towers could experience localised and elevated strains due to the presence of geological structures (known or unknown), if the surface expressions of these features are coincident with them. Non-conventional subsidence movements have not been observed during the extraction of Longwalls 301 and 302 and the likelihood of non-conventional subsidence movements at the transmission towers due to Longwall 304 is considered to be very low.

It is expected that the potential impacts on the TransGrid infrastructure can be managed with the implementation of the necessary monitoring and management strategies.

Yours sincerely

Peter DeBono
Mine Subsidence Engineering Consultants

Attachments:

Drawing No. MSEC1013-02 – Longwall 304 – TransGrid 330 kV Transmission Line

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COLLIERY
LONGWALL 304
TRANSGRID 330kV TRANSMISSION LINE

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	1:10000	MSEC1013-02	02

Grid to MGA co-ordinates

CAWLEYS CK

STUDY AREA

PREDICTED 20mm SUBSIDENCE CONTOUR

LW304

OLD PRINCES HWY

LW303

LW302

LW301

TL11 108

TL11 107

TL11 106

TL11 105

TL11 104

330kV TRANSMISSION LINE

132kV TRANSMISSION LINES

M1 PRINCES MOTORWAY

WILSONS CK

GEOLOGICAL STRUCTURES
FAULTS
DYKES

APPENDIX 3

BUILT FEATURES MANAGEMENT PLAN – SUBSIDENCE IMPACT REGISTER

Built Features Management Plan - Subsidence Impact Register

Impact Register Number[1]	Built Feature[2]	Impact Description	Does Impact Exceed the Built Feature Performance Measure/Indicators? (Yes/No)	Management Measures Implemented	Were Management Measures Effective? (Yes/No)

Notes:

1: Fill out all details in the Assessment Form and record the register number here.

2: Built feature (e.g. transmission line, tower, etc.).

3: Impacts to access roads/tracks to be included in the Land Management Plan – Subsidence Impact Register.

Built Feature Management Plan – Subsidence Impact Register
Assessment Form

Date:

Observer (Name and position):

Register Number (i.e. Number 1, 2, etc.):

Longwall Number and Chainage:

Location of Observed Impact:

(Examples: location of tower, include GPS co-ordinates and a sketch)

Description of Observed Impact:

(Examples: nature and extent of impact - cracks in road etc any relevant information, attach photographs)

Person Notified:	Manager - Technical Services	☐

Description of Photographs:

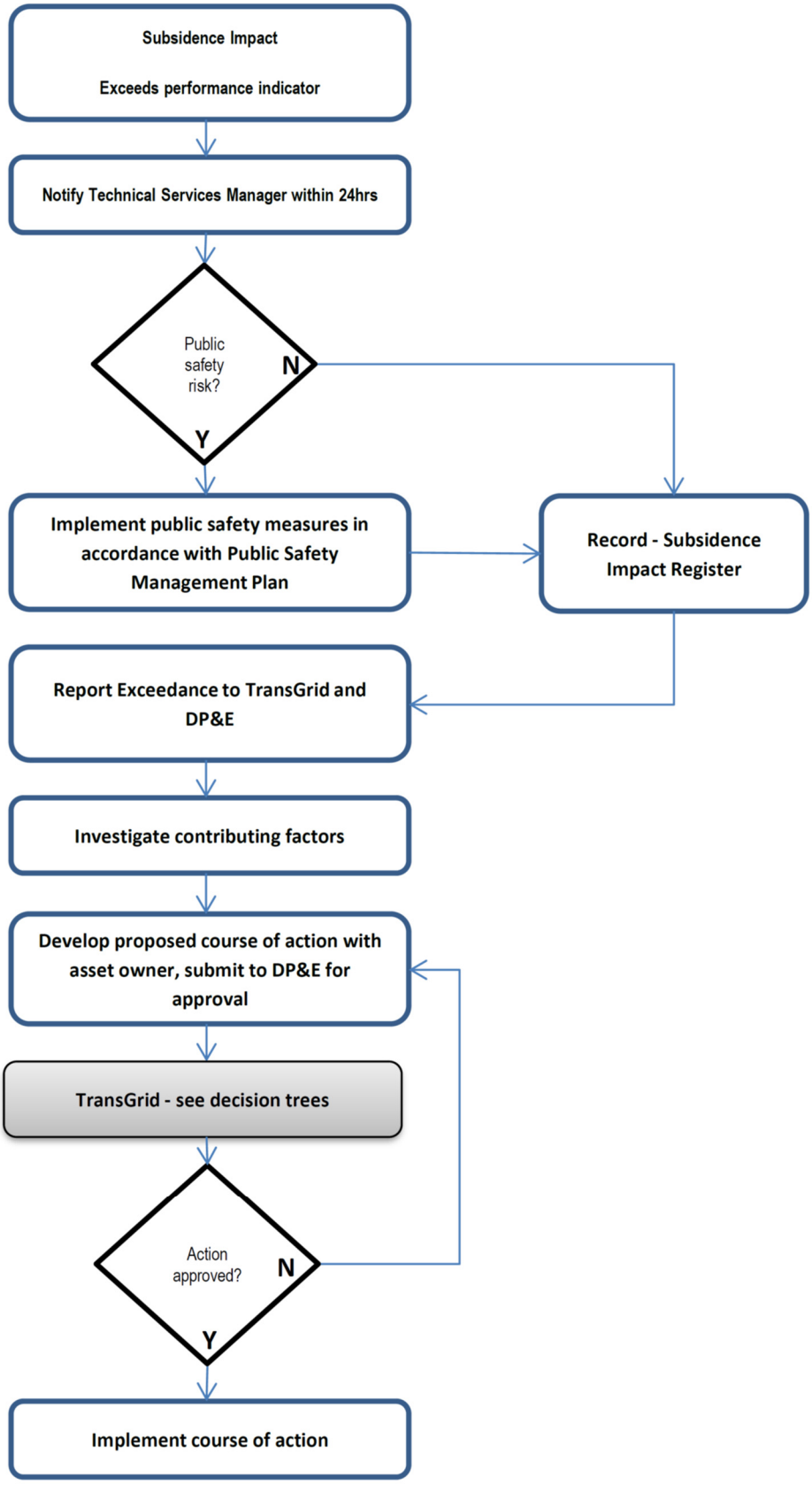
Actions Required:	Contingency Plan Initiated	☐
	Incident Notification	☐
	Safety Measures/Public Safety Management Plan Requirements	☐

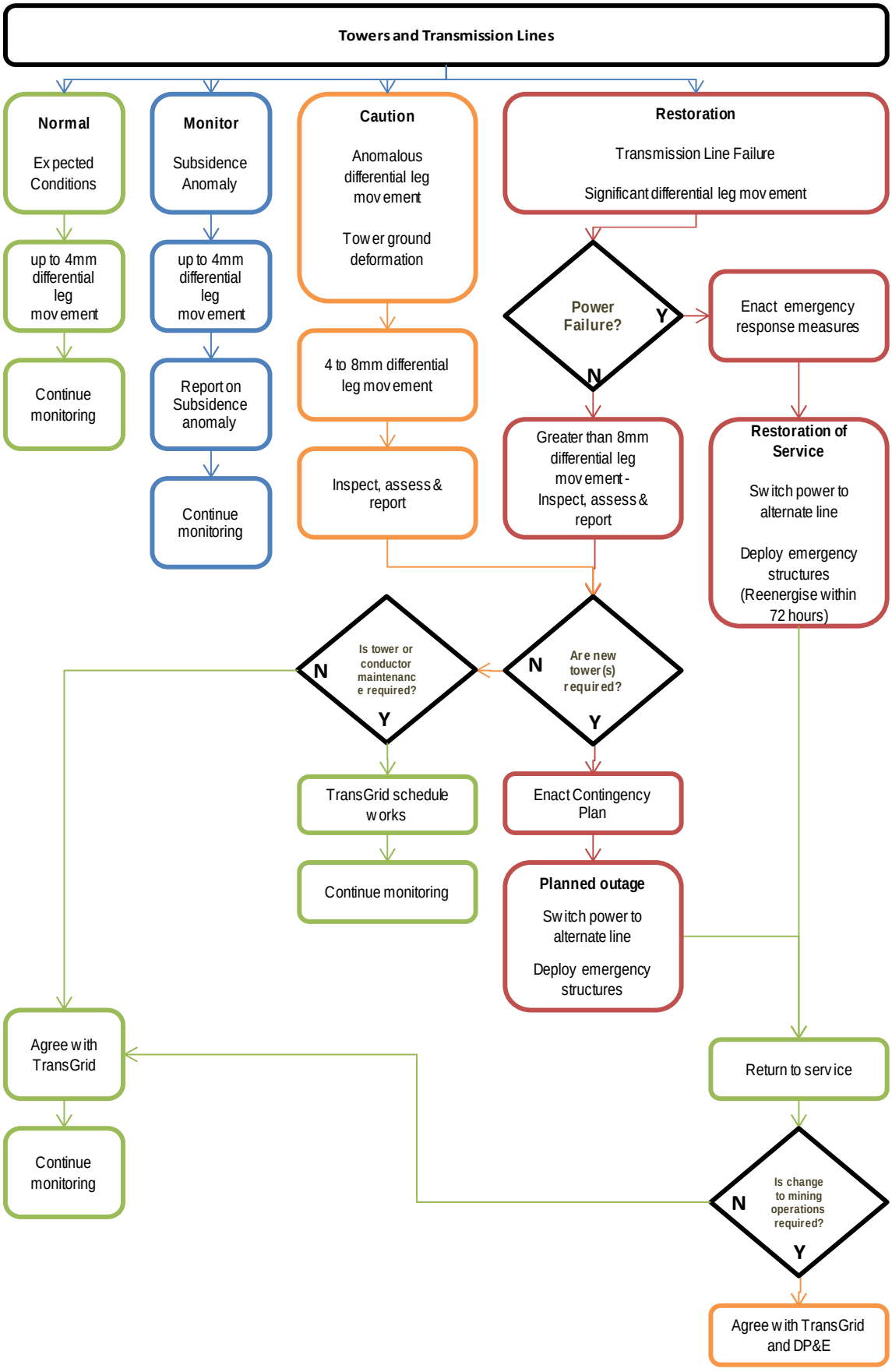
Management or Contingency Measures Implemented:

Effectiveness of Management or Contingency Measures:

APPENDIX 4

CONTINGENCY PLAN PROCEDURE AND DECISION TREE


Subsidence Impact
Exceeds performance indicator
Notify Technical Services Manager within 24hrs
Public safety risk?
N
Y
Implement public safety measures in accordance with Public Safety Management Plan
Record - Subsidence Impact Register
Report Exceedance to TransGrid and DP&E
Investigate contributing factors
Develop proposed course of action with asset owner, submit to DP&E for approval
TransGrid - see decision trees
Action approved?
N
Y
Implement course of action


Towers and Transmission Lines
Normal
Expected Conditions
up to 4mm differential leg movement
Continue monitoring
Monitor
Subsidence Anomaly
up to 4mm differential leg movement
Report on Subsidence anomaly
Continue monitoring
Caution
Anomalous differential leg movement
Tower ground deformation
4 to 8mm differential leg movement
Inspect, assess & report
Restoration
Transmission Line Failure
Significant differential leg movement
Power Failure?
Y
N
Enact emergency response measures
Greater than 8mm differential leg movement - Inspect, assess & report
Restoration of Service
Switch power to alternate line
Deploy emergency structures (Reenergise within 72 hours)
Are new tower(s) required?
N
Y
Is tower or conductor maintenance required?
N
Y
TransGrid schedule works
Continue monitoring
Enact Contingency Plan
Planned outage
Switch power to alternate line
Deploy emergency structures
Agree with TransGrid
Continue monitoring
Return to service
Is change to mining operations required?
N
Y
Agree with TransGrid and DP&E

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BUILT FEATURES MANAGEMENT PLAN
VOCUS

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&E Approval Date
All	LW301-303 BFMP_Nextgen-R01-A	Original – Draft for Consultation	Nextgen, DRG and DP&E	-
Section 4.1.1, Tables 3, 5 & 6, Figure 4 and Appendix 1	LW301-303 BFMP_Nextgen-R01-B	Revised – Incorporating Nextgen Agreement and updates	Nextgen, DRG and DP&E	11 May 2017*
Section 7.2.2, Tables 2, 5 & 7 and Appendix 4	LW301-303 BFMP_Nextgen-R01-C	Revised – Addressing DP&E and DRG requirements	Nextgen, DRG and DP&E	-
All	LW301-303 BFMP_Nextgen-R01-D	Revised TARP. Revised for LW303	Nextgen (Vocus) and DRG	8 November 2018#
All	BFMP_VOCUS-R01-E	Inclusion of Longwall 304 into BFMP	Vocus, DRG and DP&E	-

* The approval allows for the extraction of Longwalls 301 and 302 only.

Approval for the extraction of Longwall 303.

April 2019

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Appendix 3 MSEC (2019) Metropolitan Colliery – Proposed Longwall 304 – Subsidence Predictions and Impact Assessments for the Vocus Infrastructure

Appendix 4 Built Features Management Plan – Subsidence Impact Register

Appendix 5 Contingency Plan Procedure and Decision Tree

1 INTRODUCTION

Metropolitan Coal is a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under section 75J of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com).

The Project comprises the continuation, upgrade and extension of underground coal mining operations (Longwalls 20-27 and Longwalls 301-317) and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1. Following the completion of Longwall 27 in 2017, Longwalls 301, 302, 303 and 304 define the next mining sub-domains within the Project underground mining area (Figures 1 to 3).

1.1 PURPOSE AND SCOPE

In accordance with Condition 6(f), Schedule 3 of the Project Approval, this Built Features Management Plan – Vocus[1] (BFMP-VOCUS) has been developed to manage the potential consequences of longwall extraction on the Vocus assets.

The relationship of this BFMP-VOCUS to the Metropolitan Coal Environmental Management Structure is shown on Figure 4.

In accordance with Condition 6 of Schedule 3, the suitably qualified and experienced experts that have prepared this BFMP-VOCUS, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and Metropolitan Coal were endorsed by the Director-General (now Secretary) of the NSW Department of Planning and Environment (DP&E). This BFMP-VOCUS has been prepared in consultation with Vocus including consideration of prior consultation during the development of the previously approved Built Features Management Plans.

A Management Plan Agreement (Nextgen, 2016) (Appendix 1) has been developed that outlines procedures for the management and monitoring of Vocus assets in areas impacted by underground mining activities. To avoid duplication, this BFMP-VOCUS references the Nextgen Management Plan Agreement (2016) wherever possible.

1.2 STRUCTURE OF THE BFMP-VOCUS

The remainder of the BFMP-VOCUS is structured as follows:

Section 2: Describes the review and update of the BFMP-VOCUS.

Section 3: Outlines the statutory requirements applicable to the BFMP-VOCUS.

Section 4: Provides a revised assessment of the potential subsidence impacts and environmental consequences for Longwalls 301-304, and results of a risk assessment.

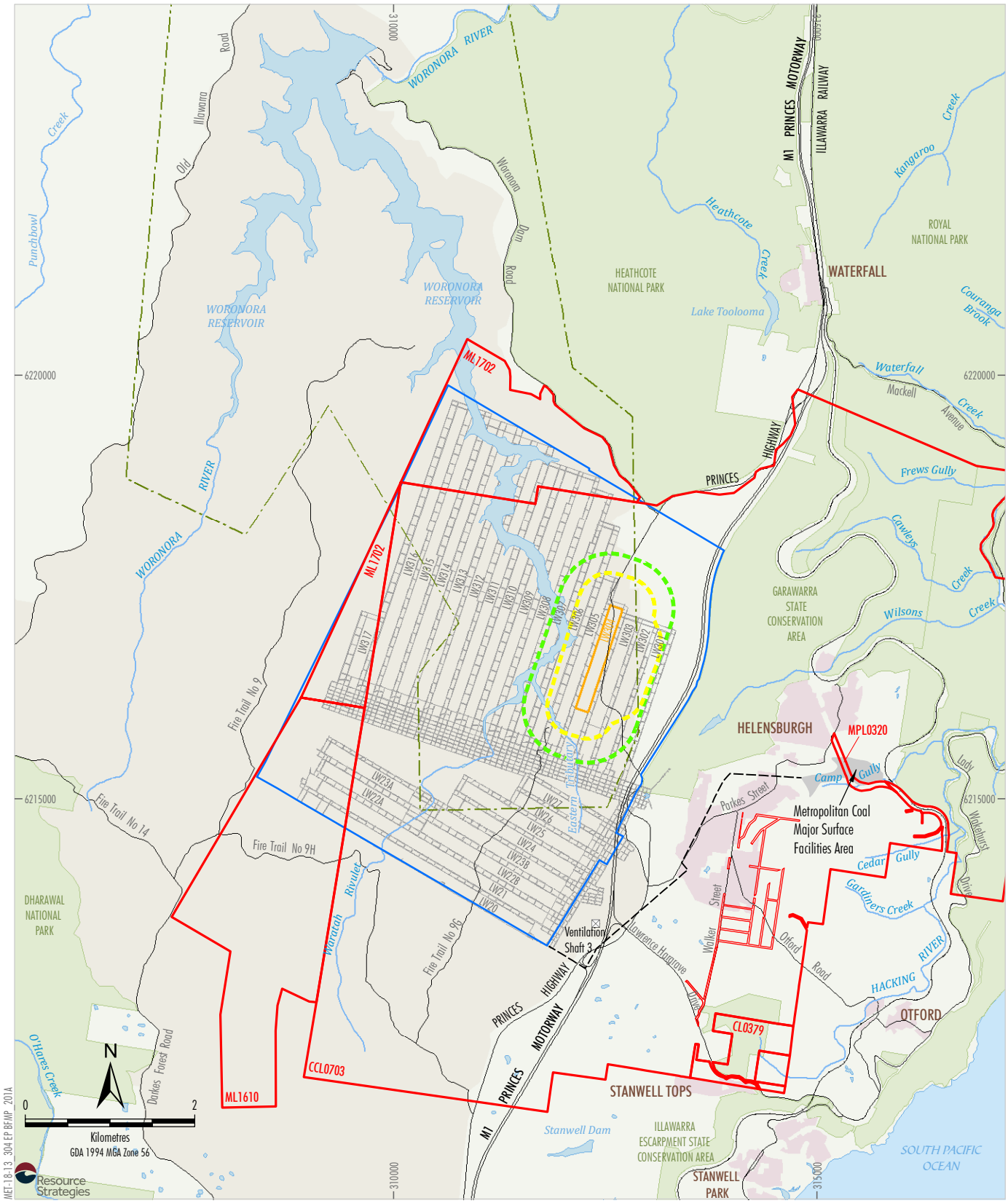
Section 5: Details the performance measures and indicators that will be used to assess the Project.

Section 6: Provides the detailed baseline data.

Section 7: Describes the monitoring program.

Section 8: Describes the management measures that will be implemented.

[1] Vocus (previously Nextgen).



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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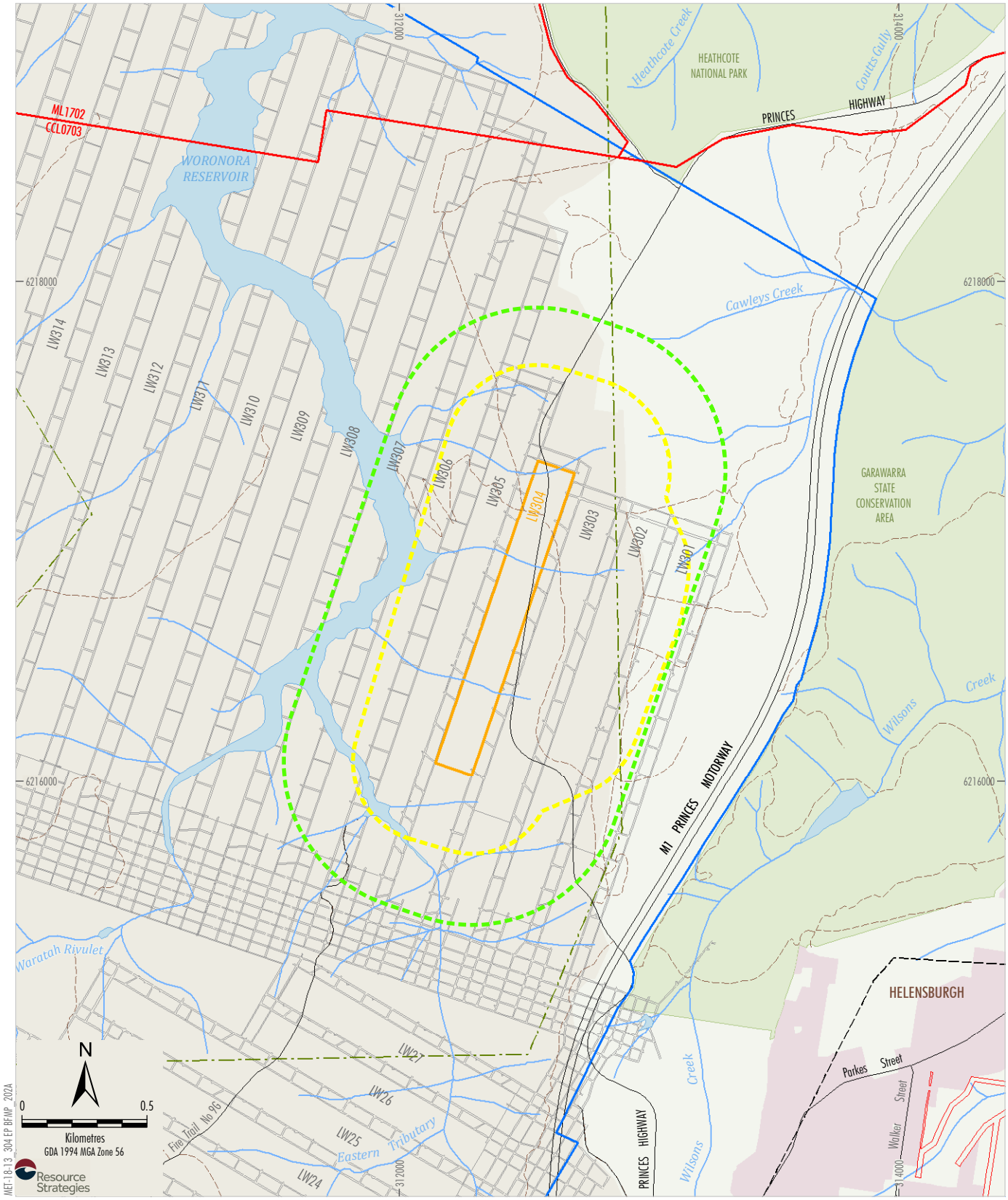
Longwalls 20-27 and Longwalls 301-317 Layout

Figure 1



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)
- Vehicular Track

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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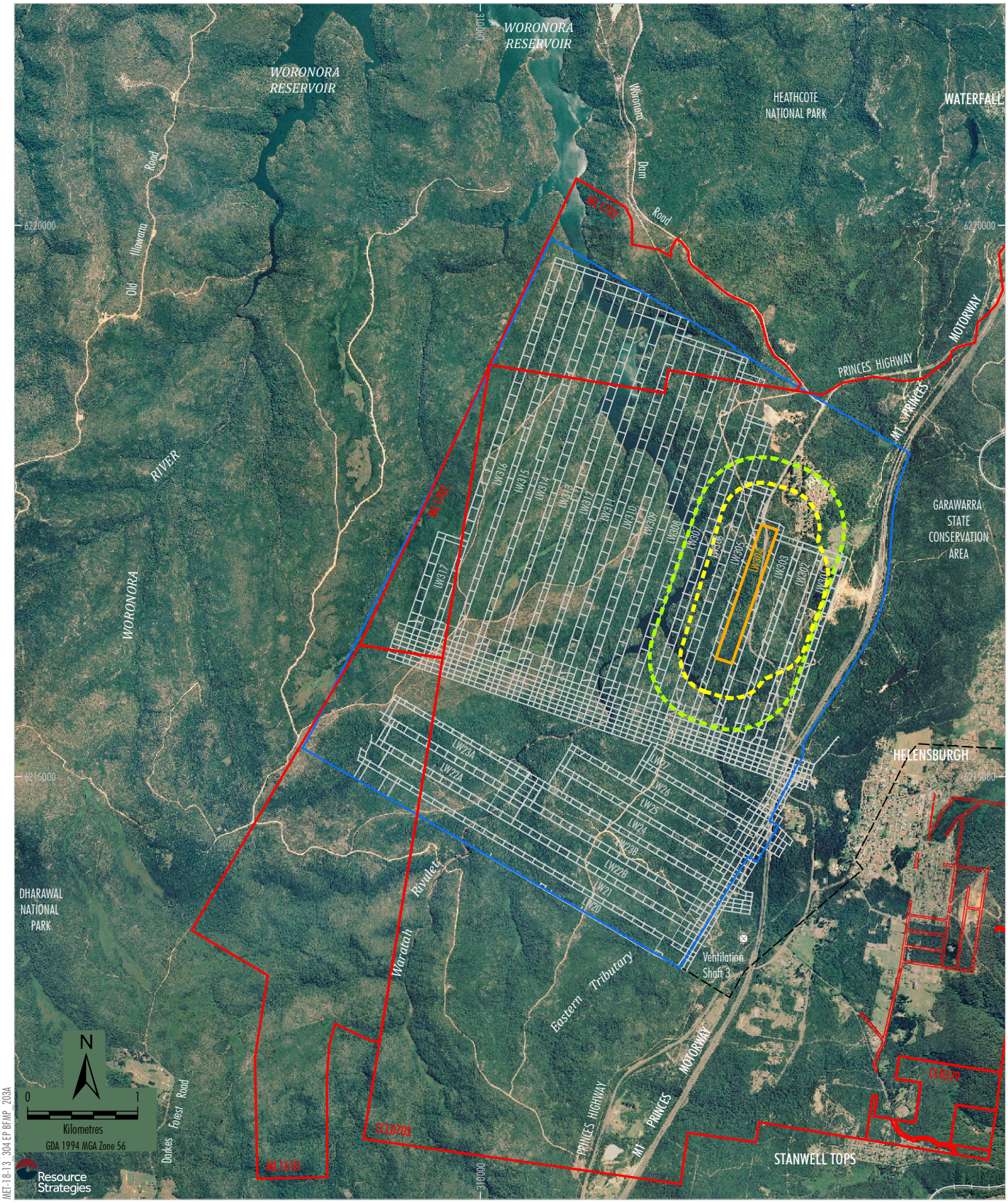
Longwalls 301-304 Layout

Figure 2



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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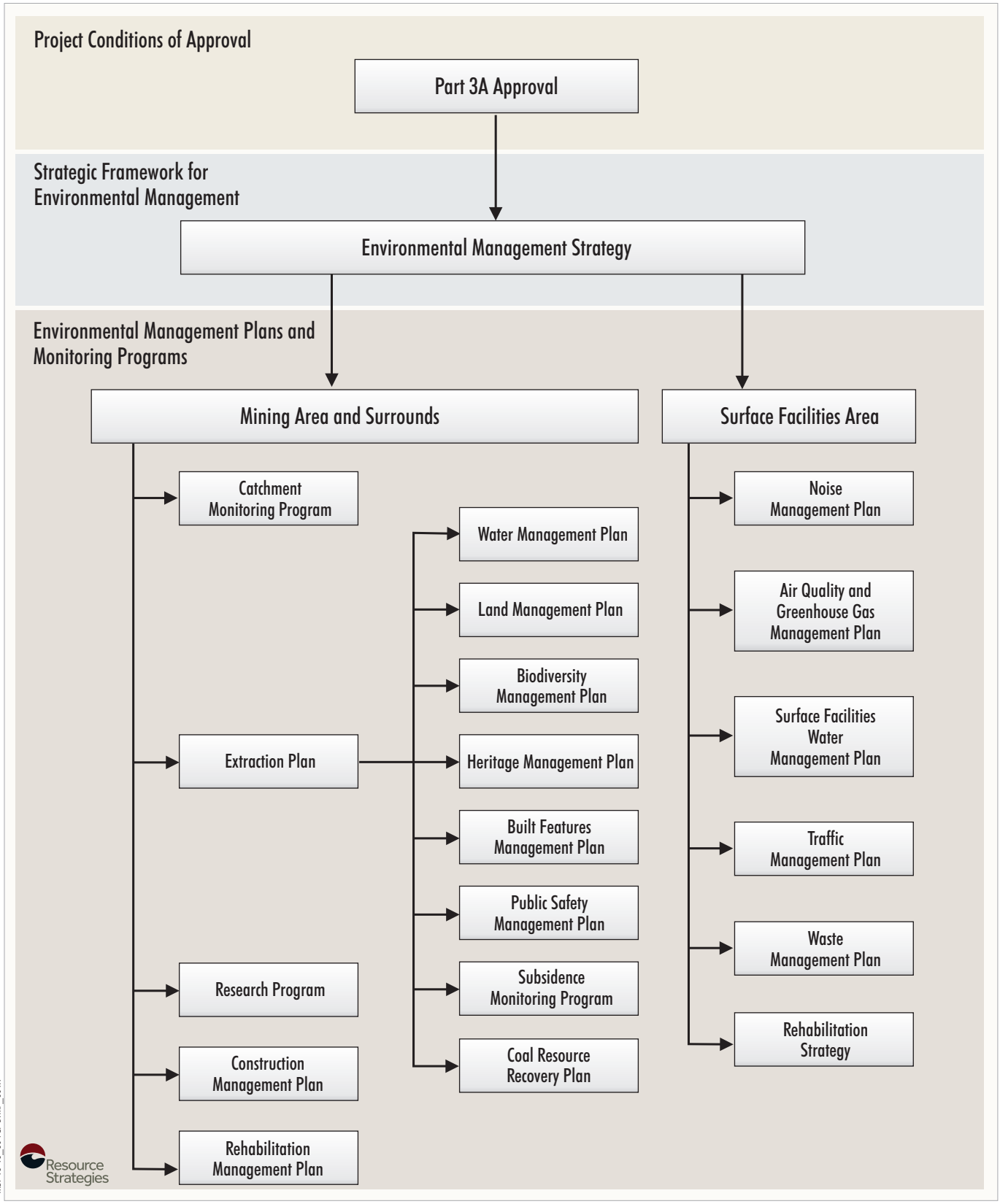
Longwalls 20-27 and Longwalls 301-317 Layout - Aerial Photograph

Figure 3



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Environmental Management Structure

Figure 4

Section 9: Provides a contingency plan to manage any unpredicted impacts and their consequences.

Section 10: Describes the Trigger Action Response Plan (TARP) management tool.

Section 11: Describes the program to collect sufficient baseline data for future Extraction Plans.

Section 12: Describes the annual review and improvement of environmental performance.

Section 13: Outlines the management and reporting of incidents.

Section 14: Outlines the management and reporting of complaints.

Section 15: Outlines the management and reporting of non-compliances with statutory requirements.

Section 16: Lists the references cited in this BFMP-VOCUS.

2 BFMP-VOCUS REVIEW AND UPDATE

In accordance with Condition 4, Schedule 7 of the Project Approval, this BFMP-VOCUS will be reviewed within three months of the submission of:

- an audit under Condition 8 of Schedule 7;
- an incident report under Condition 6 of Schedule 7;
- an annual review under Condition 3 of Schedule 7; and

if necessary, revised to the satisfaction of the Director-General (now Secretary) of DP&E, to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

This BFMP will also be reviewed within three months of approval of any Project modification and if necessary, revised to the satisfaction of the DP&E.

The revision status of this plan is indicated on the title page of each copy of the BFMP-VOCUS. The distribution register for controlled copies of the BFMP-VOCUS is described in Section 2.1.

Revisions to any documents listed within this BFMP-VOCUS will not necessarily constitute a revision of this document.

2.1 DISTRIBUTION REGISTER

In accordance with Condition 10, Schedule 7 ‘Access to Information’, Metropolitan Coal will make the BFMP-VOCUS publicly available on the Peabody website. A hard copy of the BFMP-VOCUS will also be maintained at the Metropolitan Coal site.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format. An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom the Metropolitan Coal plans and programs, such as the BFMP-VOCUS, will be distributed;

- the format (i.e. electronic or hard copy) of distribution; and
- the format of revision notification.

Metropolitan Coal has made the Distribution Register publicly available on the Peabody website. Metropolitan Coal will be responsible for maintaining the Distribution Register and for ensuring that the notification of revisions is sent by email or post as appropriate.

In addition, Metropolitan Coal employees with local computer network access will be able to view the controlled electronic version of this BFMP-VOCUS on the Metropolitan Coal local area network. Metropolitan Coal will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on Metropolitan Coal's computer system and the Peabody website.

3 STATUTORY REQUIREMENTS

Metropolitan Coal's statutory obligations are contained in:

(i) the conditions of the Project Approval;

(ii) relevant licences and permits, including conditions attached to mining leases; and

(iii) other relevant legislation.

These are described below.

3.1 EP&A ACT APPROVAL

Condition 6(f) of Schedule 3 of the Project Approval requires the preparation of a BFMP as a component of Extraction Plan(s) for second workings. Project Approval Condition 6(f), Schedule 3 states:

> ***SECOND WORKINGS***
>
> ***Extraction Plan***
>
> *6. The Proponent shall prepare and implement an Extraction Plan for all second workings in the mining area to the satisfaction of the Director-General. This plan must:*
>
> *…*
>
> *(f) include a:*
>
> *…*
>
> - *Built Features management Plan, which has been prepared in consultation with the owner of the relevant feature, to manage the potential environmental consequences of the Extraction Plan on any built features;*

In addition, Condition 2, Schedule 7 and Condition 7, Schedule 3 of the Project Approval outline management plan requirements that are applicable to the preparation of the BFMP-VOCUS.

Table 1 indicates where each component of the conditions is addressed within this BFMP-VOCUS.

Table 1
Management Plan Requirements

Project Approval Condition	BFMP-VOCUS Section
Condition 2 of Schedule 7	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Section 6
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 3
• any relevant limits or performance measures/criteria;	Section 5
• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 5
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Sections 7, 8, 9 and 10
d) a program to monitor and report on the:	Sections 7, 8 and 12
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 9 and Appendix 5
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Sections 7 and 12
g) a protocol for managing and reporting any;	
• incidents;	Section 13
• complaints;	Section 14
• non-compliances with statutory requirements; and	Section 15
• exceedances of the impact assessment criteria and/or performance criteria; and	Section 9 and Appendix 5
h) a protocol for periodic review of the plan.	Section 2
Condition 7 of Schedule 3	
7. In addition to the standard requirements for management plans (see condition 2 of schedule 7), the Proponent shall ensure that the management plans required under condition 6(f) above include:	
a) a program to collect sufficient baseline data for future Extraction Plans;	Section 11
b) a revised assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval;	Section 4
c) a detailed description of the measures that would be implemented to remediate predicted impacts; and	Section 8
d) a contingency plan that expressly provides for adaptive management.	Section 9 and Appendix 5

3.2 LICENCES, PERMITS AND LEASES

In addition to the Project Approval, all activities at or in association with the Metropolitan Coal Mine will be undertaken in accordance with the following licences, permits and leases which have been issued or are pending issue:

- The conditions of mining leases issued by the NSW Division of Resources and Geoscience (DRG), under the NSW Mining Act, 1992 (e.g. Consolidated Coal Lease [CCL] 703, Mining Lease [ML] 1610, ML 1702, Coal Lease [CL] 379 and Mining Purpose Lease [MPL] 320).
- The *Metropolitan Coal Mining Operations Plan 1 October 2012 to 30 September 2019* approved by the DRG.
- The conditions of Environment Protection Licence (EPL) No. 767 issued by the NSW Environment Protection Authority (EPA) under the NSW *Protection of the Environment Operations Act, 1997*. Revision of the EPL will be required prior to the commencement of Metropolitan Coal activities that differ from those currently licensed.
- The prescribed conditions of specific surface access leases within CCL 703 for the installation of surface facilities as required.
- Water Access Licences (WALs) issued by the NSW Department of Primary Industries – Water (now the Department of Industry – Water) under the NSW *Water Management Act, 2000*, including WAL 36475 under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* and WAL 25410 under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*.
- Mining and workplace health and safety related approvals granted by the NSW Resources Regulator and WorkCover NSW.
- Supplementary approvals obtained from WaterNSW for surface activities within the Woronora Special Area (e.g. fire road maintenance activities).

3.3 OTHER LEGISLATION

Metropolitan Coal will conduct the Project consistent with the Project Approval and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to the conduct of the Project (Helensburgh Coal Pty Ltd [HCPL], 2008)[2]:

- *Biodiversity Conservation Act, 2016;*
- *Biosecurity Act, 2015*
- *Contaminated Land Management Act, 1997;*
- *Crown Land Management Act, 2016;*
- *Dams Safety Act, 2015;*
- *Dangerous Goods (Road and Rail Transport) Act, 2008;*
- *Energy and Utilities Administration Act, 1987;*
- *Fisheries Management Act, 1994;*

[2] The list of potentially applicable Acts has been updated to reflect changes to the Acts that were in force at the time of submission of the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008).

- *Mining Act, 1992;*
- *Protection of the Environment Operations Act, 1997;*
- *Rail Safety (Adoption of National Law) Act, 2012;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Water NSW Act, 2014;*
- *Work Health and Safety Act, 2011; and*
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

Relevant licences or approvals required under these Acts will be obtained as required.

4 REVISED ASSESSMENT OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

4.1 EXTRACTION LAYOUT

Longwalls 301-304 and the area of land within 600 metres (m) of Longwall 304 secondary extraction are shown on Figures 2 and 3. Longwall extraction occurs from north to south. The longwall layouts include 163 m panel widths (void) with 45 m pillars (solid).

The provisional extraction schedule for Longwalls 301-304 is provided in Table 2.

Table 2
Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
301	June 2017	6 months	February 2018
302	March 2018	7 months	October 2018
303	November 2018	7 months	May 2019
304	July 2019	6 months	December 2019

The future Extraction Plans will consider the cumulative subsidence effects, subsidence impacts and/or environmental consequences. Note that the total cumulative predicted subsidence effects, subsidence impacts and/or environmental consequences at the completion of the Project are considered in the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008) and the Preferred Project Report (HCPL, 2009).

4.1.1 Vocus Assets

The Vocus assets of relevance for the Longwalls 301-304 extraction include (Appendix 1):

- Major Interstate Trunk Cable Sydney-Melbourne SM1 optical fibre cable (Waterfall to Corrimal Section).
- Associated Vocus Joint Housing Pit (SM1-SN-SN J08) linked to Telstra manhole using P50 conduit and P32 sub-duct passing through concrete Joint Housing Pit.

The Vocus optical fibre cable is located adjacent to Longwall 301 and above the southern end of Longwall 301 (Figure 5).

4.2 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

4.2.1 Revised Subsidence Predictions

Subsidence predictions for Longwalls 20-44 in relation to the Vocus assets was conducted by MSEC (2008) as part of the Metropolitan Coal Project EA. MSEC (2008) includes a table summarising the incremental systematic subsidence parameters for the extraction of each longwall from Longwalls 20-44. These include:

- maximum predicted incremental subsidence (vertical movement);
- maximum predicted incremental tilt along alignment;
- maximum predicted incremental tilt across alignment;
- maximum predicted incremental tensile strain; and
- maximum predicted incremental compressive strain.

Revised subsidence and impact predictions for the extraction of Longwalls 301-303 on Nextgen assets were conducted by MSEC and reported in MSEC (2016) (Appendix 2).

In relation to subsidence predictions and potential impacts due to the extraction of Longwalls 301-303, MSEC (2016) make the following conclusions:

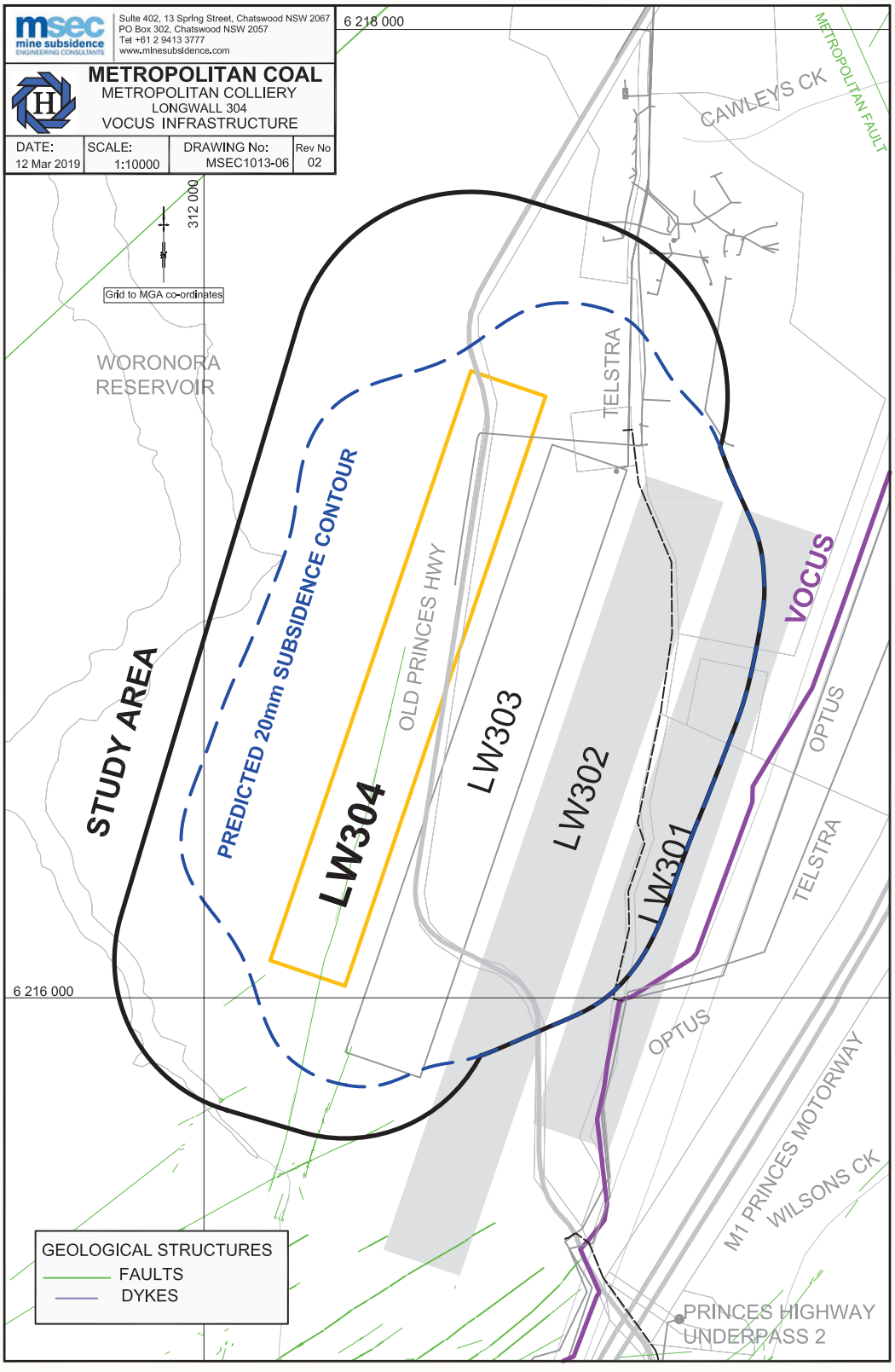
- The optical fibre cable is direct buried and, therefore, will not be impacted by the tilts resulting from the extraction of Longwalls 301-303.
- The buried optical fibre cable is likely to experience curvatures and ground strains resulting from the extraction of Longwalls 301-303.
- The predicted curvatures and strains for the optical fibre cable are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar cables.

Revised subsidence and impact predictions for the extraction of Longwall 304 on Vocus assets were conducted by MSEC and reported in MSEC (2019) (Appendix 3).

MSEC (2019) conclude that the Vocus assets are not expected to experience measurable conventional vertical subsidence, tilts or curvatures, as they are located approximately 550 m east of Longwall 304, outside the Longwall 304 35° angle of draw and/or predicted 20 mm subsidence contour. Predicted strains on Vocus infrastructure due to the extraction of Longwall 304 are expected to be less than the values predicted due to the extraction of Longwalls 301-303.

4.2.2 Risk Assessment Review

In accordance with the *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) a risk assessment review was undertaken for the Vocus assets. The risk assessment review built on previous risk assessments undertaken for other BFMP(s) in the Extraction Plan relating to optical fibre cables which included representatives from Metropolitan Coal, Comms Network Solutions Pty Ltd, MSEC and Resource Strategies.



MET-18-13_304 EP BHMP_003A

Source: MSEC (2019)

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Vocus Assets

Figure 5

The investigation and analysis methods used during the risk assessment review included:

- preliminary identification of Vocus assets;
- review of the revised subsidence predictions and potential impacts on Vocus assets (including consideration of past experience in the Southern Coalfield); and
- Development of a preliminary monitoring plan.

A number of risk control measures and procedures have been identified which considered the extraction of coal beneath the Vocus assets, and are summarised as follows:

Baseline Data / Validation

1. Obtain from Vocus an audit to confirm that all services (including any vulnerabilities due to age, installation process, etc.) of optical fibre cables that may be affected by mining of Longwalls 301 to 303 have been identified and document in the BFMP.
2. Carry out an audit of the physical location of the Optic Fibre Cable prior to any mining to confirm that physical access is available in the Study area.
3. Provide survey information on the Optic Fibre Cable and have Vocus confirm that this is correct to validate the current studies.

Management / Monitoring / Response Measures

4. Develop a Trigger Action Response Plan (TARP) and include a trigger to confirm that the Optical Fibre Cables monitoring is being carried out when the mining of Longwalls 301 to 303 may impact on the Optic Fibre Cable.
5. Include in the TARP a trigger to conduct physical audits of the Optic Fibre Cable when mining is likely to affect the cable so that rectification work can commence if required based on the TARP Conditions.

Metropolitan Coal considers all risk control measures and procedures to be feasible to manage all identified risks.

The proposed risk control measures and procedures have been incorporated where relevant in this BFMP and the program for implementation is summarised in Table 3.

Table 3
Program for Implementation of Proposed Risk Control Measures and Procedures

	Risk Control Measure / Procedure	BFMP Section	Proposed Timing
Baseline Data / Validation			
1	Obtain from Vocus an audit to confirm that all services (including any vulnerabilities due to age, installation process, etc.) of optical fibre cables have been identified and document in the BFMP	Appendix 1	Complete
2	Carry out an audit of the physical location of the Optic Fibre Cable to confirm that physical access is available in the Study area	Section 6	Complete
3	Provide survey information to Vocus on the Optic Fibre Cable	Section 6	Complete
Management / Monitoring / Response Measures			
4	Develop a TARP and include a trigger to confirm that the Optical Fibre Cables monitoring is being carried out when mining is likely to affect the main Optic Fibre	Appendix 1 / Section 10 / Table 8	Complete
5	Include in the TARP a trigger to conduct physical audits of the Optic Fibre Cable when mining is likely to affect the cable	Appendix 1 / Section 10 / Table 8	Complete

The risk control measures and procedures identified during the risk assessment for Longwalls 301-303 will be implemented for the extraction of Longwall 304.

5 PERFORMANCE MEASURES AND INDICATORS

The Project Approval requires Metropolitan Coal not to exceed the subsidence impact performance measures outlined in Table 1 of Condition 1, Schedule 3. The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

> *Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.*

The performance indicators proposed to ensure that the above performance measure is achieved include:

- negligible transmission loss in fibre optic cables from mine subsidence impacts;
- the structural integrity of the cable line and associated joint housing pit is maintained; and
- the serviceability of the access roads/tracks is maintained.

Section 7 of this BFMP-VOCUS describes the monitoring that will be conducted to assess the Project against the above performance measure. Section 9 of this BFMP-VOCUS provides a Contingency Plan in the event the performance measure is exceeded.

6 BASELINE DATA

An audit of the physical location of the Optic Fibre Cable to confirm that physical access is available was conducted prior to commencement of Longwall 301 extraction. Survey information was provided to Vocus.

Baseline data (including photograph of manholes and relevant conduits, trenches, etc.) is documented in the Nextgen Management Plan Agreement (Appendix 1).

6.1 STATE OF ASSET BEFORE MINING

In consultation with Vocus (and similar to the approach adopted for other optical fibre cables), Metropolitan Coal has assessed and determined the state of the Vocus optical fibre cables before mining of Longwall 301.

For example, the state of nearby IOF cables was previously assessed before mining commenced in Longwall 20. The amplifier outputs and fibre loss between nominated end points O2WF Waterfall CEV and O2WM Wollongong CEV were measured. Measurement points O2WF and O2WM were located on the SM2 IOF at either end of the planned mining area.

Table 4 below shows the loss measured between O2WF and O2WM from amplifier to amplifier.

Table 4
Measured Loss in O2WF Waterfall – O2WM Wollongong SM-2 IOF Section

Location	Tx Level (dBm)	Rx Level (dBm)	Loss(dBm)
O2WF 1B	14.3	-	-
O2WM 1A	-	-3.8	18.1
O2WM 2B	14.0	-	-
O2WF 2A	-	-3.8	17.8

dBm = decibel-milliwatt.

6.2 PRE-MINING INSPECTION

A pre-mining inspection was conducted prior to commencement of Longwall 301.

6.3 KEY CONTACTS

The list of key contacts for Peabody and Vocus during the development and implementation of this BFMP are provided in Table 5.

Table 5
List of Key Contacts

Company	Position	Contact
Peabody (Metropolitan Coal)	Manager – Technical Services Jon Degotardi	Metropolitan Coal Control Room 24hr 02 4294 7333
Vocus	Peter Hickey	Vocus Support Centre 1800 262 663

7 MONITORING

The monitoring components are described in the Nextgen Management Plan Agreement (Appendix 1) and summarised below in Table 6.

Remote fibre monitoring system (RFMS) monitoring would include obtaining feedback from the continuous monitoring system installed on the adjacent Telstra cable F HOME 2005 in the cable section Engadine-Dapto using Optical Time Domain Reflectometer (OTDR) monitoring on a spare fibre, and physical inspection of the cable line.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts for comparison with baseline photographic records.

Table 6
BFMP-VOCUS Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Baseline	Optical Fibre	Survey	Adjacent subsidence lines - points at approximately 20 m spacing	Establish base conditions pre-mining effects	Prior to Longwall 301 extraction	Complete
		Visual Inspection	Photography of cable pits			
		Remote Fibre Monitoring System (RFMS)	Optical Time Domain Reflectometer (OTDR) monitoring data	Establish signal integrity pre-mining effects	Prior to longwall face approaching within 400 m of passing under the cables	Complete
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Establish condition pre-mining effects	Prior to Longwall 301 extraction	Complete
During Mining	Optical Fibre	Survey	GPS survey of subsidence lines	Determine subsidence, tilt, tensile strain, compressive strain	Survey to commence as longwall face approaches within 400 m of passing under the cables	Weekly, until movement stabilises
		RFMS	Automated alarm. Initial loss level set at ±1.0 dB	Monitor fibre signal integrity (loss signal)	Monitoring commencement to occur as longwall face approaches within 400 m of passing under the cables	Continuous
		Visual inspection	Open applicable cable pits and record any movement or changes evident	Direct signs of conduit movement, and degree of freedom of cable in conduit	Commence when longwall face is at 100m prior to cable and finish 400 m past cable line	Weekly, when in nominated zone
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Monitor for surface cracks, buckling and general safety	At the completion of each longwall	Once per Longwall
					As per Longwall 304 LMP	
Post Mining	Optical Fibre	Visual Inspection	Surface marker locations and photography of cable pits	Determine level of impact of mining (if any)	Within 3 months of the completion of each Longwall	Once per longwall
		RFMS	Record any changes to OTDR monitoring data			
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Determine level of impact of mining (if any)	Within 3 months of the completion of each Longwall	Once per longwall

Vocus or their delegates will conduct the various visual inspections. Metropolitan Coal will be notified of the timing of inspections and accompany Vocus or delegates if considered necessary. All personnel will complete necessary inductions or orientation relevant to the tasks required.

Survey frequency will increase to weekly if the ground strain between adjacent pegs exceeds 1 mm/m. Survey frequency will be reviewed if total subsidence exceeds 20 mm.

The frequency of monitoring will be further reviewed either:

- in accordance with the Annual Review outlined in Section 12; or
- if triggered as a component of the Contingency Plan as outlined in Section 9 of this BFMP-VOCUS.

7.1 SUBSIDENCE PARAMETERS

Subsidence parameters (i.e. subsidence, tilt, tensile strain, compressive strain, absolute horizontal translation, and differential leg movement) associated with mining will be measured in accordance with the Longwall 304 Subsidence Monitoring Program (Figure 6).

In summary, surveys will be conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence movements (i.e. subsidence, tilt, tensile strain and compressive strain) will be measured along subsidence lines that have been positioned across the general landscape.

Monitoring of subsidence parameters specific to the Vocus assets include the survey lines along optical fibre cable (at the southern end of Longwall 301) and the adjacent 330 kilovolt (kV) and 132 kV transmission line corridor. These surveys will monitor the general movement about the longwalls and the data will allow evaluation of the likely ground movements about the cable line (by comparison between measured and predicted movements).

7.2 SUBSIDENCE IMPACTS

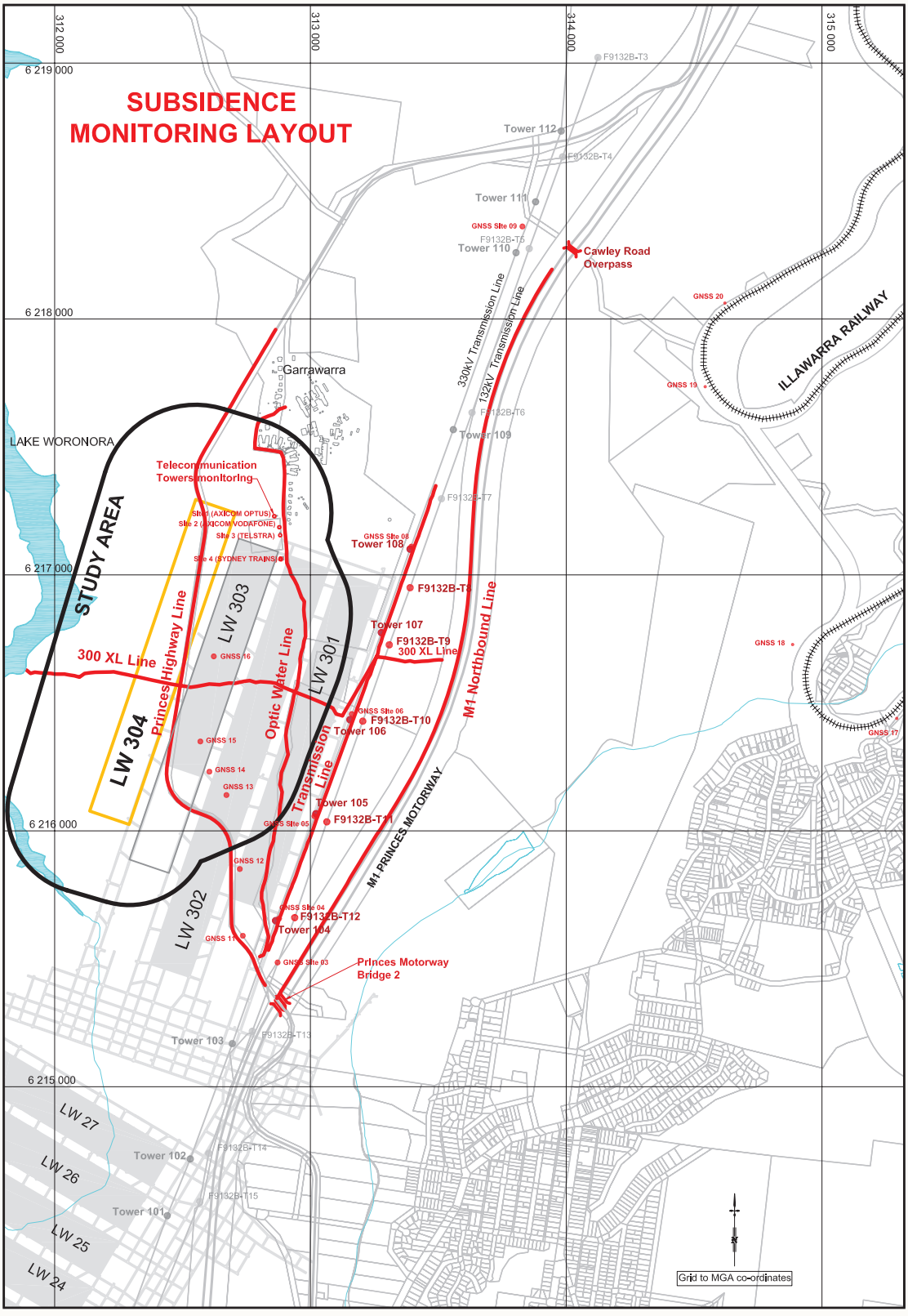
7.2.1 Fibre Optic Cables

Visual inspections will be conducted on the cable line and joint house pit in accordance with the Vocus inspection system or if triggered by a transmission fault detected by the Vocus monitoring system (Appendix 1).

Specific details that will be noted and/or photographed include:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- assessment against the performance indicators and performance measure;
- whether any actions are required (e.g. initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The information will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 4) and reported in accordance with the Project Approval conditions.



MET-18-13_304 EP BFMP_017A

Source: MSEC (2019)

Peabody

METROPOLITAN COAL

Subsidence Monitoring Layout

Figure 6

7.2.2 Access Roads/Tracks

Visual inspection of the access roads/tracks to the Vocus assets will occur prior to the commencement of Longwall 301, and following extraction of each longwall panel.

Visual observations of access roads/tracks would occur as part of routine works and inspections within 600 m of Longwalls 301-304 secondary extraction as described in the Metropolitan Coal Longwall 304 Land Management Plan (Longwall 304 LMP).

Specific details that will be noted and/or photographed that are relevant to the Nextgen access roads/tracks include:

- the location, approximate dimensions (length, width and depth), and orientation of surface tension cracks;
- the location of the surface tension crack in relation to the access road/track to the Vocus asset;
- whether any actions are required (e.g. implementation of management measures as outlined in the Longwall 304 LMP, initiation of the Contingency Plan as outlined in the Longwall 304 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The date of the observation, details of the observer and the location of longwall extraction will also be documented.

The information obtained will be recorded in the Longwall 304 LMP - Subsidence Impact Register and reported in accordance with the Project Approval conditions.

The information obtained will be used to assess the potential environmental consequences of the subsidence impact (described in Section 7.3 of the Longwall 304 LMP) and to identify required management measures. Management measures are discussed in the Longwall 304 LMP.

In the event the subsidence impacts are deemed to present a safety hazard (i.e. regardless of the nature or extent of the subsidence impact), actions will be implemented in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan.

7.3 ENVIRONMENTAL CONSEQUENCES

Metropolitan Coal and Vocus will compare the results of the subsidence impact monitoring against the built features performance measure and indicators. In the event the observed subsidence impacts exceed the performance measure or indicators, Metropolitan Coal and Vocus will assess the consequences of the exceedance in accordance with the Contingency Plan described in Section 9.

8 MANAGEMENT MEASURES

A number of potential management measures in relation to fibre optic cables are considered to be applicable. These are described in the Nextgen Management Plan Agreement (Appendix 1).

Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.

Management measures will be reported in the Annual Review (Section 12).

9 CONTINGENCY PLAN

In the event the subsidence impacts observed exceed the performance measure or indicators detailed in Section 5 of this BFMP-VOCUS, Metropolitan Coal will implement the following Contingency Plan (Appendix 5):

- The observation will be reported to the Manager - Technical Services within 24 hours.
- With the exception of access roads/tracks, the observation will be recorded in the Built Features Management Plan – Subsidence Impact Register (Appendix 4) consistent with the monitoring program described in Section 7 of this BFMP-VOCUS.
- If relating to an access road/track, the observation will be recorded in the Metropolitan Coal Longwall 304 Land Management Plan – Subsidence Impact Register.
- Metropolitan Coal will report any exceedance of the performance measure or indicators to the DP&E and Vocus as soon as practicable after Metropolitan Coal becomes aware of the exceedance.
- Metropolitan Coal will assess public safety and where appropriate implement safety measures in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan;
- Metropolitan Coal will conduct an investigation to evaluate the potential contributing factors. The investigation will:
  - include the re-survey of relevant subsidence monitoring lines;
  - compare and critically analyse measured versus predicted subsidence parameters;
  - review measured subsidence parameters against the observed impact; and
  - review the subsidence monitoring program and update the program where appropriate.
- The course of action with respect to the identified impact(s), in consultation with specialists and relevant agencies, will include:
  - a program to review the effectiveness of the contingency measures; and
  - consideration of adaptive management.

  Contingency measures are provided in Section 9.1.
- Metropolitan Coal will submit the proposed course of action to the DP&E for approval.
- Metropolitan Coal will implement the approved course of action to the satisfaction of the DP&E.

In accordance with Condition 6, Schedule 6 of the Project Approval, Metropolitan Coal will provide a suitable offset to compensate for the impact to the satisfaction of the Director-General (now Secretary) of DP&E if either the contingency measures implemented by Metropolitan Coal have failed to remediate the impact or the Director-General (now Secretary) determines that it is not reasonable or feasible to remediate the impact.

Metropolitan Coal will comply with the NSW *Coal Mine Subsidence Compensation Act 2017* in the event that property damages occur as a result of mining Longwalls 301-304.

9.1 CONTINGENCY MEASURES

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of environmental consequences).

In the event of unforeseen impacts, contingency measures will be developed as described in the Nextgen Management Plan Agreement (Appendix 1) and may include those summarised in Table 7. The decision tree for the contingency measures is shown in Appendix 5.

Table 7
Contingency Measures

Asset	Contingency Measures / Description	
Fibre Optic Cable	Stabilisation	• Automatic monitoring detects degradation in signal. Trench fill material is removed from the identified degradation zone, allows fibre to flex, and relieve compression forces.
	Emergency	• Spare cores available in cable. Bypass affected cores to re-establish functionality.
	Rebuilding	• Fibre heat treatment to soften compression point and return affected cores to operation.
	Contingency	• Temporary alternative diverse path for Sydney-Melbourne fibre optic cable [*NB: alternative potentially undermined concurrently at Douglas Park*].

10 TARP – MANAGEMENT TOOL

The framework for the various components of the BFMP-VOCUS are summarised in the BFMP-VOCUS TARP shown in Table 8. The BFMP-VOCUS TARP illustrates how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

The TARP comprises:

- baseline conditions;
- predicted subsidence impacts;
- trigger levels from monitoring to assess performance; and
- triggers that flag implementation of contingency measures.

The TARP system provides a simple and transparent snapshot of the monitoring of environmental performance and the implementation of management and/or contingency measures.

Table 8
BFMP-VOCUS Trigger Action Response Plan

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
Safe, serviceable and repairable.	Negligible transmission loss in fibre optic cables from mine subsidence impacts.	Remote fibre monitoring system (RFMS).	Signal loss.	Continuous.	Monitor when longwall within 400m of passing under the optic cables.		Pre-mining audit conducted prior to commencement of LW 301.	Level 1	Signal loss < 0.3dB	Continue monitoring.
	The structural integrity of the cable line and associated joint housing pit is maintained.	Physical inspection of the cable pits.	Movement about cable pits.	Weekly when LW is between 100 m before and 400 m after the cable.	Visual inspection by experienced person.				No movement about cable pits. No signs of conduit movement or reduction in freedom of movement of the cable conduit.	
	Subsidence parameters.	Survey lines along the adjacent transmission line corridor and the 300 XL subsidence monitoring line.	Direct signs of conduit movement, and degree of freedom of cable in conduit. Subsidence, Strain.	Weekly when LW is within ±400 m of being directly under cable and after LW 301, 302, 303 and 304.	Evaluation of the general ground movements about the site by comparison between measured and predicted movements.	Subsidence measurement accuracy.			At end of LW 302, at end of LW 303 and LW 304. Subsidence <425 mm Tensile strain < 1.5 mm/m Compressive strain < 3.2 mm/m (i.e. measured subsidence parameters generally in accordance with predicted).	
								Level 2	Signal loss between 0.3 and 0.5 dB Movement about cable pits detected. Restriction in movement of cable conduits identified. Subsidence effects up to 15% greater than predicted. Subsidence between 425 mm and 490 mm Strain between 3.2 and 3.4 mm/m.	Implement actions in accordance with the Nextgen Management Plan Agreement (Appendix 1). Report subsidence anomaly. Immediately resurvey subsidence line to confirm results. Engage subsidence expert to assess results. Confirm results are consistent with other subsidence lines. Compare and critically analyse measured versus predicted subsidence. Inform and provide report to Vocus of subsidence results. Collaboratively share information with Vocus to monitor situation. **<u>Vocus</u>** Assess information provided by Metropolitan Coal. Coordinate Comms Network Solutions Pty Ltd to complete “close-in” detailed monitoring of Telstra Cable F KNST 2005 from Engadine exchange. Increase frequency of OTDR assessments to weekly for signs of signal loss.

Table 8 (Continued)
BFMP-VOCUS Trigger Action Response Plan

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
								Level 3	Signal loss > 0.5 dB Strain > 3.4 mm/m	Implement actions in accordance with the Nextgen Management Plan Agreement (Appendix 1). **<u>Vocus</u>** Inform Metropolitan Coal of anomalous signal degradation from continuous monitoring. Physically audit cable pits in area. In conjunction with Metropolitan Coal identify signal loss location; expose cable to investigate if tension/compression being imposed on cable. Relieve cable tension or compression by adjusting the trench geometry, the outer conduit, the fill material or by heat treatment of cable. Make determination if necessary to leave trench open for remainder of longwall extraction to avoid further stress build-up.
								Level 4	Fault detected	Implement Contingency Plan as per BFMP Section 9. General Manager to be involved in all decision making processes. Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwall 304 Public Safety Management Plan. Report exceedance of the performance measure or indicators to the DP&E as soon as practicable. Update the 'Built Features Management Plan – Subsidence Impact Register'. **<u>Vocus</u>** • As per Level 3 event, plus: o Nextgen to enact emergency transmission cutover of affected fibres at exchange and transmit on alternate fibres in bundle and/or on alternate routes. o Expose the affected section of cable and determine appropriate course of action for cable restoration being straightening/ heat treatment or full joint to joint replacement depending on severity of physical cable fault. o Complete restoration works. Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.
	The serviceability of the access roads and tracks are maintained.	Access roads and tracks in the vicinity of the Nextgen assets.	Cracking about access road/tracks.	After LW 301, 302, 303 and 304	Visual Inspection. Visual observations of access roads/tracks will also be conducted by Metropolitan Coal as part of routine works and inspections within 600 m of Longwalls 301-304 secondary extraction as described in the Metropolitan Coal Longwall 304 Land Management Plan.		Pre-mining audit conducted prior to commencement of LW 301.	Level 1	Minor cracking.	**<u>Continue monitoring.</u>** Consider whether any actions are required (e.g. implementation of management measures as outlined in the Longwall 304 LMP, initiation of the Contingency Plan as outlined in the Longwall 304 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.).
								Level 2	Moderate cracking (i.e. cracking that requires implementation of management measures).	Implement management measures as outlined in the Longwall 304 LMP.
								Level 3	Greater than moderate cracking.	Implement contingency measures as outlined in the Longwall 304 LMP.

11 FUTURE EXTRACTION PLANS

In accordance with Condition 7 of Schedule 3, Metropolitan Coal will collect baseline data for the next Extraction Plan (i.e. Longwalls 305-310). The collection of baseline data will be consistent with the baseline data collected for Longwalls 301-304. Specifically, baseline data obtained will include pre-mining inspection of the telecommunications lines.

In addition to the baseline data collection, consideration of the environmental performance and management measures in accordance with the review(s) conducted as part of this BFMP-VOCUS will inform the appropriate type and frequency of monitoring of the assets relevant to the next Extraction Plan.

12 ANNUAL REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

In accordance with Condition 3, Schedule 7 of the Project Approval, Metropolitan Coal will conduct an Annual Review of the environmental performance of the Project by the end of March each year.

The Annual Review will:

- describe the works carried out in the past year, and the works proposed to be carried out over the next year;
- include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the EA, Preferred Project Report and Extraction Plan;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

As described in Section 2, this BFMP will be reviewed within three months of the submission of an Annual Review, and revised where appropriate.

13 INCIDENTS

An incident is defined as a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval.

The reporting of incidents will be conducted in accordance with Condition 6, Schedule 7 of the Project Approval. Metropolitan Coal will notify the Director-General (now Secretary) of DP&E and any other relevant agencies of any incident associated with the Project as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of DP&E and any relevant agencies with a detailed report on the incident.

Vocus will be notified within 24 hours of any access limitations or restrictions.

14 COMPLAINTS

A protocol for the managing and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

The Environment & Community Superintendent is responsible for maintaining a system for recording complaints.

Metropolitan Coal will maintain public signage advertising the telephone number on which environmental complaints can be made. The Environment & Community Superintendent is responsible for ensuring that the currency and effectiveness of the service is maintained. Notifications of complaints received are to be provided as quickly as practicable to the Environment & Community Superintendent.

Complaints and enquiries do not have to be received via the telephone line and may be received in any other form. Any complaint or enquiry relating to environmental management or performance is to be relayed to the Environment & Community Superintendent as soon as practicable. All employees are responsible for ensuring the prompt relaying of complaints. All complaints will be recorded in a complaints register.

For each complaint, the following information will be recorded in the complaints register:

- date and time of complaint;
- method by which the complaint was made;
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- nature of the complaint;
- the action(s) taken by Metropolitan Coal in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken by Metropolitan Coal, the reason why no action was taken.

The Environment & Community Superintendent is responsible for ensuring that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary.

In accordance with Condition 10, Schedule 7 of the Project Approval, the complaints register will be made publicly available on the website and updated on a monthly basis. A summary of complaints received and actions taken will be presented to the Community Consultative Committee as part of the operational performance review.

15 NON-COMPLIANCES WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with Metropolitan Coal, and will be developed through promotion of Metropolitan Coal ownership under the direction of the General Manager.

The Manager - Technical Services and/or Environment & Community Superintendent will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 13, Metropolitan Coal will notify the Director-General (now Secretary) of the DP&E and any other relevant agencies of any incident associated with Metropolitan Coal as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of the DP&E and any relevant agencies with a detailed report on the incident.

A review of Metropolitan Coal's compliance with all conditions of the Project Approval, mining leases and all other approvals and licenses will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the Peabody website.

Additionally, in accordance with Condition 8, Schedule 7 of the Project Approval, an independent environmental audit was undertaken by the end of December 2011, and is undertaken a minimum of once every three years thereafter. A copy of the audit report will be submitted to the Director-General (now Secretary) of the DP&E and made publicly available on the Peabody website. The independent audit will be undertaken by an appropriately qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General (now Secretary) of the DP&E.

16 REFERENCES

Department of Planning & Environment and Division of Resources and Energy (2015) *Guidelines for the Preparation of Extraction Plans*.

Helensburgh Coal Pty Ltd [HCPL] (2008) *Metropolitan Coal Project Environmental Assessment*.

Helensburgh Coal Pty Ltd [HCPL] (2009) *Metropolitan Coal Project Preferred Project Report.*

Mine Subsidence Engineering Consultants (2008) *Subsidence Assessment Report on the Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Surface Infrastructure Resulting from the Proposed Extraction of Longwalls 20 to 44 at Metropolitan Colliery in Support of a Part 3A Application.*

Mine Subsidence Engineering Consultants (2016) *Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Nextgen Infrastructure*, 31 August 2016.

Mine Subsidence Engineering Consultants (2019) *Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Vocus Infrastructure*.

APPENDIX 1

NEXTGEN MANAGEMENT PLAN AGREEMENT (2016)

Nextgen Networks Pty Ltd
Level 1, 74 Mentmore Avenue
Roseberry, NSW, 2018.

Metropolitan Coal,
Peabody Energy Pty Ltd,
Helensburgh, N.S.W,

Management Plan

Helensburgh Coal,
Metropolitan Colliery,
Longwall Coal Extraction LW301 toLW303,
Below Nextgen Network,
@ Garrawarra, N.S.W.

Authorised on behalf of
Nextgen Networks Pty Ltd

…….

(Name:…….)
(Position:…….)
(Date: …….)

Authorised on behalf of
Metropolitan Coal,

……..

(Name:……)
(Position…….)
(Date: …….)

Issue Date: **DRAFT 26-10-16**

Revision No. & Date:

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1.0 Introduction

The Metropolitan Mine is owned and operated by Metropolitan Coal Pty Ltd (MCPL), a wholly owned subsidiary of Peabody Energy Australia Pty Ltd. MCPL was granted approval for the Metropolitan Coal Project under Section 75J of the New South Wales (NSW) Environmental Planning and Assessment Act, 1979 on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com).

MCPL has identified surface assets which may potentially be affected by the mining operations during the longwall extraction. Some of the assets in the area are owned by Nextgen, and there is a possibility of subsidence impacts, on these assets. Refer to Mine Subsidence Engineering Consultants (MSEC) Report " Metropolitan Colliery – Proposed Longwalls 301 to 303 – Subsidence Predictions and Impact Assessments for the Nextgen Infrastructure" dated 31st August 2016, Reference No 1, for subsidence predictions affecting Telstra infrastructure within the Study Area. This assessment of predictions for the Telstra cables has been used for the Nextgen cables since both cables are co-located crossing the south eastern end of LW301. Following preliminary identification of the Nextgen network within the subsidence zone and in consultation with Peter Hickey Field Manager Nextgen Networks it was advised to MCPL that Comms Network Solutions Pty Ltd (CNS) be engaged to carry out a survey and audit of the Nextgen network and to then prepare a management plan for the Nextgen network in the proposed mining area

The audit by CNS of the Nextgen network was completed on 9th and 21st September 2016 covering the Nextgen network installed within the Study Area, defined by the 35 degree angle of draw outlined in yellow on Plate 1, following page. The area of the audit is also shown in the attached Google Earth Plan, Appendix A. "Telstra & Nextgen Cable Route -Longwalls LW301 to LW303". Following the audit of the Nextgen network, the information is presented in this management plan for MCPL and Nextgen Operations to review and if found acceptable then sign off, by both parties, as acceptance of the management plan. This management plan will only consider the potential impacts on the Nextgen network located within the SMP investigation area as shown in Appendix A and Plate 1 on the following page and within the Predicted 20mm Subsidence Contour outlined on Appendix B. The Nextgen network located in the SMP Area has been identified from the field audit as follows :-

i) Major Interstate Trunk Cable Sydney-Melbourne SM1 optical fibre cable Waterfall to Corrimal Section.
ii) Associated Nextgen Joint Housing Pit (SM1-SN-SN J08) linked to Telstra manhole using P50 conduit and P32 sub-duct passing through concrete Joint Housing Pits carrying the cable across the SMP area

Refer to Appendix B & C for location details of the Nextgen cable network installed within investigation area to the north of the Nextgen joint at SM1-SN-SN-LP2.

The two items above within 35 degree angle of draw Plate 1, the yellow outlined area, are both within LW301 and then run alongside and parallel to the eastern goaf edge of LW301 following the Telstra main optical fibre cable route through this area.

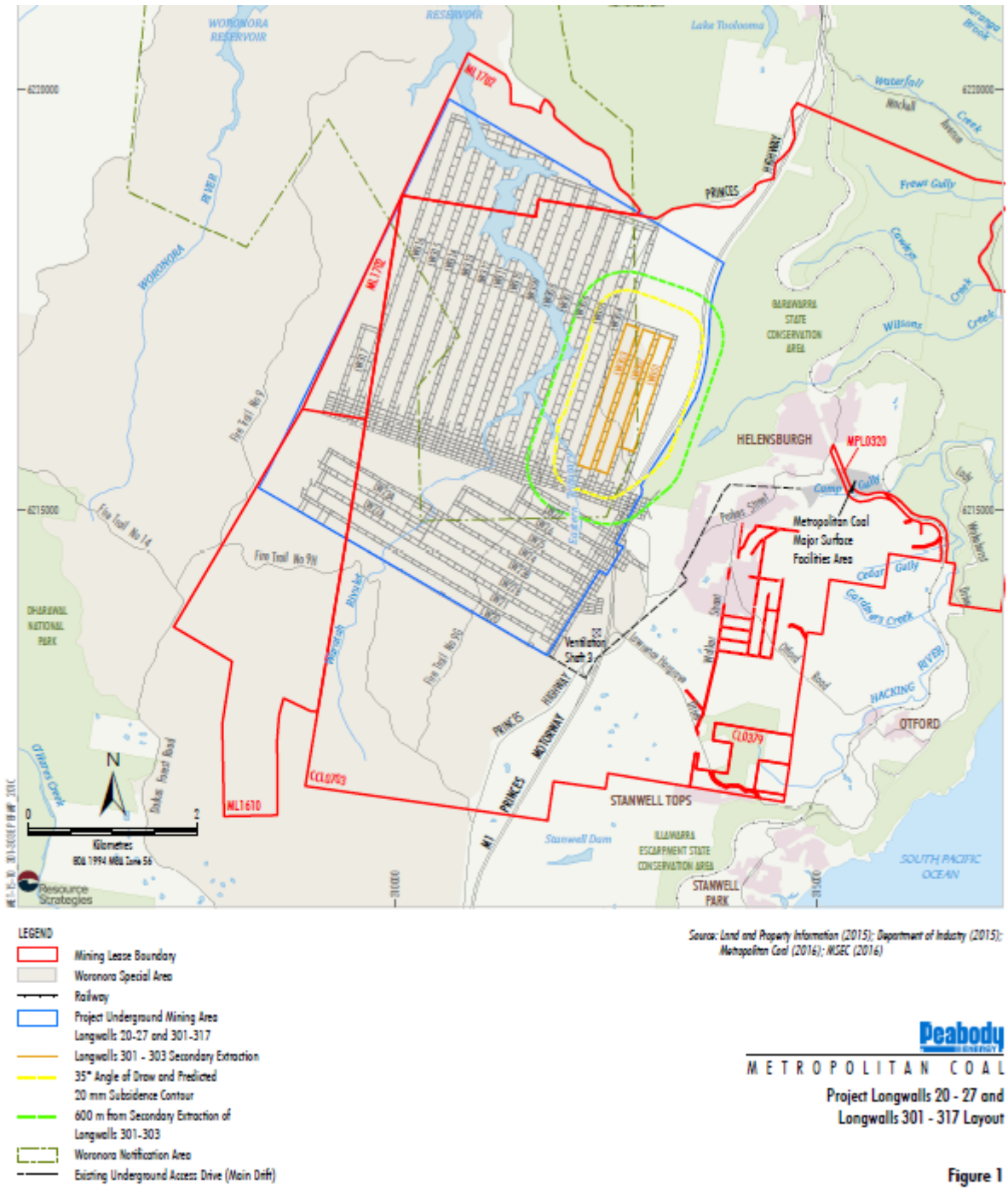

Plate 1:
Extract from Figure 1 Reference No 1:
General Arrangement of the Metropolitan Mine longwall mining area showing area under consideration for this management Plan, Longwalls LW301-303. Yellow outline around extraction area is the 20mm Subsidence Contour line and green outline is the 600m limit from Secondary Extraction.

The Nextgen Built Features Management Plan (Nextgen BFMP) August 2016 has been prepared by MCPL and references this management plan as Appendix 1. This management plan will detail predicted impacts and proposed monitoring actions on the Nextgen infrastructure.

1.1) Predicted Systematic Ground Movements:

As discussed above in Reference No 1 predictions have been made for ground movements related to the various items of the Telstra network which directly relates to the Nextgen infrastructure identified above, items i) to ii). The degree of ground subsidence and curvature generally provides an indication of the impact anticipated on the network however ground strain has the greatest impact on buried cables and on the conduit and pit network. The other relevant ground movement factor is tilt and for above ground structures however this is not relevant to the Nextgen plant in this area.

The predicted compressive and tensile strain levels from Reference 1 are as per extract below:-
The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

1.2) Anomalous Movement & Valley Closure:

There is also the potential for anomalous ground movement occurring during mine subsidence however this is minimised by the exclusion of known geological faults within the study area and also including an allowance for valley upsidence and closure within the predictions for ground strain. As indicated in the extract from Reference 1 below there are no known geological faults present in the study area as it is located just south of the east-west Metropolitan Fault line and to the north of the Main West Fault line. See Appendix A for location of known fault lines.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures and the streams are shown in Drawing No. MSEC844-04.

There are no mapped faults located within the extents of Longwalls 301 to 303. It is possible that the infrastructure located above the longwalls could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The optical fibre cables do not cross any major streams within the Study Area. These cables, therefore, are not expected to experience any measurable valley closure effects.

For a continuous cable line the predictions of relative movement between observed survey marks is the critical issue for impacts on the buried cable. From previous experience it has been found that impacts occur on buried optical fibre cables when there is an area of continuous compressive strain which is able to build up over a number of bay lengths. This sustained compression or indeed tension over a continuous number of survey bays, can transfer to the cable sheath at stress concentrators along the line, to cause localised deformation of the cable, resulting in transmission loss on individual fibres. A stress concentration can occur due to a change in ground conditions soft soil / clay to rock, rock intrusion, tree root or void area around the cable.
Relative movements recorded by survey between survey pegs provide a high degree of confidence of the level of actual ground strain that develops with the longwall progress. However it must be remembered that these are average strains levels recorded over 20m survey bay lengths and it is also possible that much higher localised ground strain can occur at a specific locations within a bay along a continuous cable line. Hence instead of a 20mm movement over 20m, 0.1% strain this same movement may be confined to say 1m where it would present as a 2.0% strain. This may occur where for example, surface rock has been cut, which may allow stress relief in the rock structure at the surface, near or along the cable line.

Over LW301 at the southern end due to the presence of sandstone boulders and surface rock which have been cut with a rock saw to allow placement of the conduit and subsequently cables, it is considered that there is some added risk to the cable line, due to the possibility of anomalous movement due to the installation method providing a stress relief in the surrounding rock surface. This area over approximately 350m should be monitored carefully during subsidence as it presents a unique installation method compared to the general plough method of cable installation.

Plate 2:
View north along cable line approximately 400m north of Princes Highway over LW301. Shows cable trench cut into old sandstone road cutting where the potential is for relative movement between sandstone road area and trench line.

2.0) Scope

The predicted systematic strains at 99% confidence levels of 1.5mm/m tensile and 3.2mm/m compression are relatively high particularly for optical fibre cables however the extent of the cable projection into the south eastern area of LW301 indicates that the cable may be subject to these maximum strain levels. The cable at the south eastern finishing end of LW301 will develop tensile travelling and compressive strains and then will also develop systematic compressive and tensile strains due to the location of the cable line along and then across the longwall. Therefore it is anticipated that particularly for this cable it may sustain the high levels of compressive strain predicted.

The Nextgen cable is the major interstate Sydney-Melbourne No 1 cable carrying the majority of Nextgen's telephone, data and internet traffic between the two major capital cities in Australia. The network, identified in section 1.0), has been assessed, in relation to the predicted level of subsidence impact, based on previous experience with telecommunication cables in mine subsidence areas. Currently the adjacent cable in the conduit network with the Nextgen cable, the Telstra interstate cable

F HOME 2005 has a RFMS installed on a spare fibre in the cable and additionally it will be monitored using an OTDR at 1625nm from Engadine exchange. Through consultation with Colin Dove any loss detected on this cable will be advised to Nextgen to indicate any potential problem developing within the Telstra cable and conduit network so that Nextgen are able to evaluate the extent of any possible impact on their network.

The RFMS and OTDR feedback will be combined with feedback to Nextgen Networks from MCPL survey monitoring data along the cable line combined with a physical monitoring / inspection also along the cable line, including pit inspections, during mining at the south eastern ends of LW301 & LW302. See Appendix C for proposed cable monitoring lines

Monitoring at 1625nm of the Telstra cable, which is a similarly constructed optical fibre cable, would provide detailed surveillance to indicate any minor loss that may occur on a fibre. Cable monitoring is important in this instance since the Nextgen Sydney-Melbourne No 2 cable is potentially impacted within the same two year period by longwall mining operations at Douglas Park NSW. So with mining somewhat concurrent in two geographic areas the combined risk to the Nextgen network increases as the mining operations coincide. Hence the management plan will put in place some actions to monitor the condition of the cable and associated pit and pipe network, during the extraction of coal principally from longwalls LW301 and LW302.

2.1) Limitations.

It must be understood that the mechanism of mine subsidence and its impact on the telecommunications network has only been studied recently in some detail. Generally it has been considered that impacts were only possible on optical fibre cables in tension in that tension applied to the cable sheath would then transmit to the fibres within the sheath causing attenuation of transmission signal and interruption to services. However experience has shown that cable compression can also lead to transmission loss due to micro bending of the fibres contained within the loose tubes that supports the fibres. Since cable installation is continuous through varying ground conditions it is possible that cumulative strains or physical constraints within the trench line can cause high localised stress concentrations on the conduit and then on the cable at specific locations from unpredicted ground movement.

Once the mine subsidence is initiated there is no method of halting the subsidence event. Hence if the degree of ground movement begins to affect the Telstra conduit then there are limited options available to relieve the stresses on the cables, without exposing the cables to high risk of damage from the remedial work undertaken. The aim of the management plan is to identify any vulnerability present in the network and monitor the performance of that part of the network during and after subsidence impacts. This action will not prevent the remote possibility of damage but provides a risk assessment and a method for monitoring that risk.

2.2) Objectives & Risk

The objectives of this management plan in relation to the Nextgen Sydney-Melbourne cable are to initially audit the network and then identify risks associated with the existing cable network and to provide a strategy for monitoring this risk.

In relation to the assets identified in 1.0) and 2.3) below, the following are the assessed relative risks associated with existing plant within the proposed mine subsidence area. The two main items of plant at risk have been assessed according to the probability of damage and the consequences resulting from that damage. The Risk Factors are shown in the following table, Table 1.

Table 1
Relative Risk Factor **(RF)** for Telecommunications Plant

Risk Assessment Matrix		**Consequence**				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Almost Certain	Significant	Significant	High	High	High
	Likely	Moderate	Significant	Significant	High	High
	Moderate	Low	Moderate	Significant	High	High
	Unlikely	Low	Low	Moderate	Significant	High
	Rare	Low	Low	Moderate	Significant	Significant
	Very Rare	Low	Low	Low	Moderate	Significant

Refer to Appendix A & B for cable locations identified in the field audit.

2.3) Nextgen Network & Audit Details - Risk Assessment

2.3.1) Major Interstate Optical Fibre Cable Sydney-Melbourne No1, Waterfall –Corrimal Section SM1 –SN:SN.
(Likelihood – Moderate, Consequence- Major, Risk Assessment **- High)**

Due to potential for high compressive strains and the possibility of anomalous ground movement in the rocky terrain as mentioned in 1.1) above, the likelihood of damage is possible with major consequences. However offsetting this is the fact that the cable is installed in conduit and sub-duct similarly configured Telstra cables have sustained subsidence levels of 1000mm and strains of + and – 1.5mm/m without impact on the cable or conduit network.

This optical fibre cable is a standard haul construction optical fibre cable installed in the mid 1990's. The cable is hard jacketed with glass reinforced central strength member with Kevlar wrapping with an allowable haul tension of 2000 N and short term crush resistance of 2000 Newtons. Since the haul cable construction is suitable for cable hauling and accepting reasonable tensile loads during cable installation it is considered relatively robust.

This cable, however is installed in continuous 32mm diameter sub-duct and then installed in 50mm PVC pipe along & across the longwalls and hence it is relatively isolated from anomalous movement that may impact on the conduit installation. Therefore due to the relatively high level of predicted subsidence along with the presence of sub-duct and 4mm wall thickness uPVC conduit it is very unlikely that there will be any impact on this cable. However since the cable is installed in very rocky isolated terrain where anomalous surface movements are a remotely possibility, as a precautionary measure, it is recommended that close physical inspection, detailed survey data be provided by MCPL and feedback also to be provided to Nextgen from monitoring of the adjacent Telstra cable F HOME 2005 in the cable section Engadine-Dapto.
The physically inspected must be completed during the subsidence process by a suitably qualified expert familiar with subsidence ground movements and optical fibre cable behaviour in these conditions to ensure that there are no adverse ground impacts occurring as subsidence develops. The ground inspection regime should be combined with relevant ground survey data to indicate if any particular areas along the cable are indicating additional subsidence impacts or anomalous ground movement.

Plate 3
View of Nextgen optical fibre joint pit SM-01-13 located adjacent to the Telstra manhole at change of angle of cable route approximately 350 metres north of Princess Highway over LW301. Pit and manhole are linked with P50 conduit and north and south tails are jointed in the Nextgen pit.

2.3.2) Nextgen Joint Housing Pit (SM1-01-12) linked to Telstra manhole using P50 conduit. This also includes the Telstra P100 conduit and P32 sub-duct installed between concrete Joint Housing Pits across the SMP area
(Likelihood – Moderate, Consequence- Major, Risk Assessment - **High**)

As discussed above, the Sydney Melbourne optical fibre cable, is installed in continuous 32mm polyethylene sub-duct which has been hauled into 50mm and 100mm PVC conduit and which passes through reinforced concrete joint housing pits in the area east of LW301 and east of LW302.

Plate 4:
Typical reinforced concrete Transition Pit showing four polyethylene 32mm dia.sub-ducts entering pit from 100mm conduit. Nextgen optical fibre cable is installed within tagged sub-duct exiting manhole in P50 conduit to the joint location shown in Plate 3.

3.0) <u>Control Procedure</u>

As identified in Item 2.3.1) to 2.3.2) above it is considered there are **High** risks associated with mine subsidence impacts on the Nextgen network principally due to the importance of the Sydney-Melbourne cable and the location of the cable route over LW301. Since subsidence and developing ground strain produces risk to the interstate Sydney - Melbourne No 1 optical fibre cable it is recommended that actions be taken to ensure this critical part of the Nextgen network is secure. This is particularly the case since an alternate diverse path for the Sydney-Melbourne link may be subject to mine subsidence impacts at Douglas Park from Illawarra Coal's mining in LW707 & LW708, in a similar time period.

As mentioned above the control methods proposed, since the network is isolated from general subsidence impacts by the presence of the sub-duct and conduit, is to:-

a) i) Obtain feedback from Telstra RFMS monitoring of the adjacent Telstra cable using 1625nm OTDR monitoring to supervise the performance of the conduit network containing the Nextgen cable. The RFMS is installed on the Telstra cable monitoring the cable section between Engadine and Dapto. Should transmission loss be detected on the fibre the system will generate an alarm that will

be recorded by the Telstra Global Operations Centre and the "Hazard Advice" issued will provide contact details for Telstra maintenance operations and their consultant Colin Dove who will advise Nextgen Field Manager Peter Hickey of the location and extent of the alarm generated.

ii) CNS P/L to complete 'close-in' detailed monitoring of the Telstra cable F KNST 2005 from Engadine exchange so that any minor loss presents can be detected prior to the loss becoming a transmission issue.

In the event of loss being recorded of (+ or –) 0.3 dB then:-

- The point loss or area of loss should be recorded and an investigation carried out of the conduit network at that location to determine if any damage is evident, i.e. movement of conduit, relative movement between pit/manhole and conduit, degree of freedom of cable in conduit, degree of ground compression / tension.
- The loss event should continue to be continuously monitored and should the loss progress to (+ or -) 0.5dB then the cable and conduit should be exposed at the recorded location to attempt to relieve pressure or tension/compression on the conduit and or cable.
- In the event of the loss on the cable continuing and exceeding 1dB an interruption cable should be laid and pits installed in preparation for cable cutover of the cable if considered necessary.

b) MCPL to install subsidence monitoring survey line in the area adjacent to the Telstra conduit carrying the Nextgen optical fibre cable over LW301 and LW302 as identified in Appendix C. MCPL to report survey data obtained at regular intervals to Nextgen Networks, during mining particularly during LW301 & LW302 extraction. Survey data to be reported for both total and incremental subsidence, strain and tilt:-

Should the ground strain exceed 1.0 mm/m between adjacent survey pegs that section of the survey line should be re-surveyed at a minimum of weekly intervals until results stabilise and the results reported to Nextgen Networks. Additionally should subsidence survey results show subsidence above 225mm in the area along the cable line then Nextgen is to be advised, to complete inspections and to review current information and amend survey frequency in that area as required. Note 400mm is predicted maximum subsidence along the cable line after LW303 extraction Reference 1 Table 1.

c) As a final control to supplement the RFMS monitoring and survey data physical inspections should be maintained during the critical periods of mining LW301 to 303, where there is the possibility of mining impacting on the cable line. This would involve an inspection along the cable line checking pit entries and condition of the cable line. This physical inspection of the network should be supplemented by feedback to Nextgen from MCPL of the subsidence monitoring in b) above and any objective or anecdotal subsidence information available in the area concerning impacts on other structures such as access roads, transmission towers, R&MS Freeway and bridges and creek lines in the area of the cable installation. Hence MCPL is to advise Nextgen of mining commencement dates and progress in the longwall extraction of LW301 to LW303 so that inspections can be completed during extraction. The physical cable monitoring of the telecommunications network required by this management plan is to be carried out by a suitably qualified consultant experienced with both mine subsidence issues and the behaviour of optical fibre cables during mine subsidence impacts.

4.0) Geological fault:

Refer to the discussion in Section 1.1) above identifying the fault lines present to the north and south of the Study Area which both cross the Southern Freeway. See Appendix A. There is an area immediately south of the longwalls where fault lines are present in the vicinity of the Nextgen cable line near the Princes Highway underpass which have the potential to intersect with the cable line and may cause differential movement at the structures along the cable line. Should any detailed evidence of anomalous surface movement be detected during survey monitoring in this area, this information should be reported

to Nextgen immediately to consider the implications for the network in the area. See Appendix A for location of known fault lines

5.0) Resources

Resources required to carry out the monitoring as identified in Section 3) above are to be provided by Nextgen. The costs associated with the monitoring work required for the protection of the Nextgen network are to be accepted by MCPL. As well MCPL will provide the survey resources required for the line surveys to determine incremental subsidence, strain and tilt during the operation of the management plan, at agreed intervals, as each longwall approaches the cable line. Should survey results show any anomalous ground movement in the area of the cables then Nextgen is to be advised, to complete immediate inspections and to be able to review current survey information and amend the monitoring regime on the network as required.

In the event of unforeseen impacts on the Nextgen network, prior to commencing any proposed repair work, Nextgen Operations representatives will detail the extent of the proposed work and the associated costs to Metropolitan Colliery. A meeting should be called with representatives of Nextgen, Metropolitan Colliery, and the Mine Subsidence Board to discuss the responsibility for the costs of the proposed work. In the event of a dispute as to responsibility for the costs, involving work to secure Nextgen's network, where loss of service to customers or line system outage is involved, the work will be carried out by Nextgen immediately to protect their customer network, while the discussion and resolution of the dispute regarding costs will continue.

6.0) Functions

The monitoring of the Nextgen network described in this management plan is to be carried out by Nextgen, their consultants and MCPL as required. Regular discussions are to take place between Nextgen, their consultants and MCPL who are to provide :-

- regular updates of the mine progress and distance from cable line.
- relevant survey data showing subsidence, strain and tilt along the agreed survey lines.
- advice as to anomolous ground subsidence or other observed impacts on adjacent infrastructure such as transmission towers, freeway or freeway bridges access roads and creeks in the area.
- current understanding of the status of the subsidence relative to the predictions and any change in potential risk to the network determined as mining progresses.
- timing details of future longwallextraction to determine revision of the management plan and the frequency of contact on mining related issues.

The representatives involved in discussions involving potential impacts on the Nextgen network are:-

Jon Degotardi, Technical Services Manager, Metropolitan Colliery.
Peter Hickey, Field Manager, Nextgen.
Matthew Montgomery, District Manager, Mine Subsidence Board
Colin Dove, Consultant Telecommunications Engineer.

Meetings via teleconference should be convened where necessary to resolve any issues raised during mining. Should significant risk be identified to the Nextgen network then either party involved may call for a meeting, with one day's notice, to discuss proposed action and to keep other parties informed of developments in the monitoring and protection of the Nextgen cable.

7.0) Audit and Review

It is anticipated that this plan will be in place for approximately 2 years from the commencement of LW301 operations or for a minimum period of three months following final ground settlement after completion of mining in LW303.

Should an audit of the management plan be required during its period of operation then a representative is to be appointed by Nextgen, MCPL and the Mine Subsidence Board to review the operation of the plan and prepare a draft management plan for review by the interested parties.

Other factors which may require the management plan to be reviewed are:-

- Poor performance of the Nextgen cable in regard to mine subsidence impacts, such as cable damage.
- Favourable performance of the Nextgen cable in regard to mine subsidence, no observed or recorded impacts.
- Significant variations between actual and predicted subsidence, tilt or strain occurring.
- Significant movement identified at the geological fault lines

8.0) Associated Documents

8.1) References:

Reference No 1 - Mine Subsidence Engineering Consultants (MSEC) Report " Metropolitan Colliery – Proposed Longwalls 301 to 303 – Subsidence Predictions and Impact Assessments for the Nextgen Infrastructure" dated 31st August 2016

8.2) Appendices

Appendix A.-

Telstra & Nextgen Cable Route,
Showing Metropolitan Coal's
Longwalls LW301 to LW303
(Google Earth 2016) Sheet 1 of 1

Appendix B -

"Metropolitan Coal Pty Ltd, Metropolitan Colliery
Longwalls 301 to 303, Nextgen Infrastructure"
MSEC Dwg – MSEC844-06 Rev D Sheet 1 of 1

Appendix C -

"Metropolitan Coal Pty Ltd, Metropolitan Colliery
Proposed Monitoring Lines LW301 to LW303"
MSEC Drawing Sheet 1 of 1

9.0) Contact List.

Metropolitan Colliery
Jon Degotardi,
Technical Services Manager,
PO Box 402, Helensburgh, NSW, 2508
Telephone: 4294 7233, Mobile 0407 241 761
Email : jdegotardi@peabodyenergy.com

Nextgen Networks
Peter Hickey,
Field Manager,
PO Box 1125, Mascot, 1460, NSW,
Telephone: 1300 653 351, Mobile 0409 215 690, Fax: 8339 1134,
Email :peterhickey@nn.com.au

Mine Subsidence Board
Matthew Montgomery,
District Manager,
Southern Coalfields
Telephone: 4677 1967,
Mobile: 0425 275 564.
Email: m.montgomery@minesub.nsw.gov.au

Colin Dove,
Telecommunications Consultant, External Plant,
Mobile 0428 970 826,
Email cdove@bigpond.com.au,

……..

Appendices

Appendix A.-

Telstra & Nextgen Cable Route,
Showing Metropolitan Coal, Longwalls LW301 to LW303
(Google Earth 2016) Sheet 1 of 1

Appendix B -

"Metropolitan Coal Pty Ltd, Metropolitan Colliery
Longwalls 301 to 303, Telstra Infrastructure"
MSEC Dwg – MSEC844-04 rev D Sheet 1 of 1

Appendix C -

"Metropolitan Coal Pty Ltd, Metropolitan Colliery
Proposed Monitoring Lines LW301 to LW303"
MSEC Drawing Sheet 1 of 1

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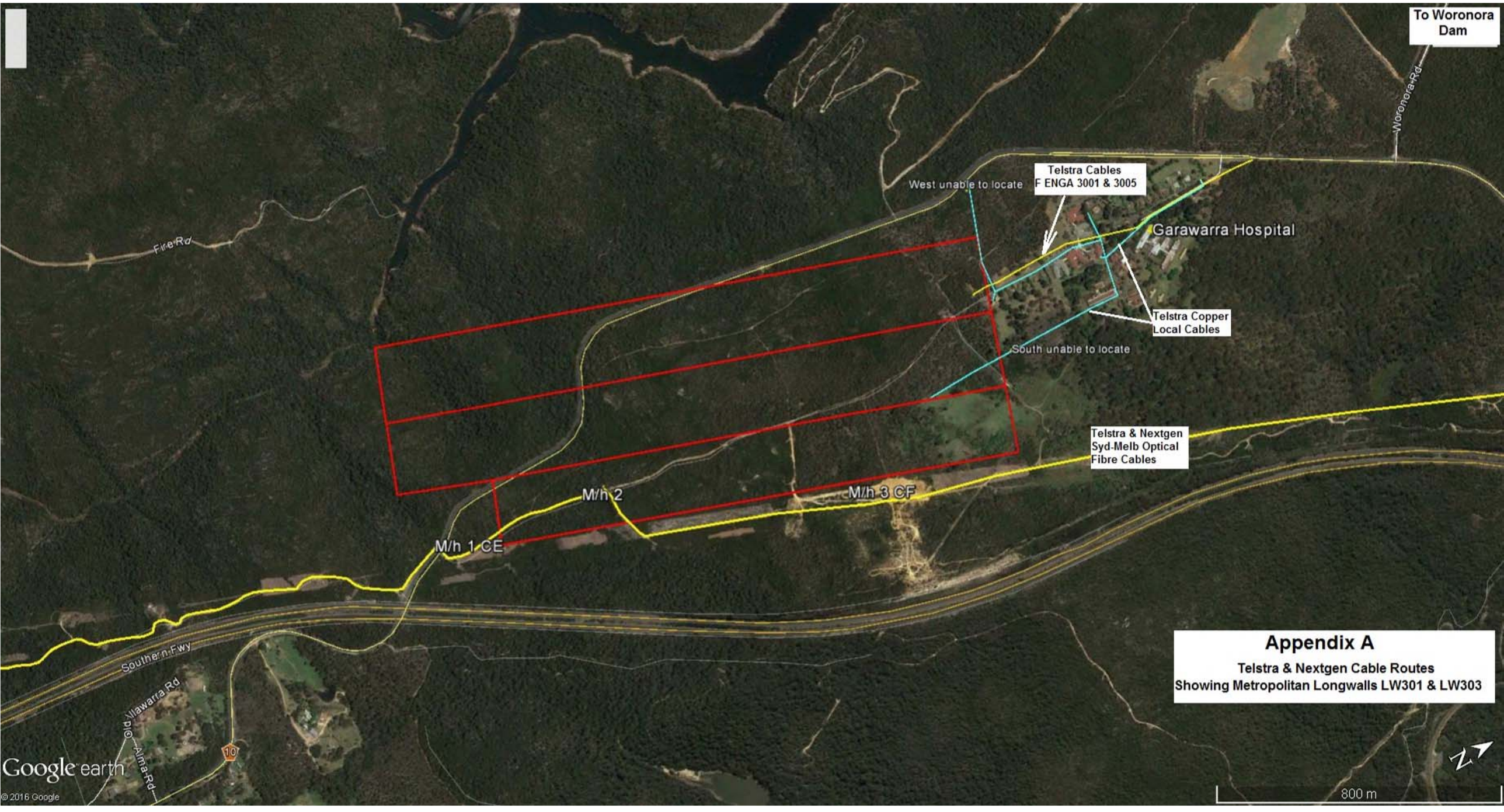
To Woronora Dam
Woronora Rd
West unable to locate
Telstra Cables
F ENGA 3001 & 3005
Garawarra Hospital
Fire Rd
Telstra Copper
Local Cables
South unable to locate
Telstra & Nextgen
Syd-Melb Optical
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Appendix A
Telstra & Nextgen Cable Routes
Showing Metropolitan Longwalls LW301 & LW303

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COAL

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
NEXTGEN INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
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Grid to MGA co-ordinates

CAWLEY ROAD OVERPASS
CAWLEYS CK
STUDY AREA
TELSTRA
METROPOLITAN FAULT
WORONORA RESERVOIR
PREDICTED 20mm SUBSIDENCE CONTOUR
20
OLD PRINCES HWY
LW303
LW302
LW301
NEXTGEN
OPTUS
TELSTRA
M1 PRINCES MOTORWAY
OPTUS
WILSONS CK
PRINCES HIGHWAY UNDERPASS 2
FAULT
MAIN WEST FAULT
POWELL FAULT

GEOLOGICAL STRUCTURES
FAULTS
DYKES

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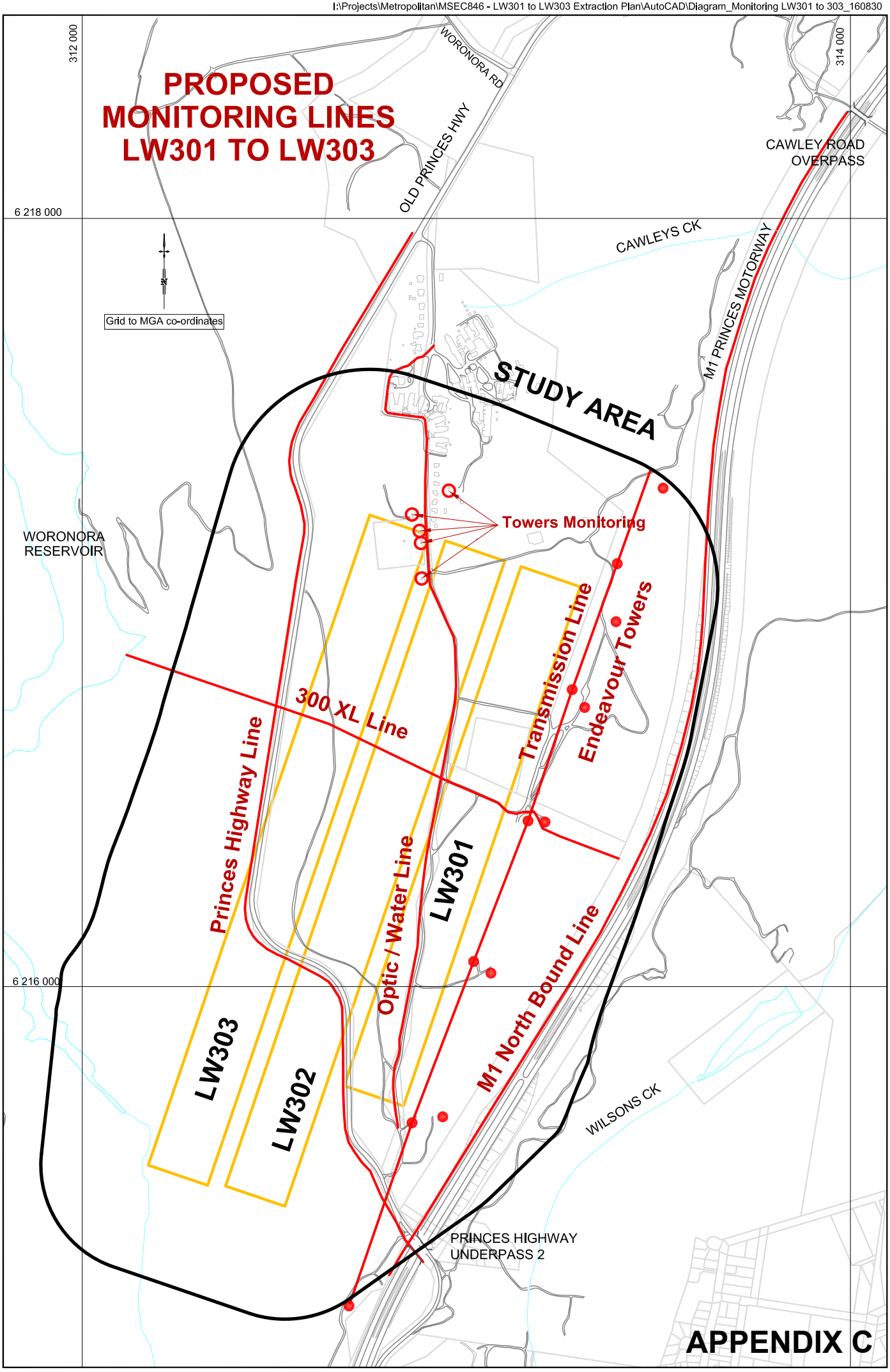

APPENDIX 2

MSEC (2016) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 301 TO 303 - SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE NEXTGEN INFRASTRUCTURE, DATED 31 AUGUST 2016

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

31st August 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-06

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Nextgen Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Nextgen infrastructure resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery.

The locations of the Nextgen infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC844-06. The infrastructure within the Study Area comprises one optical fibre cable that is located above the southern end of Longwall 301.

The predictions and impact assessments for the Nextgen infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the Nextgen Infrastructure

The following provides summaries of the maximum predicted conventional movements for the Nextgen infrastructure resulting from the extraction of Longwalls 301 to 303. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

The predicted profiles of incremental and total conventional subsidence, tilt and curvature along the alignment of the Nextgen optical fibre cable, resulting from the extraction of Longwalls 301 to 303, are shown in the attached Fig. A.1. The black dashed lines are the incremental profiles that represent the additional movements due to each of the longwalls. The solid blue lines represent the total or accumulated movements after the completion of each longwall. The range of predicted curvatures in any direction at any time during or after the extraction of the longwalls is shown by the grey shading.

A summary of the maximum predicted values of incremental subsidence, tilt and curvature for the optical fibre cable, due to the extraction of each of the Longwalls 301 to 303, are provided in Table 1. The values are the maxima anywhere along the cables at any time during or after the extraction of each longwall.

Table 1 Maximum Predicted Incremental Subsidence, Tilt and Curvature for the Nextgen Optical Fibre Cable Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
Due To LW301	80	< 0.5	< 0.01	< 0.01
Due To LW302	275	2.5	0.04	< 0.01
Due To LW303	80	< 0.5	< 0.01	< 0.01

The maximum predicted incremental subsidence for the optical fibre cable, due to the extraction of each of the Longwalls 301 to 303, varies from 80 mm to 275 mm. It is noted, that the maximum predicted incremental subsidence due to Longwall 302 is greater than that due to Longwall 301, as it is a second panel in the series and therefore results in higher magnitudes of subsidence above the mining area.

A summary of the maximum predicted values of total subsidence, tilt and curvature for the optical fibre cable, resulting from the extraction of Longwalls 301 to 303, are provided in Table 2. The values are the maxima anywhere along the cable at any time during or after the extraction of the longwalls.

Table 2 Maximum Predicted Total Subsidence, Tilt and Curvature for the Nextgen Optical Fibre Cable Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	80	< 0.5	< 0.01	< 0.01
After LW302	350	2.5	0.03	< 0.01
After LW303	425	3.0	0.04	< 0.01

The maximum predicted total subsidence for the optical fibre cable, resulting from the extraction of Longwalls 301 to 303, is 425 mm. The maximum predicted conventional tilt for this cable is 3.0 mm/m (i.e. 0.3 %, or 1 in 335). The maximum predicted conventional curvatures are 0.04 km^{-1} hogging and less than 0.01 km^{-1} sagging, which equate to minimum radii of curvature of 25 kilometres and greater than 100 kilometres, respectively.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the Nextgen infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The Nextgen infrastructure is partially located above Longwalls 301 to 303. A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 1. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

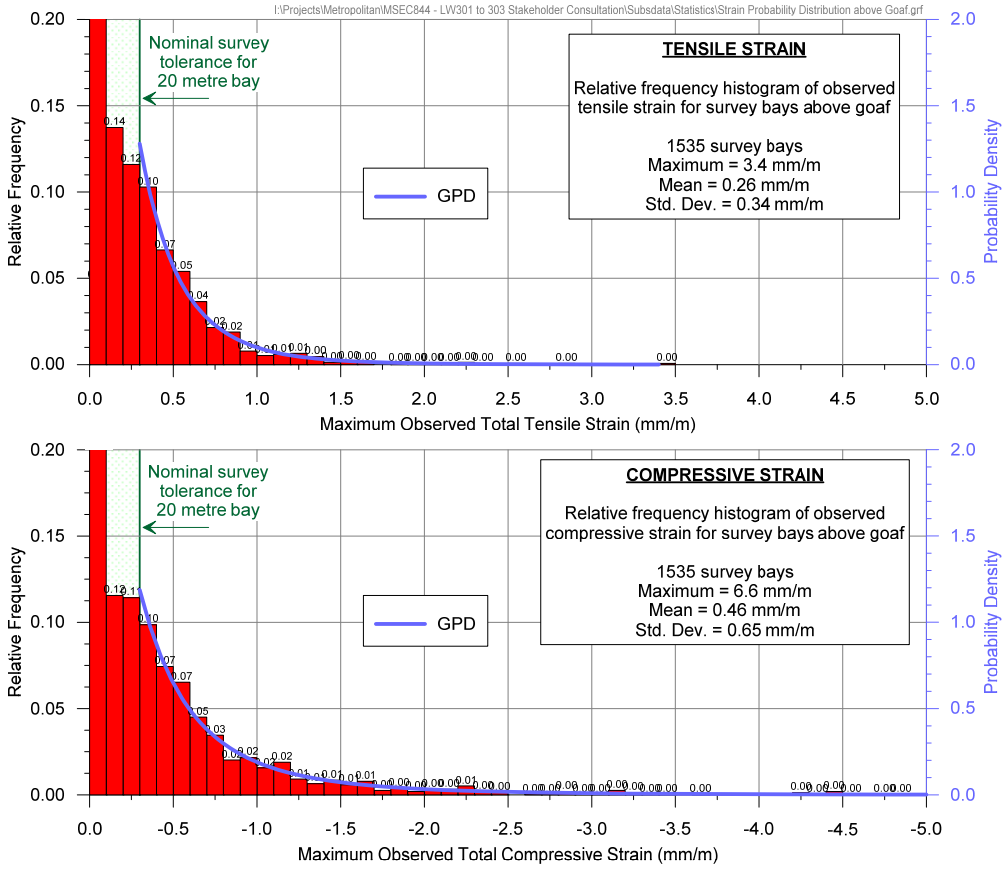

Figure 1 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based on the fitted GPDs, is provided in Table 3.

Table 3 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures and the streams are shown in Drawing No. MSEC844-06.

There are no mapped faults located within the extents of Longwalls 301 to 303. It is possible that the infrastructure located above the longwalls could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The optical fibre cable does not cross any major streams within the Study Area. This cable, therefore, is not expected to experience any measurable valley closure effects.

Impact Assessments for the Optical Fibre Cable

The optical fibre cable within the Study Area is direct buried and, therefore, will not be impacted by the tilts resulting from the extraction of Longwalls 301 to 303. The cable, however, is likely to experience the curvatures and ground strains resulting from the extraction of these longwalls.

The tensile strains in the optical fibre cable can be higher, however, where the cable connects to the support structures, which may act as anchor points, preventing any differential movements that may have been allowed to occur within the ground. Tree roots have also been known to anchor cables to the ground. The extent to which the anchor points affect the ability of the cable to tolerate the mine subsidence movements depends on the cable size, type, age, installation method and ground conditions.

In addition to this, optical fibre cables contain additional fibre lengths over the sheath lengths, where the individual fibres are loosely contained within tubes. Compression of the sheaths can transfer to the loose tubes and fibres and result in 'micro-bending' of the fibres constrained within the tubes, leading to higher attenuation of the transmitted signal. If the maximum predicted compressive strains were to be fully transferred into the optical fibre cable, they could be of sufficient magnitude to result in the reduction in capacity of the cable or transmission loss.

Localised and elevated curvatures could develop along the optical fibre cable due to non-conventional movements resulting from near surface geological structures (i.e. anomalies). It is possible that these non-conventional movements could be sufficient to result in the attenuation of signal.

The predicted curvatures and strains for the optical fibre cable are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar cables. It has been found from this previous experience that the potential impacts on optical fibre cables in the Southern Coalfield can be managed with the implementation of suitable monitoring and management strategies.

Some examples of mining beneath optical fibre cables in the Southern Coalfield are provided in Table 4.

Table 4 Examples of Mining Beneath Optical Fibre Cables in the Southern Coalfield

Colliery and Longwalls	Length of Optical Fibre Cables Directly Mined Beneath (km)	Observed Maximum Movements at Optical Fibre Cables	Pre-Mining Mitigation, Monitoring and Observed Impacts
Appin LW301 and LW302	0.8	650 mm Subsidence 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	600 metre aerial cable on standby. Ground survey, visual, OTDR. No reported impacts.
Appin LW703 to LW706	12.7 total for eight cables	1,200 mm Subsidence 2.1 mm/m Tensile Strain 4.5 mm/m Comp. Strain (Measured HW2, ARTC and MPR Lines)	New cable redirection to avoid potential impacts to old optical fibre cable. Ground survey, visual, OTDR. Strain concentrations detected in three cables, attenuation losses were relieved by locally exposing the cables or by building a bypass cable.
Tahmoor LW22 to LW29	1.9	775 mm Subsidence 0.8 mm/m Tensile Strain 3.9 mm/m Comp. Strain	Ground survey, visual, OTDR, SBS. No reported impacts.
Tower LW1 to LW10	1.7	400 mm Subsidence 3 mm/m Tilt 0.5 mm/m Tensile Strain 1 mm/m Comp. Strain	No reported impacts
West Cliff LW5A3, LW5A4 and LW29 to LW38	3.4	1,300 mm Subsidence 1.3 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	Survey, visual, OTDR, SBS. No reported impacts.

The strains transferred into the Nextgen optical fibre cable can be monitored using Optical Time Domain Reflectometry (OTDR). The ground movements can also be monitored using traditional survey lines and visual inspections. These monitoring methods can be used to identify the development of irregular ground movements. If non-conventional movements or signal attenuation are detected during active subsidence, then the cable can be relieved by locally exposing and then reburying the affected section of cable.

It is recommended that monitoring and management strategies are developed, in consultation with Nextgen, to manage the optical fibre cable for potential irregular ground movements. It is expected that this cable can be maintained in serviceable condition with the implementation of the appropriate monitoring and management strategies.

Summary

The Nextgen optical fibre cable is located above the southern end of Longwall 301. The previous experience from the Southern Coalfield has found that the potential impacts on optical fibre cables can be managed with the implementation of suitable monitoring and management strategies. These strategies could include Optical Time Domain Reflectometry (OTDR), traditional ground monitoring lines and visual inspections.

It is expected that the potential impacts on the Nextgen infrastructure can be managed with the implementation of the necessary monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:

Drawing No. MSEC844-06 – Longwalls 301 to 303 – Nextgen Infrastructure

Fig. A.1 Predicted Profiles of Conventional Subsidence, Tilt and Curvature for the Nextgen Optical Fibre Cable due to LW301 to LW303

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COAL

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
NEXTGEN INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
26 Aug 2016	1:12500	MSEC844-06	D

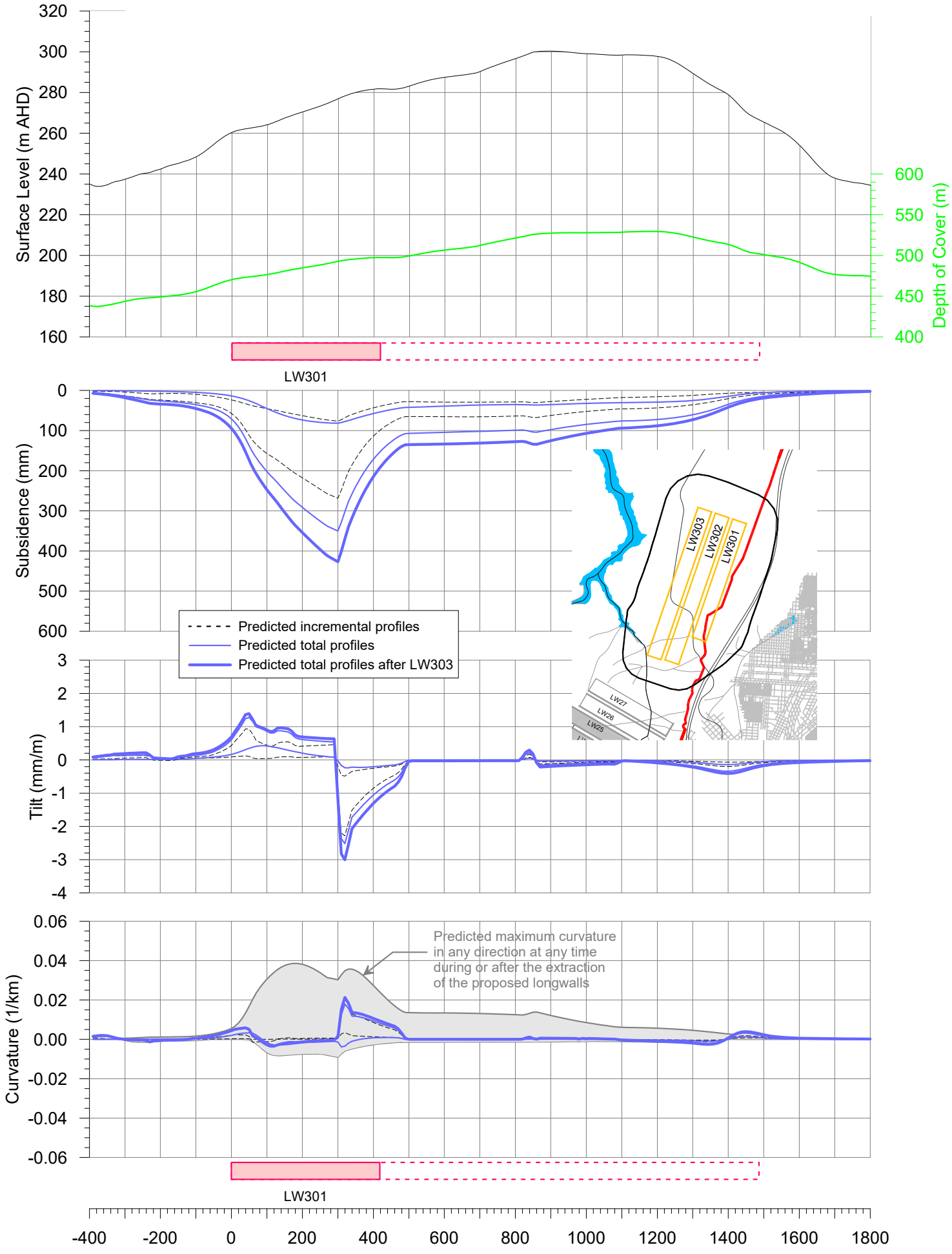
6 218 000
312 000
314 000
6 216 000

Grid to MGA co-ordinates

CAWLEY ROAD OVERPASS
CAWLEYS CK
STUDY AREA
TELSTRA
METROPOLITAN FAULT
WORONORA RESERVOIR
PREDICTED 20mm SUBSIDENCE CONTOUR
20
OLD PRINCES HWY
LW303
LW302
LW301
NEXTGEN
OPTUS
TELSTRA
M1 PRINCES MOTORWAY
OPTUS
WILSONS CK
PRINCES HIGHWAY UNDERPASS 2
FAULT
MAIN WEST FAULT
POWELL FAULT

GEOLOGICAL STRUCTURES
FAULTS
DYKES

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Nextgen Optical Fibre Cable due to LW301 to LW303



msec

Fig. A.1

APPENDIX 3

MSEC (2019) METROPOLITAN COLLIERY – PROPOSED LONGWALL 304
- SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE VOCUS INFRASTRUCTURE.

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

13th March 2019

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC1013-06

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Vocus Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Vocus infrastructure resulting from the extraction of the proposed Longwall 304 at Metropolitan Colliery.

The location of the Vocus infrastructure and the proposed Longwall 304 are shown in the attached Drawing No. MSEC1013-06. The Vocus infrastructure comprises an optical fibre cable that is located above the southern end of existing Longwall 301 and runs approximately parallel with Longwall 304. The cable is approximately 550 m from Longwall 304 at its nearest point.

A Study Area is shown in Drawing No. MSEC1013-06 and is based on the outer limits of a 35° angle of draw line from Longwall 304 and the predicted 20mm subsidence contour for Longwall 304. The Vocus optical fibre cable is outside the Study Area for Longwall 304.

The predictions and impact assessments for this Vocus infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the Vocus Infrastructure

The optical fibre cable is located outside the Study Area and is approximately 550 m to the east of Longwall 304 at its nearest point. At this distance, the cable is not expected to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwall 304. The cable could experience low level far-field horizontal movement. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield, which tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain. It is unlikely that the cable would experience adverse impacts as a result of conventional subsidence movements due to Longwall 304.

It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to unknown geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the Vocus infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The optical fibre cable is partially located above existing Longwall 301. The predicted range of total strains at the optical fibre cable for the extraction of Longwalls 301 to 303 were 0.9 mm/m tensile and 1.6 mm/m compressive based on the 95 % confidence interval, and 1.5 mm/m tensile and 3.2 mm/m compressive based on the 99 % confidence interval. The distribution of strains due to the extraction of Longwall 304 are expected to be less than these values.

An assessment was undertaken on strain data measured above extracted longwalls in the southern coalfield and based on a distance of 500 m to 700 m from an extracted longwall panel. Based on the result of this assessment, the predicted range of total strains at the optical fibre cable for the extraction of Longwalls 304 are 0.8 mm/m tensile and 1.3 mm/m compressive based on the 95 % confidence interval, and 1.3 mm/m tensile and 2.8 mm/m compressive based on the 99 % confidence interval.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as ‘anomalous’ movements.

The locations of the known geological structures at seam level and the major streams are shown in Drawing No. MSEC1013-06. There are no mapped faults located within the Study Area that extend beneath the Vocus infrastructure. It is possible that the Vocus infrastructure could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). Non-conventional or anomalous movements have not been identified during the extraction of Longwalls 301 and 302. The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The optical fibre cable does not cross any major streams within the Study Area and, therefore, is not expected to experience any measurable valley closure effects.

Impact Assessments for the Optical Fibre Cable

The Vocus optical fibre cable adjacent to the Study Area is conservatively assumed to be direct buried. The cable is unlikely to be impacted by the minor conventional tilts and curvatures resulting from extraction of Longwall 304. The cable, however, is likely to experience horizontal movement resulting from the extraction of Longwall 304.

Tensile strains in the optical fibre cable can be higher where the cable connects to the support structures, which may act as anchor points, preventing any differential movements that may have been allowed to occur within the ground. Tree roots have also been known to anchor cables to the ground. The extent to which the anchor points affect the ability of the cable to tolerate the mine subsidence movements depends on the cable size, type, age, installation method and ground conditions.

In addition to this, optical fibre cables contain additional fibre lengths over the sheath lengths, where the individual fibres are loosely contained within tubes. Compression of the sheaths can transfer to the loose tubes and fibres and result in 'micro-bending' of the fibres constrained within the tubes, leading to higher attenuation of the transmitted signal. If the maximum predicted compressive strains were to be fully transferred into the optical fibre cable, they could be of sufficient magnitude to result in the reduction in capacity of the cable or transmission loss.

Localised and elevated curvatures could develop along the optical fibre cable due to non-conventional movements resulting from near surface geological structures (i.e. anomalies). It is possible that these non-conventional movements could be sufficient to result in the attenuation of signal.

The strains transferred into the optical fibre cable can be monitored using Optical Time Domain Reflectometry (OTDR). The ground movements can also be monitored using traditional survey lines and visual inspections. These monitoring methods can be used to identify the development of irregular ground movements. If non-conventional movements or signal attenuation are detected during active subsidence, then the cable can be relieved by locally exposing and then reburying the affected section of cable.

A monitoring program, including a trigger action response plan, has been in place since the commencement of Longwall 301. Observed subsidence parameters and optical fibre signal monitoring have been within expected levels with no identified non-conventional movements. Based on these results the likelihood of non-conventional movements occurring as a result of the extraction of Longwall 304 is considered to be very low.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301 to 303 are updated and continued for Longwall 304, in consultation with Vocus, to manage the cable for potential non-conventional ground movements.

Summary

The Vocus optical fibre cable is located above the southern end of existing Longwall 301 and is outside the Study Area for Longwall 304. The previous experience from the Southern Coalfield has found that the potential impacts on optical fibre cables can be managed with the implementation of suitable monitoring and management strategies. These strategies could include Optical Time Domain Reflectometry (OTDR), traditional ground monitoring lines and visual inspections.

It is expected that the potential impacts on the Vocus infrastructure can be managed with the implementation of the necessary monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:

Drawing No. MSEC1013-06 – Longwall 304 – Vocus Infrastructure

I:\Projects\Metropolitan\MSEC1013 - LW304 Stakeholders Consultation\AcadData\MSEC1013-06 Vocus.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

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METROPOLITAN COLLIERY
LONGWALL 304
VOCUS INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	1:10000	MSEC1013-06	02

6 218 000

312 000

Grid to MGA co-ordinates

CAWLEYS CK

METROPOLITAN FAULT

WORONORA RESERVOIR

TELSTRA

STUDY AREA

PREDICTED 20mm SUBSIDENCE CONTOUR

LW304

OLD PRINCES HWY

LW303

LW302

LW301

VOCUS

OPTUS

TELSTRA

6 216 000

OPTUS

M1 PRINCES MOTORWAY

WILSONS CK

PRINCES HIGHWAY UNDERPASS 2

GEOLOGICAL STRUCTURES
FAULTS
DYKES

APPENDIX 4

BUILT FEATURES MANAGEMENT PLAN – SUBSIDENCE IMPACT REGISTER

Built Features Management Plan - Subsidence Impact Register

Impact Register Number[1]	Built Feature[2]	Impact Description	Does Impact Exceed the Built Feature Performance Measure/Indicators? (Yes/No)	Management Measures Implemented	Were Management Measures Effective? (Yes/No)

Notes:

1: Fill out all details in the Assessment Form and record the register number here.

2: Built feature (e.g. cable, etc.).

3: Impacts to access roads/tracks to be included in the Land Management Plan – Subsidence Impact Register.

Built Feature Management Plan – Subsidence Impact Register
Assessment Form

Date:

Observer (Name and position):

Register Number (i.e. Number 1, 2, etc.):

Longwall Number and Chainage:

Location of Observed Impact:

(Examples: location of cable, include GPS co-ordinates and a sketch)

Description of Observed Impact:

(Examples: nature and extent of impact - cracks in road etc any relevant information, attach photographs)

Person Notified:	Manager - Technical Services	☐

Description of Photographs:

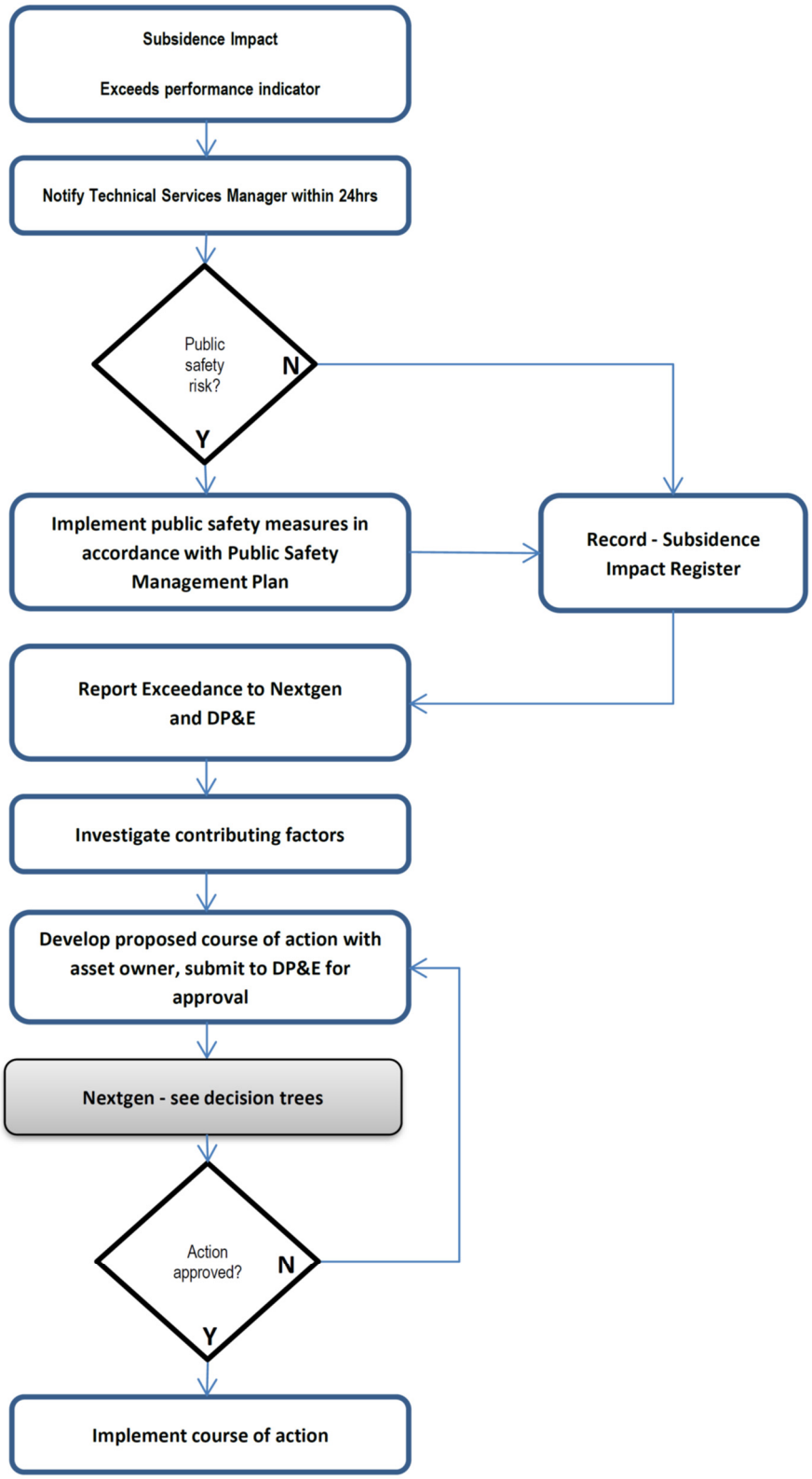
Actions Required:	Contingency Plan Initiated	☐
	Incident Notification	☐
	Safety Measures/Public Safety Management Plan Requirements	☐

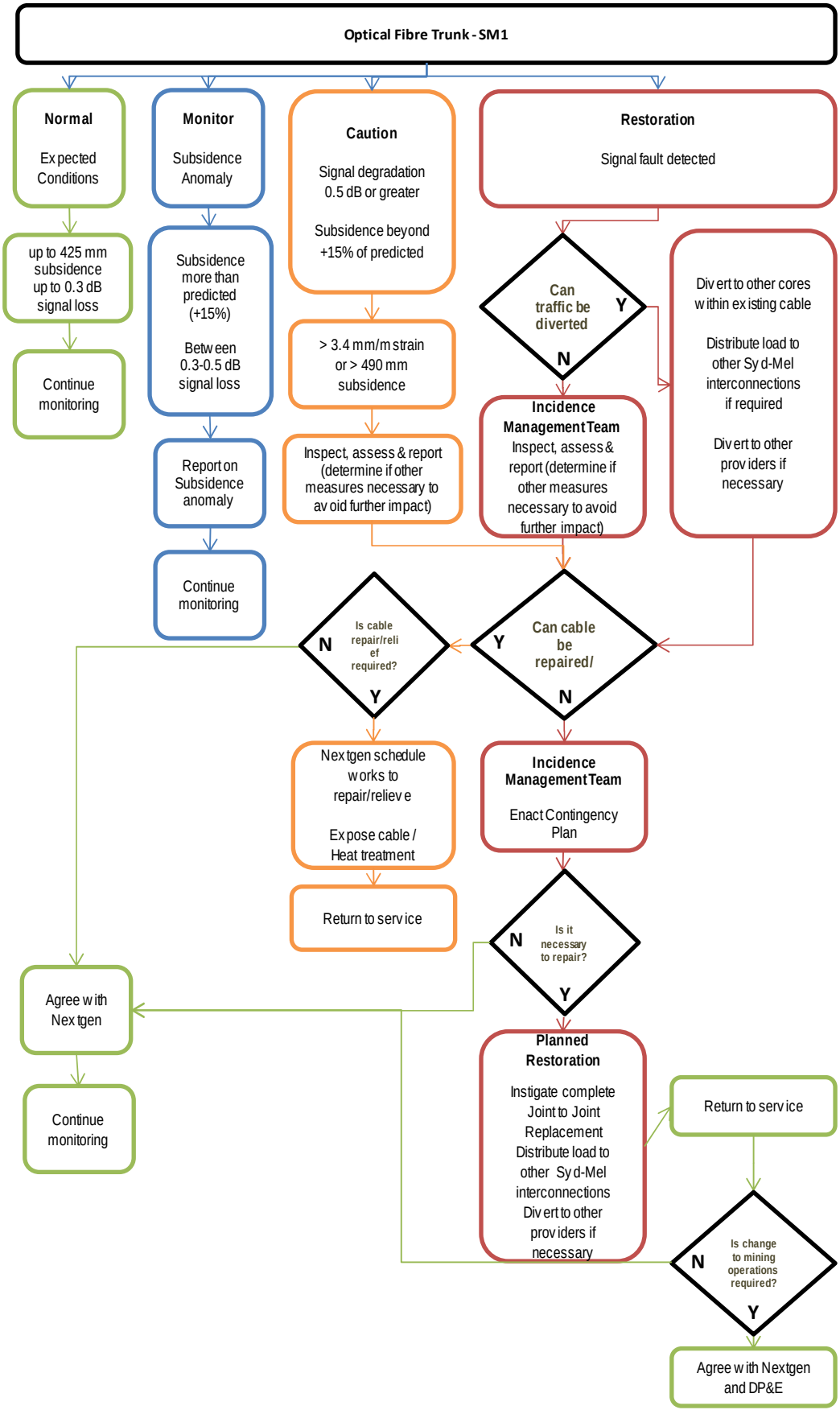
Management or Contingency Measures Implemented:

Effectiveness of Management or Contingency Measures:

APPENDIX 5

CONTINGENCY PLAN PROCEDURE AND DECISION TREE


Subsidence Impact
Exceeds performance indicator
Notify Technical Services Manager within 24hrs
Public safety risk?
N
Y
Implement public safety measures in accordance with Public Safety Management Plan
Record - Subsidence Impact Register
Report Exceedance to Nextgen and DP&E
Investigate contributing factors
Develop proposed course of action with asset owner, submit to DP&E for approval
Nextgen - see decision trees
Action approved?
N
Y
Implement course of action


Optical Fibre Trunk - SM1
Normal
Expected Conditions
up to 425 mm subsidence up to 0.3 dB signal loss
Continue monitoring
Monitor
Subsidence Anomaly
Subsidence more than predicted (+15%)
Between 0.3-0.5 dB signal loss
Report on Subsidence anomaly
Continue monitoring
Caution
Signal degradation 0.5 dB or greater
Subsidence beyond +15% of predicted
> 3.4 mm/m strain or > 490 mm subsidence
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration
Signal fault detected
Can traffic be diverted
Y
N
Incidence Management Team
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Divert to other cores within existing cable
Distribute load to other Syd-Mel interconnections if required
Divert to other providers if necessary
Can cable be repaired/
Y
N
Is cable repair/relief required?
N
Y
Nextgen schedule works to repair/relieve
Expose cable / Heat treatment
Return to service
Incidence Management Team
Enact Contingency Plan
Is it necessary to repair?
N
Y
Agree with Nextgen
Continue monitoring
Planned Restoration
Instigate complete Joint to Joint Replacement
Distribute load to other Syd-Mel interconnections
Divert to other providers if necessary
Return to service
Is change to mining operations required?
N
Y
Agree with Nextgen and DP&E

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BUILT FEATURES MANAGEMENT PLAN
OPTUS

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&E Approval Date
All	LW301-303 BFMP_OPTUS-R01-A	Original – Draft for Consultation	Optus, DRG and DP&E	-
Sections 1.1, 4.1.1, 6.2, 6.3, 7.2.1, 8 & 9.1, Tables 3, 5, 6 & 8, Figure 4 and Appendices	LW301-303 BFMP_OPTUS-R01-B	Revised – Incorporating updates	Optus, DRG and DP&E	11 May 2017*
Sections 4.2.2 & 7.2.2, Tables 2, 6, 9 & 10 and Appendix 3	LW301-303 BFMP_OPTUS-R01-C	Revised – Addressing DP&E and DRG requirements	Optus, DRG and DP&E	-
All	LW301-303 BFMP_OPTUS-R01-D	Revised TARP. Revised for LW303	Optus and DRG	-
All	LW301-303 BFMP_OPTUS-R01-E	Incorporate revisions to text and reference Optus Network mine subsidence management plan	Optus and DP&E	-
Sections 4.1.1, 4.2.2 & 9, Table 6	LW301-303 BFMP_OPTUS-R01-F	Revised – Incorporating updates by Optus	Optus, DRG and DP&E	8 November 2018#
All	BFMP_OPTUS-R01-G	Inclusion of Longwall 304 into BFMP	Optus	-

* The approval allows for the extraction of Longwalls 301 and 302 only.

Approval for the extraction of Longwall 303.

April 2019

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Figure 4 Environmental Management Structure

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Appendix 2 MSEC (2019) Metropolitan Colliery – Proposed Longwall 304 – Subsidence Predictions and Impact Assessment for the Optus Infrastructure

Appendix 3 Built Features Management Plan – Subsidence Impact Register

Appendix 4 Contingency Plan Procedure and Decision Trees

1 INTRODUCTION

Metropolitan Coal is a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under section 75J of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com).

The Project comprises the continuation, upgrade and extension of underground coal mining operations (Longwalls 20-27 and Longwalls 301-317) and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1. Following the completion of Longwall 27 in 2017, Longwalls 301, 302, 303 and 304 define the next mining sub-domains within the Project underground mining area (Figures 1 to 3).

1.1 PURPOSE AND SCOPE

In accordance with Condition 6(f), Schedule 3 of the Project Approval, this Built Features Management Plan – Optus (BFMP-OPTUS) has been developed to manage the potential consequences of longwall extraction on the Optus assets.

The relationship of this BFMP-OPTUS to the Metropolitan Coal Environmental Management Structure is shown on Figure 4.

In accordance with Condition 6, Schedule 3 of the Project Approval, the suitably qualified and experienced experts that have prepared this BFMP-OPTUS, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and Metropolitan Coal were endorsed by the Director-General (now Secretary) of the Department of Planning and Environment (DP&E). This BFMP-OPTUS has been prepared in consultation with Optus including consideration of prior consultation during the development of the previously approved Built Features Management Plans.

1.2 STRUCTURE OF THE BFMP-OPTUS

The remainder of the BFMP-OPTUS is structured as follows:

Section 2: Describes the review and update of the BFMP-OPTUS.

Section 3: Outlines the statutory requirements applicable to the BFMP-OPTUS.

Section 4: Provides a revised assessment of the potential subsidence impacts and environmental consequences for Longwalls 301-304.

Section 5: Details the performance measures and indicators that will be used to assess the Project.

Section 6: Provides the detailed baseline data.

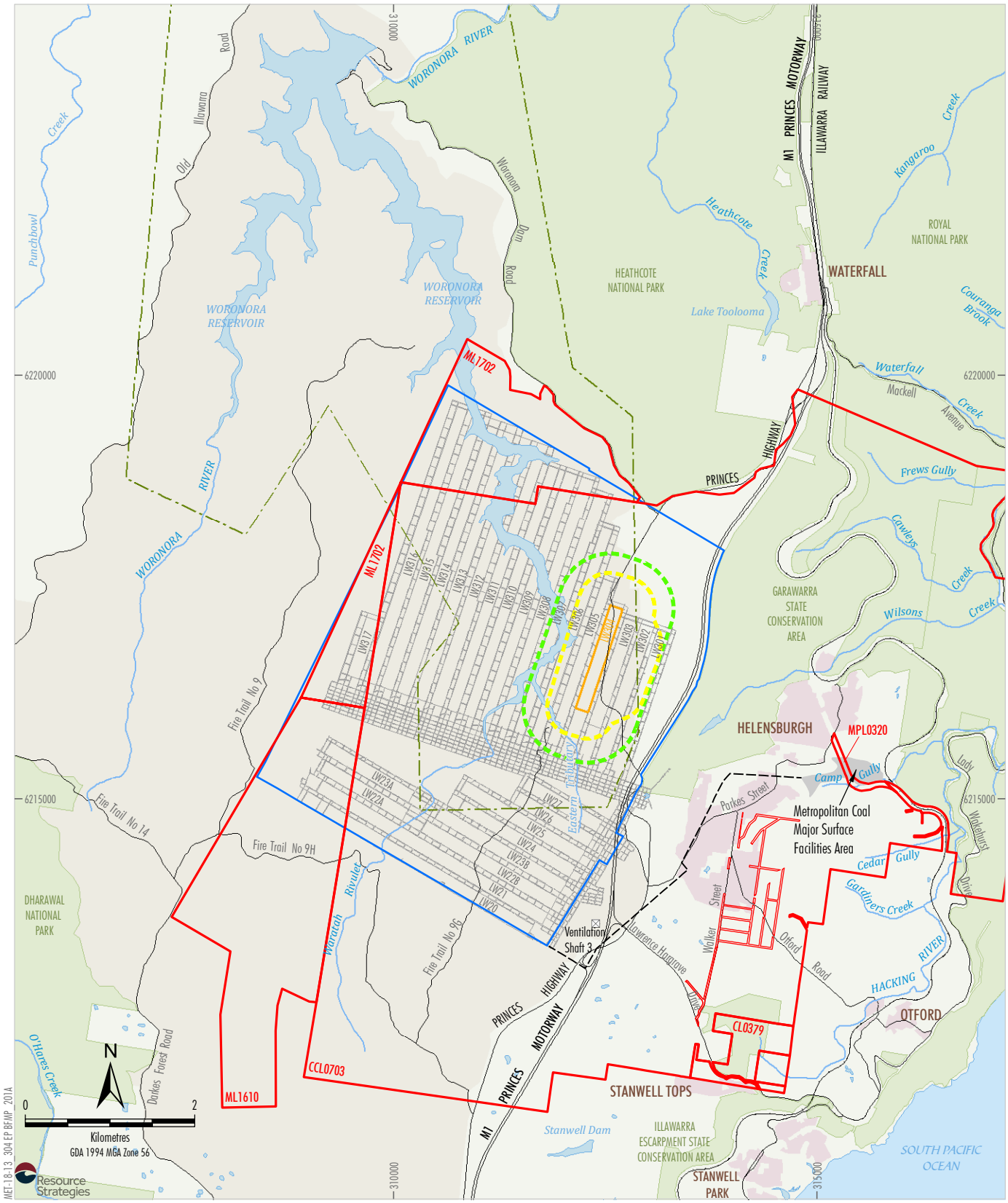
Section 7: Describes the monitoring program.

Section 8: Describes the management measures that will be implemented.

Section 9: Provides a contingency plan to manage any unpredicted impacts and their consequences.

Section 10: Describes the Trigger Action Response Plan (TARP) management tool.

Section 11: Describes the program to collect sufficient baseline data for future Extraction Plans.



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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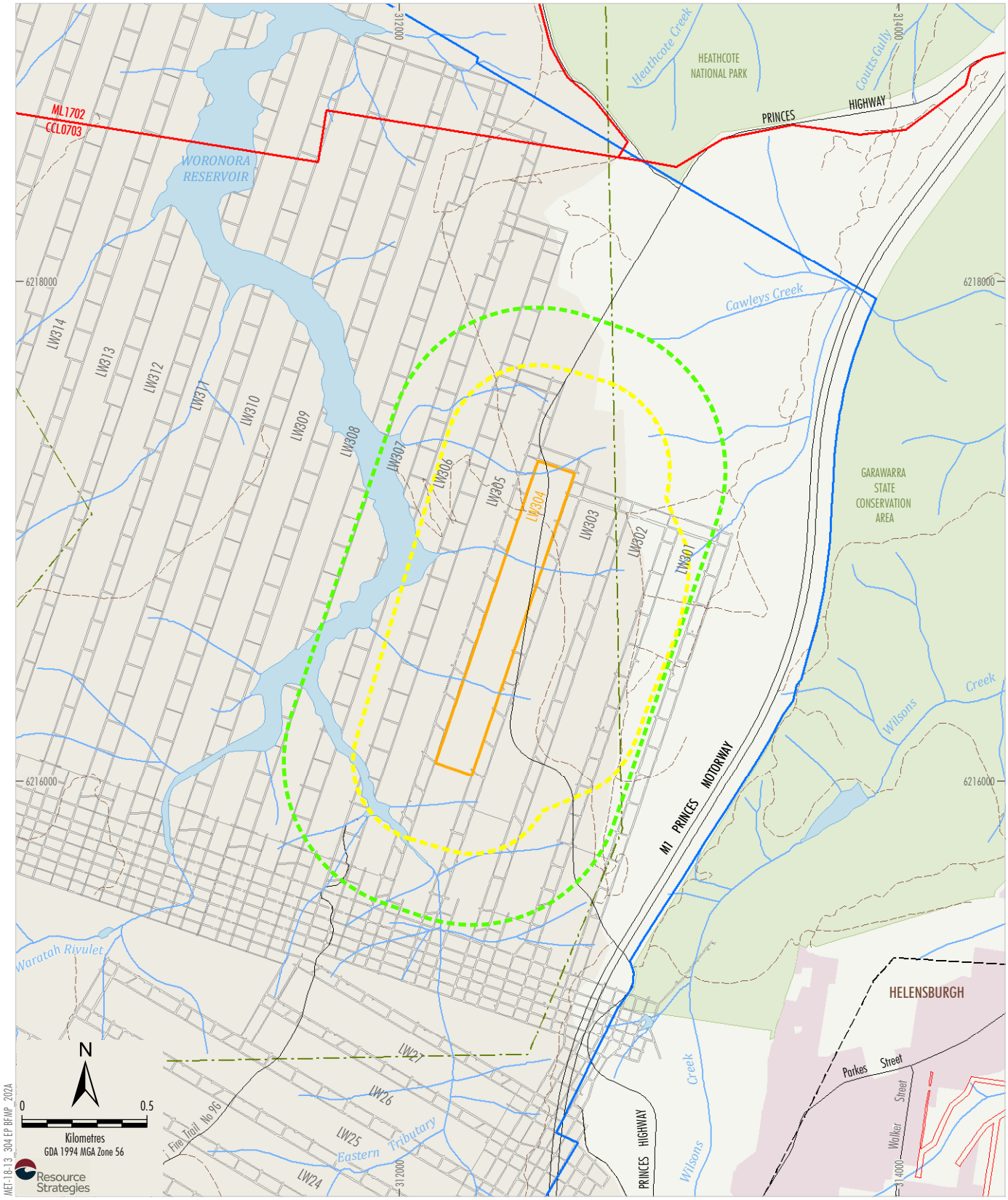
Longwalls 20-27 and Longwalls 301-317 Layout

Figure 1



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)
- Vehicular Track

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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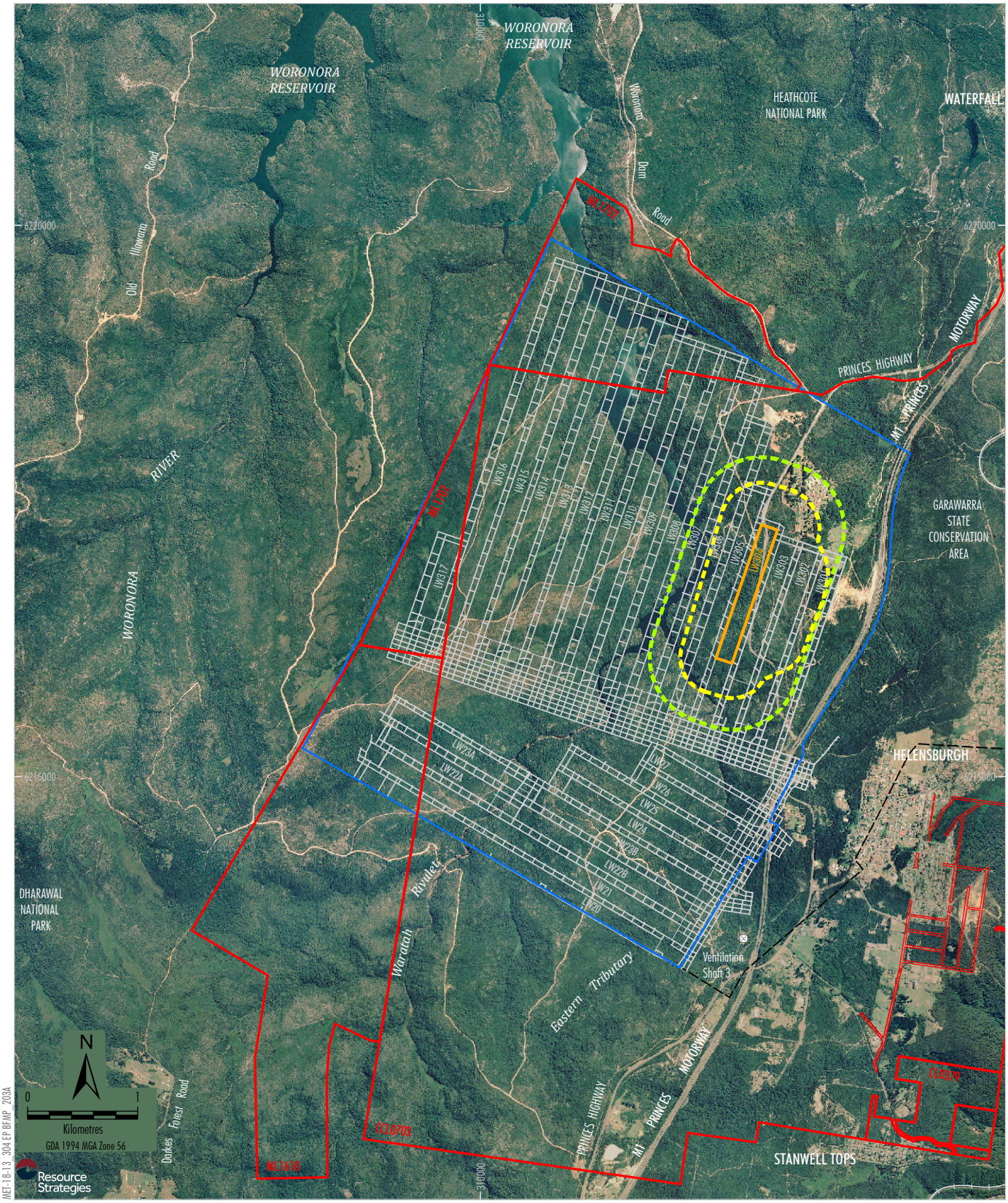
Longwalls 301-304 Layout

Figure 2



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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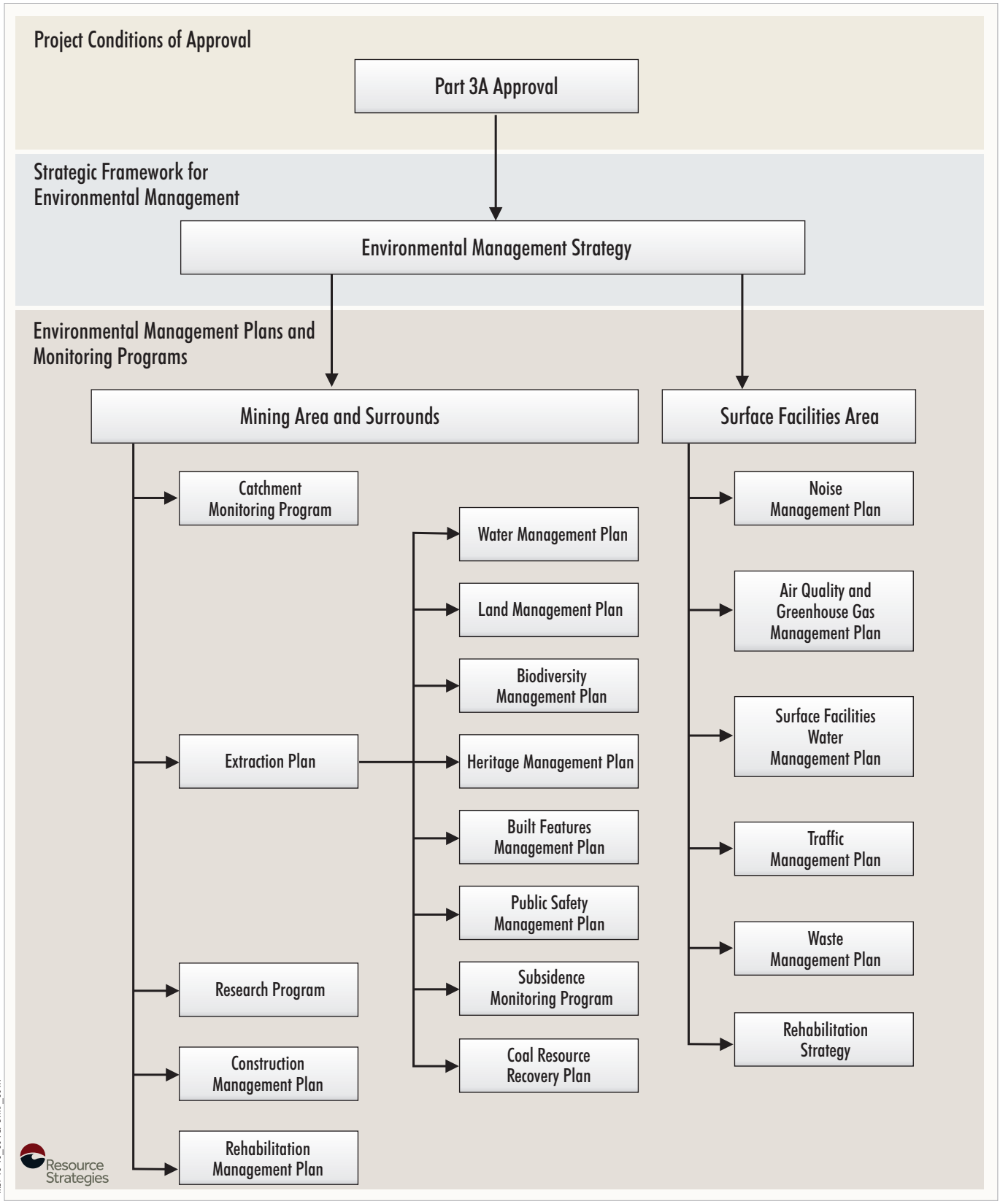
Longwalls 20-27 and Longwalls 301-317 Layout - Aerial Photograph

Figure 3



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Environmental Management Structure

Figure 4

Section 12: Describes the annual review and improvement of environmental performance.

Section 13: Outlines the management and reporting of incidents.

Section 14: Outlines the management and reporting of complaints.

Section 15: Outlines the management and reporting of non-compliances with statutory requirements.

Section 16: Lists the references cited in this BFMP-OPTUS.

2 BFMP-OPTUS REVIEW AND UPDATE

In accordance with Condition 4, Schedule 7 of the Project Approval, this BFMP-OPTUS will be reviewed within three months of the submission of:

- an audit under Condition 8 of Schedule 7;
- an incident report under Condition 6 of Schedule 7;
- an annual review under Condition 3 of Schedule 7; and

if necessary, revised to the satisfaction of the Director-General (now Secretary) of DP&E, to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

This BFMP-OPTUS will also be reviewed within three months of approval of any Project modification and if necessary, revised to the satisfaction of the DP&E.

The revision status of this plan is indicated on the title page of each copy of the BFMP-OPTUS. The distribution register for controlled copies of the BFMP-OPTUS is described in Section 2.1.

Revisions to any documents listed within this BFMP-OPTUS will not necessarily constitute a revision of this document.

2.1 DISTRIBUTION REGISTER

In accordance with Condition 10, Schedule 7 'Access to Information', Metropolitan Coal will make the BFMP-OPTUS publicly available on the Peabody website. A hard copy of the BFMP-OPTUS will also be maintained at the Metropolitan Coal site.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format. An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom Metropolitan Coal plans and programs, such as the BFMP-OPTUS, will be distributed;
- the format (i.e. electronic or hard copy) of distribution; and
- the format of revision notification.

Metropolitan Coal will make the Distribution Register publicly available on the Peabody website.

Metropolitan Coal will be responsible for maintaining the Distribution Register and for ensuring that the notification of revisions is sent by email or post as appropriate.

In addition, Metropolitan Coal employees with local computer network access will be able to view the controlled electronic version of this BFMP-OPTUS on the Metropolitan Coal local area network. Metropolitan Coal will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on Metropolitan Coal's computer system and the Peabody website.

3 STATUTORY REQUIREMENTS

Metropolitan Coal's statutory obligations are contained in:

(i) the conditions of the Project Approval;

(ii) relevant licences and permits, including conditions attached to mining leases; and

(iii) other relevant legislation.

These are described below.

3.1 EP&A ACT APPROVAL

Condition 6(f), Schedule 3 of the Project Approval requires the preparation of a BFMP as a component of Extraction Plan(s) for second workings. Project Approval Condition 6(f), Schedule 3 states:

> ***SECOND WORKINGS***
>
> ***Extraction Plan***
>
> *6. The Proponent shall prepare and implement an Extraction Plan for all second workings in the mining area to the satisfaction of the Director-General. This plan must:*
>
> *…*
>
> *(f) include a:*
>
> *…*
>
> - *Built Features Management Plan, which has been prepared in consultation with the owner of the relevant feature, to manage the potential environmental consequences of the Extraction Plan on any built features;*
>
> *…*

In addition, Condition 2, Schedule 7 and Condition 7, Schedule 3 of the Project Approval outline management plan requirements that are applicable to the preparation of the BFMP-OPTUS. Table 1 indicates where each component of the conditions is addressed within this BFMP-OPTUS.

Table 1
Management Plan Requirements

Project Approval Condition	BFMP-OPTUS Section
Condition 2 of Schedule 7	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Section 6
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 3
• any relevant limits or performance measures/criteria;	Section 5
• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 5
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Sections 7, 8, 9 and 10
d) a program to monitor and report on the:	Sections 7, 8 and 12
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 9 and Appendix 4
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Sections 7 and 12
g) a protocol for managing and reporting any;	
• incidents;	Section 13
• complaints;	Section 14
• non-compliances with statutory requirements; and	Section 15
• exceedances of the impact assessment criteria and/or performance criteria; and	Section 9 and Appendix 4
h) a protocol for periodic review of the plan.	Section 2
Condition 7 of Schedule 3	
7. In addition to the standard requirements for management plans (see condition 2 of schedule 7), the Proponent shall ensure that the management plans required under condition 6(f) above include:	
a) a program to collect sufficient baseline data for future Extraction Plans;	Section 11
b) a revised assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval;	Section 4
c) a detailed description of the measures that would be implemented to remediate predicted impacts; and	Section 8
d) a contingency plan that expressly provides for adaptive management.	Section 9 and Appendix 4

3.2 LICENCES, PERMITS AND LEASES

In addition to the Project Approval, all activities at or in association with the Metropolitan Coal Mine will be undertaken in accordance with the following licences, permits and leases which have been issued or are pending issue:

- The conditions of mining leases issued by the NSW Division of Resources and Geoscience (DRG), under the NSW *Mining Act, 1992* (e.g. Consolidated Coal Lease [CCL] 703, Mining Lease [ML] 1610, ML 1702, Coal Lease [CL] 379 and Mining Purpose Lease [MPL] 320).
- The Metropolitan Coal Mining Operations Plan 1 October 2012 to 30 September 2019 approved by the DRG.
- The conditions of Environment Protection Licence (EPL) No. 767 issued by the NSW Environment Protection Authority (EPA) under the NSW *Protection of the Environment Operations Act, 1997*. Revision of the EPL will be required prior to the commencement of Metropolitan Coal activities that differ from those currently licensed.
- The prescribed conditions of specific surface access leases within CCL 703 for the installation of surface facilities as required.
- Water Access Licences (WALs) issued by the NSW Department of Primary Industries – Water (now the Department of Industry – Water) under the NSW *Water Management Act, 2000*, including WAL 36475 under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* and WAL 25410 under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*.
- Mining and workplace health and safety related approvals granted by the NSW Resources Regulator and WorkCover NSW.
- Supplementary approvals obtained from WaterNSW for surface activities within the Woronora Special Area (e.g. fire road maintenance activities).

3.3 OTHER LEGISLATION

Metropolitan Coal will conduct the Project consistent with the Project Approval and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to the conduct of the Project (Helensburgh Coal Pty Ltd [HCPL], 2008)[1]:

- *Biodiversity Conservation Act, 2016;*
- *Biosecurity Act, 2015;*
- *Contaminated Land Management Act, 1997;*
- *Crown Land Management Act, 2016;*
- *Dams Safety Act, 2015;*
- *Dangerous Goods (Road and Rail Transport) Act, 2008;*
- *Energy and Utilities Administration Act, 1987;*
- *Fisheries Management Act, 1994;*
- *Mining Act, 1992;*

[1] The list of potentially applicable Acts has been updated to reflect changes to the Acts that were in force at the time of submission of the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008).

- *Protection of the Environment Operations Act, 1997;*
- *Rail Safety (Adoption of National Law) Act, 2012;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Water NSW Act, 2014;*
- *Work Health and Safety Act, 2011; and*
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

Relevant licences or approvals required under these Acts will be obtained as required.

4 REVISED ASSESSMENT OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

4.1 EXTRACTION LAYOUT

Longwalls 301-304 and the area of land within 600 metres (m) of Longwall 304 secondary extraction are shown on Figures 2 and 3. Longwall extraction occurs from north to south. The longwall layout includes 163 m panel widths (void) with 45 m pillars (solid).

The provisional extraction schedule for Longwalls 301-304 is provided in Table 2.

Table 2
Provisional Extraction Schedule

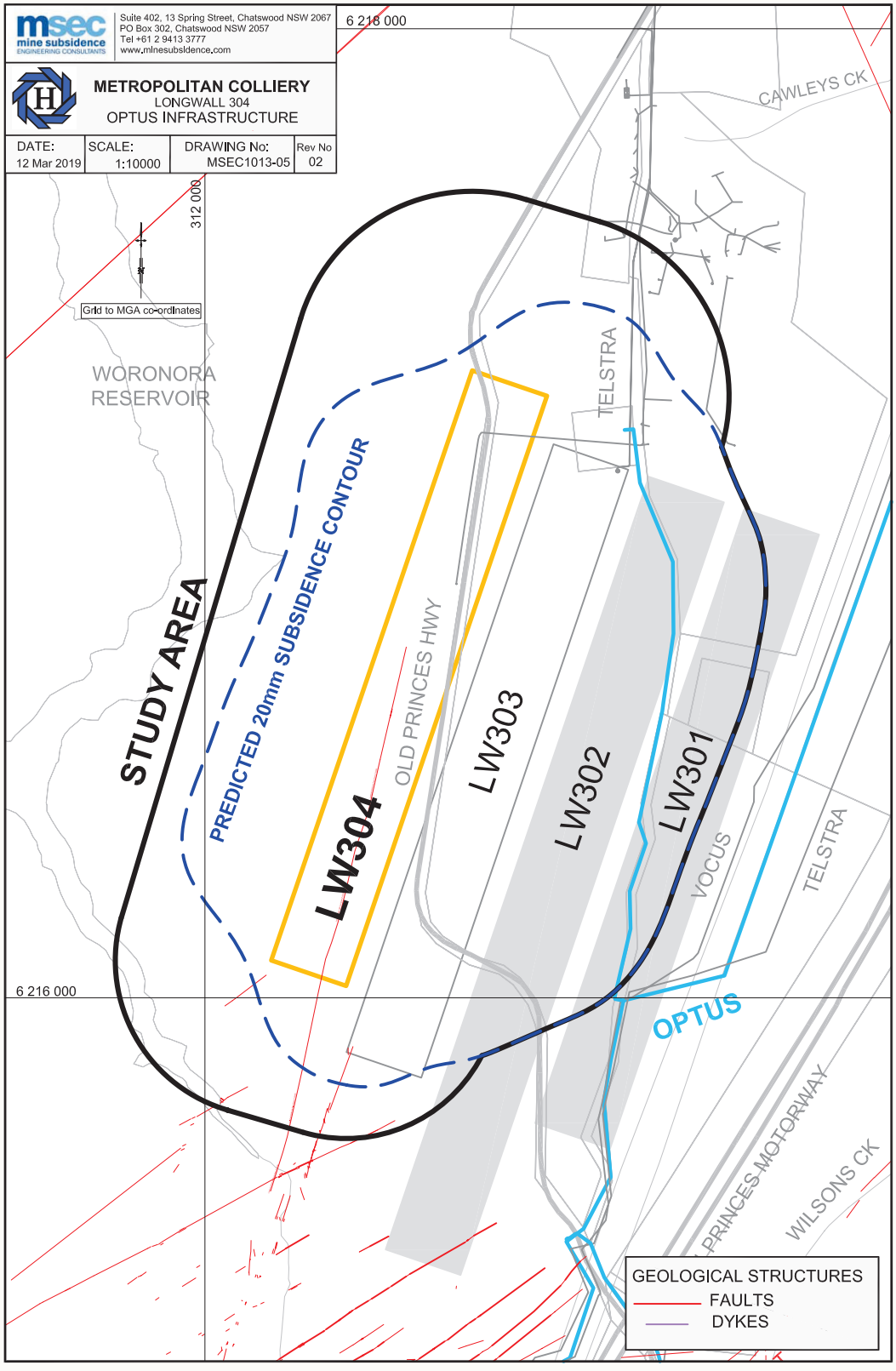
Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
301	June 2017	6 months	February 2018
302	March 2018	7 months	October 2018
303	November 2018	7 months	May 2019
304	July 2019	6 months	December 2019

The future Extraction Plans will consider the cumulative subsidence effects, subsidence impacts and/or environmental consequences. Note that the total cumulative predicted subsidence effects, subsidence impacts and/or environmental consequences at the completion of the Project are considered in the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008) and the Preferred Project Report (HCPL, 2009).

4.1.1 Optus Assets

The main Optus assets of relevance for the Longwalls 301-304 (Figure 5) extraction include:

- Trunk Network Fibre (36 SMOF): SYD-MELB 2 IOF. Coastal Inter Office Fibre in leased P32 Telstra subduct within larger Telstra P100 conduit, and leased Telstra Manholes/pits, Cable manufacturer, MM Olex. Heavy polyethylene Sheath, manufactured prior to 1993. Installation completed 1993.
- Access Network Fibre (144 SMOF) – 22BSS23719 - 1.5km in P50 Conduit, and
- Access Network Fibre (72 SMOF) 22BSS25914 - 0.3km in P50 conduit



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Source: MSEC (2019)

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Optus Assets

Figure 5

This BFMP incorporates considerations and learnings from Optus management plan, *Optus Network Mine Subsidence Management Plan, OM 38395*.

4.2 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

4.2.1 Revised Subsidence Predictions

Subsidence predictions for Longwalls 20-44 in relation to the Optus assets was conducted by MSEC (2008) as part of the Metropolitan Coal Project EA. MSEC (2008) includes a table summarising the incremental systematic subsidence parameters for the extraction of each longwall from Longwalls 20-44. These include:

- maximum predicted incremental subsidence (vertical movement);
- maximum predicted incremental tilt along alignment;
- maximum predicted incremental tilt across alignment;
- maximum predicted incremental tensile strain; and
- maximum predicted incremental compressive strain.

Revised subsidence and impact predictions for the extraction of Longwalls 301-303 and Longwall 304 on Optus assets were conducted by MSEC and reported in MSEC (2016) and MSEC (2019) (Appendices 1 and 2), respectively.

In relation to subsidence predictions for Longwalls 301-303, MSEC (2016) make the following conclusions:

- The optical fibre cables will not be impacted by the tilts resulting from the extraction of Longwalls 301-303.
- The buried optical fibre cables are likely to experience curvatures and ground strains resulting from the extraction of Longwalls 301-303.
- The predicted curvatures and strains for the optical fibre cables are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar cables.
- It is expected that the optical fibre cables can be maintained in a serviceable condition with the implementation of the appropriate monitoring and management strategies.

The Optus fibre optic cables (Cables 1 and 2) are located to the south and east of the study area, with a portion of Cable 2 overlying Longwalls 301 and 302 within the Longwall 304 study area. In relation to subsidence predictions for Longwall 304, MSEC (2019) make the following conclusions:

- Cable 1, (SYD-MELB 2 IOF, 36 SMOF), is not expected to experience measurable convetional vertical subsidence, tilts or curvatires due to the extraction of Longwall 304. Cable 1 could experience low level far-field horizontal movement. It is unlikely Cable 1 would experience adverse impacts as a result of Longwall 304.
- Cable 2, (144 & 72 SMOF), is expected to experience a minor increase in total subsidence up to 1000 mm due to the extraction of Longwall 304, however Cable 2 it is not predicted to experience measurable changes from extraction of Longwall 304 on tilt, strains or curvatures.
- It is expected that the optical fibre cables, 36, 72 and 144, can be maintained in a serviceable condition with the continuation of the monitoring and management strategies.

4.2.2 Risk Assessment Meeting

In accordance with the *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) a risk assessment meeting for Longwalls 301-303 was held on 12 August 2016. Attendees at the risk assessment meeting included representatives from Metropolitan Coal, Optus, MSEC, Resource Strategies and Axys Consulting (risk assessment facilitator).

The investigation and analysis methods used during the risk assessment review included:

- preliminary identification of Optus assets[2];
- review of the revised subsidence predictions and potential impacts on Optus assets (including consideration of past experience in the Southern Coalfield); and
- Development of a preliminary monitoring plan.

A number of risk control measures and procedures relevant to the fibre optic cable have been identified which considered the extraction of coal beneath the Optus assets, and are summarised as follows:

Baseline Data / Validation

1. Obtain from Optus an audit to confirm that all services, that may be affected by mining of Longwalls 301 to 303 have been identified and documented in the BFMP.[1]
2. Carry out an audit of the physical location of all the Optic Fibre Cables within the Study area prior to any mining to confirm that physical access is available.
3. Provide survey information on all the Optic Fibre Cable runs within the Study area to Optus.
4. Metropolitan Coal to carry out further investigation to determine the asset owner of the telecommunications tower and compound.[1]
5. Metropolitan Coal to arrange further consultation with relevant personnel (e.g. mobile department) for the telecommunications tower and hut.[1]
6. Metropolitan Coal to include a reference to the “management plan process” in the BFMP, similar to the approach adopted for previous Extraction Plans.

Management / Monitoring / Response Measures

7. Develop a Trigger Action Response Plan (TARP) and include a trigger to confirm that the Optical Fibre Cables monitoring is being carried out when the mining of Longwalls 301 to 303 may impact Optic Fibre Cables.
8. Include in the TARP a trigger to conduct physical audits of the Optic Fibre Cables when mining is likely to affect the cable so that rectification work can commence if required based on the TARP Conditions.
9. Metropolitan Coal to arrange further consultation with relevant personnel for the fibre optic cable for consideration of specific measures and contingency planning.
10. Include in the BFMP relevant details regarding the potential for underground blast vibration impacts at the surface.

[2] Since the risk assessment meeting was held, Axicom confirmed that the telecommunication tower and compound (initially considered during the Optus risk assessment) is an Axicom asset which is managed separately in the BFMP-Axicom.

Contingency Planning

11. Include in the BFMP contact information from Optus for liaison during implementation of management measures and contingency planning.
12. Obtain an understanding of the time the telecommunication tower and compound systems would operate in the event of a power outage.[1]

Metropolitan Coal considers all risk control measures and procedures to be feasible to manage all identified risks.

The proposed risk control measures and procedures have been incorporated where relevant in this BFMP and the program for implementation is summarised in Table 3.

Table 3
Program for Implementation of Proposed Risk Control Measures and Procedures

	Risk Control Measure / Procedure	BFMP Section	Timing
Baseline Data / Validation			
1	Obtain from Optus an audit to confirm that all services have been identified and documented in the BFMP	Section 6	Complete
2	Carry out an audit of the physical location of the Optic Fibre Cable within the Study area to confirm that physical access is available from existing tracks	Section 6	Complete
3	Provide survey location information to Optus on the Optic Fibre Cable runs based on surface markers	Section 6	Complete
4	Carry out further investigation to determine the asset owner of the telecommunications tower and compound	BFMP-Axicom	Complete*
5	Arrange further consultation with relevant personnel (e.g. mobile department) for the telecommunications tower and hut	BFMP-Axicom	Complete*
6	Include a reference to the “management plan process” in the BFMP	All	Complete
Management / Monitoring / Response Measures			
7	Develop a TARP and include a trigger to confirm that the Optical Fibre Cables monitoring is being carried out when mining is likely to affect the main Optic Fibre Cable run between Sydney to Melbourne	Section 10 / Table 8	Complete – Optus network mine subsidence management plan
8	Include in the TARP a trigger to conduct physical audits of the Optic Fibre Cable between Sydney to Melbourne when mining is likely to affect the cable	Section 10 / Table 8	Complete – Optus network mine subsidence management plan
9	Arrange further consultation with relevant personnel for the fibre optic cable for consideration of specific measures and contingency planning	Section 6.3	Complete
10	Include in the BFMP relevant details regarding the potential for underground blast vibration impacts at the surface	Section 4.3	Complete
Contingency Planning			
11	Include contact information from Optus for liaison.	Section 6.3	Complete
12	Obtain an understanding of the time the telecommunication tower and compound systems would operate in the event of a power outage	BFMP-Axicom	Complete*

* Since the risk assessment meeting was held, Axicom confirmed that the telecommunication tower and compound (initially considered during the Optus risk assessment) is an Axicom asset which is managed separately in the BFMP-Axicom.

The risk control measures and procedures identified during the risk assessment for Longwalls 301-303 (Table 3) will be implemented for the extraction of Longwall 304.

4.3 UNDERGROUND BLAST VIBRATION IMPACTS

Use of explosives is not required for existing or proposed general underground coal mining. Occasionally, geological structures (e.g. dykes) may be encountered underground that have to be broken up using very low mass explosives. This underground blasting would be undertaken at significant depth (e.g. greater than 400 m below the surface).

Ground vibration and airblast levels which cause human discomfort are generally lower than the recommended structural damage limits. Therefore, compliance with the lowest applicable human comfort criteria ensures that the potential to cause structural damage is minimal. Based on the assessment results presented in the Metropolitan Coal Project Noise Impact Assessment (Heggies, 2008), ground vibration levels are predicted to meet the most stringent night-time criteria of 1 mm/s at a distance of 500 m from the blast site. As blasting is conducted at least 400 m below the surface, vibration impacts are likely to be minimal (which is consistent with the existing Metropolitan Colliery blasting practices and experience).

5 PERFORMANCE MEASURES AND INDICATORS

The Project Approval requires Metropolitan Coal not to exceed the subsidence impact performance measures outlined in Table 1 of Condition 1, Schedule 3. The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

> *Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.*

The performance indicators proposed to ensure that the above performance measure is achieved include:

- negligible transmission loss from mine subsidence impacts;
- the structural integrity of the cable lines and associated facilities is maintained; and
- the serviceability of the access roads/tracks is maintained.

Section 7 of this BFMP-OPTUS describes the monitoring that will be conducted to assess the Project against the above performance measure and indicators. Sections 8 and 9 of this BFMP-OPTUS provide management measures and a Contingency Plan in the event the performance indicators or performance measure is exceeded.

6 BASELINE DATA

An audit of the physical location of the optic fibre cables within the Study area was conducted by Metropolitan Coal to confirm that physical access is available and not obstructed by vegetation growth.

6.1 KEY CONTACTS LIST

The list of key contacts for Peabody and Optus are provided in Table 4.

Table 4
List of Key Contacts

Company	Position	Contact
Peabody (Metropolitan Coal)	Manager Technical Services Jon Degotardi	Metropolitan Control Room 24 hour 02 4294 7333
Optus	Manager NSW IDM, Operations & Provisioning Glen Gordon	Optus 24hr infrastructure contact 1800 505 777

7 MONITORING

A monitoring program will be implemented to monitor the impacts of the Project on the Optus assets. Table 5 summarises the BFMP-OPTUS monitoring components.

The frequency of monitoring will be reviewed either:

- in accordance with the Annual Review outlined in Section 12; or
- if triggered as a component of the Contingency Plan as outlined in Section 9 of this BFMP-OPTUS.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts for comparison with baseline photographic records. Optus or their delegates will conduct the visual inspections. Metropolitan Coal will be notified of the timing of inspections and accompany Optus or delegates if considered necessary. All personnel will complete necessary inductions or orientation relevant to the tasks required.

Table 5
BFMP-OPTUS Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Baseline	Optical Fibre	Survey	Subsidence lines - points at approximately 20 m spacing	Establish base conditions pre-mining effects	Prior to Longwall 301 extraction	Completed
		Visual Inspection	Surface marker locations and photography of cable pits			
		Remote Fibre Monitoring System (RFMS)	Pre-mining RFMS less than 4.5dB	Establish signal integrity pre-mining effects	Prior to longwall face approaching within 400 m of the cables	Completed
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Establish condition pre-mining effects	Prior to Longwall 301 extraction	Completed
During Mining	Optical Fibre	Survey	GPS survey of subsidence lines	Determine subsidence, tilt, tensile strain, compressive strain	Survey to commence when longwall face approaches within 400 m of passing under a cable	Weekly, until movement stabilises
		RFMS	Optus conducted system monitoring on signal degradation level of 4.5dB	Fibre signal integrity (loss signal)	Monitoring will occur as per Optus schedule	Routine semiautomated basis
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Monitor for surface cracks, buckling and general safety	At the completion of each longwall	Once per Longwall
					As per Longwall 304 LMP	
Post Mining	Optical Fibre	Visual Inspection	Surface marker locations and photography of cable pits	Determine level of impact of mining (if any)	Within 3 months of the completion Longwalls 303 and 304.	Once per longwall
		RFMS	Optus conducted system monitoring on signal degradation level of 4.5 dB	Determine level of impact of mining (if any)	Within 6 months post Longwalls 303 and 304	Once per longwall
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Determine level of impact of mining (if any)	Within 3 months of the completion of each longwall	Once per longwall

7.1 SUBSIDENCE PARAMETERS

Subsidence parameters (i.e. subsidence, tilt, tensile strain, compressive strain, absolute horizontal translation, and differential leg movement) associated with mining will be measured by Metropolitan Coal in accordance with the Longwall 304 Subsidence Monitoring Program (Figure 6).

In summary, surveys will be conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence movements (i.e. subsidence, tilt, tensile strain and compressive strain) will be measured along subsidence lines that have been positioned across the general landscape.

Monitoring of subsidence parameters specific to the Optus assets include the survey lines along fire trail to Garrawarra containing Optus optical fibre cable 72 and 144 SMOF (and the adjacent 330 kilovolt (kV) transmission line corridor, containing Optus 36 SMOF. These surveys will monitor the general movement about the longwalls and the data will allow evaluation of the likely ground movements about the cable line (by comparison between measured and predicted movements).

7.2 SUBSIDENCE IMPACTS

7.2.1 Fibre Optic Cables

Visual inspections will be conducted of the cable lines by Optus as required, in accordance with the Optus inspection system or if triggered by a transmission fault detected by Optus

Specific details that will be noted and/or photographed include:

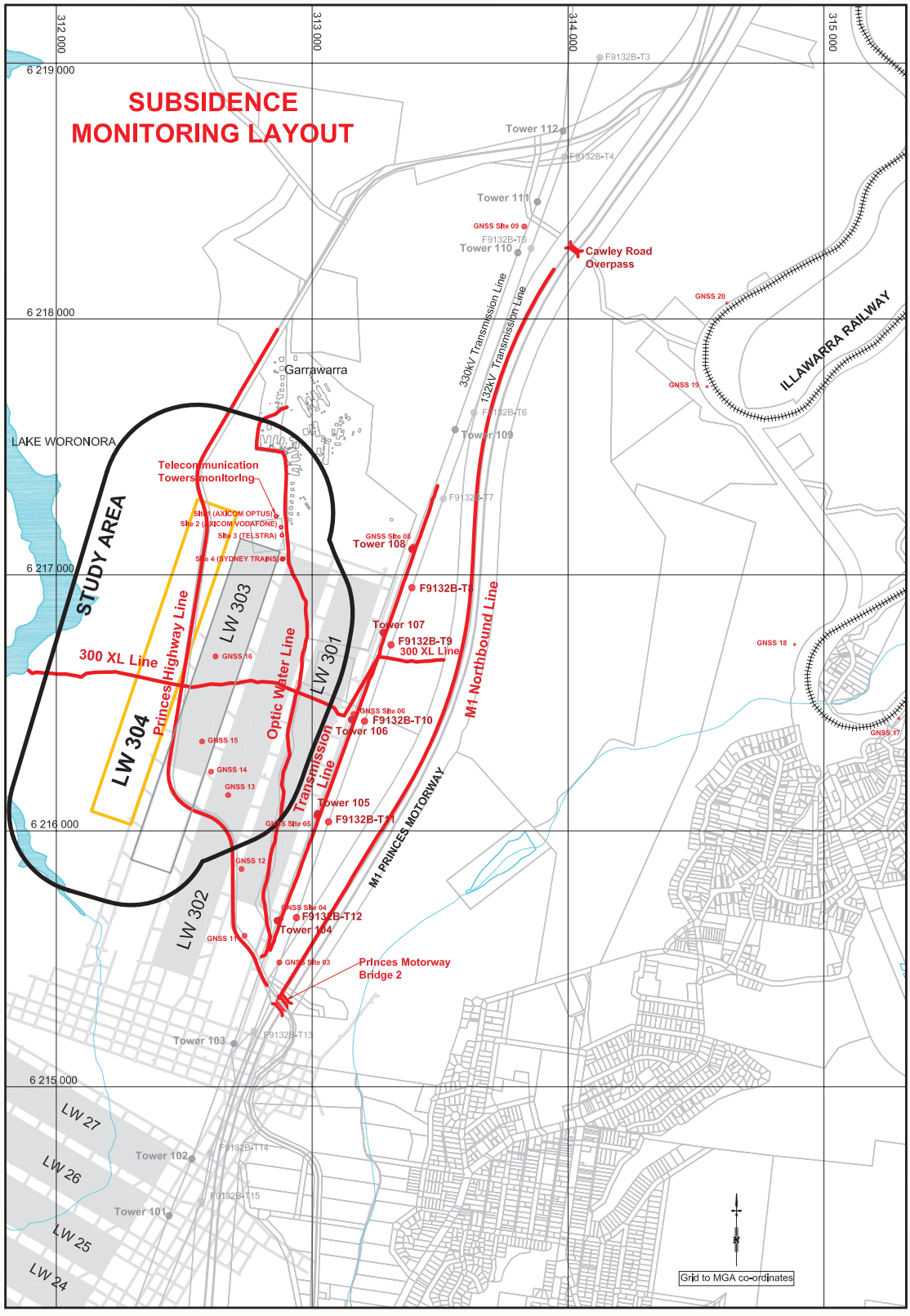
- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- assessment against the performance indicators and performance measure;
- whether any actions are required (e.g. initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The information will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 3) and reported in accordance with the Project Approval conditions.

7.2.2 Access Roads/Tracks

Visual inspection of the access roads/tracks were conducted by Metropolitan Coal prior to the commencement of Longwall 301, and will be conducted following extraction of Longwalls 303 and 304.

Visual observations of access roads/tracks will also be conducted by Metropolitan Coal as part of routine works and inspections within 600 m of Longwalls 301-304 secondary extraction as described in the Metropolitan Coal Longwall 304 Land Management Plan (Longwall 304 LMP).



MEF-18-13_304 EP BFMP_017A

Source: MSEC (2019)

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Subsidence Monitoring Layout

Figure 6

Specific details that will be noted and/or photographed that are relevant to the Optus access roads/tracks include:

- the location, approximate dimensions (length, width and depth), and orientation of surface tension cracks;
- the location of the surface tension crack in relation to access road/track to the Optus asset;
- whether any actions are required (e.g. implementation of management measures as outlined in the Longwall 304 LMP, initiation of the Contingency Plan as outlined in the Longwall 304 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The date of the observation, details of the observer and the location of longwall extraction will also be documented.

The information obtained will be recorded in the Longwall 304 LMP - Subsidence Impact Register and reported in accordance with the Project Approval conditions.

The information obtained will be used to assess the potential environmental consequences of the subsidence impact (described in the Longwall 304 LMP) and to identify required management measures. Management measures are discussed in the Longwall 304 LMP.

In the event the subsidence impacts are deemed to present a safety hazard (i.e. regardless of the nature or extent of the subsidence impact), actions will be implemented in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan.

7.3 ENVIRONMENTAL CONSEQUENCES

Metropolitan Coal and Optus will compare the results of the subsidence impact monitoring against the built features performance indicators and performance measure. In the event the observed subsidence impacts exceed the performance indicators or performance measure, Metropolitan Coal and Optus will assess the consequences of the exceedance in accordance with the Contingency Plan described in Section 9.

8 MANAGEMENT MEASURES

A number of potential management measures in relation to cable lines are considered to be applicable and contingency measures are summarised in Section 9.1.

Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.

Management measures will be reported in the Annual Review (Section 12).

9 CONTINGENCY PLAN

In consultation with Optus and drawing upon prior Optus experience with regards Subsidence Impacts to Optic Fibre Cables, contingency planning is primarily aimed at cable outage from a significant subsidence event. In the event that subsidence impacts observed exceed the performance measure or indicators detailed in Section 5 of this BFMP-OPTUS, Metropolitan Coal will implement the following Contingency Plan (Appendix 4):

Inform;

- Optus will inform Metropolitan Coal of a relevant cable loss of service event, or
- Metropolitan will inform Optus of a relevant subsidence anomaly noted during subsidence surveys.
- Anomalous subsidence observations will be reported to the Metropolitan Manager - Technical Services within 24 hours.

Assess Public Safety:

- Metropolitan Coal will assess public safety and where appropriate implement safety measures in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan

Investigation;

- Metropolitan Coal will conduct an investigation to evaluate the potential contributing factors. The investigation will:
  - include the re-survey of relevant subsidence monitoring lines;
  - compare and critically analyse measured versus predicted subsidence parameters;
  - review measured subsidence parameters against the observed impact; and
  - review the subsidence monitoring program and update the program where appropriate.

Restoration of Service;

- Optus will determine the program to restore services with regards to an outage on a cable that has been installed under Schedule 3 of the Telecommunications Act 1997 (Cth)
- Metropolitan Coal will in consultation with the asset owner, specialists and relevant agencies determine a course of action with respect to the identified impact(s), to include:
  - a program to review the effectiveness of the contingency measures; and
  - consideration of adaptive management to avoid further impacts.

  Contingency measures are provided in Section 9.1.
- Metropolitan Coal will submit the proposed course of action with regards changes to the Extraction Plan or contained management plans to the DP&E for approval.
- Metropolitan Coal will implement the approved course of action to the satisfaction of the DP&E.

Reporting:

- With the exception of access roads/tracks, the observation will be recorded in the Built Features Management Plan – Subsidence Impact Register (Appendix 3) consistent with the monitoring program described in Section 7 of this BFMP-OPTUS.
- If relating to an access road/track, the observation will be recorded in the Metropolitan Coal Longwall 304 Land Management Plan – Subsidence Impact Register.
- Metropolitan Coal will report any exceedance of the performance measure or indicators to the DP&E and Optus as soon as practicable after Metropolitan Coal becomes aware of the exceedance.

In accordance with Condition 6, Schedule 6 of the Project Approval, Metropolitan Coal will provide a suitable offset to compensate for the impact to the satisfaction of the Director-General (now Secretary) of DP&E if either the contingency measures implemented by Metropolitan Coal have failed to remediate the impact or the Director-General (now Secretary) determines that it is not reasonable or feasible to remediate the impact.

Metropolitan Coal recognizes that the NSW *Coal Mine Subsidence Compensation Act, 2017* does not apply to Optus infrastructure installed utilising its statutory rights under Schedule 3 of the Telecommunication Acts 1991 or 1997 (Cth).

9.1 CONTINGENCY MEASURES

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of environmental consequences).

In the event of unforeseen impacts and drawing upon Optus experience that any subsidence event significant enough to impact performance of the fibre optic cable will cause an outage, contingency measures are summarised in Table 6. The decision tree for the contingency measures is shown in Appendix 4.

Table 6
Contingency Measures

Asset	Contingency Measures / Description	
Fibre Optic Cable	Replace	• Optus to replace affected length of fibre optic cable. • Optus to engage with Telstra if Telstra owned conduit is impacted and requires replacing.

10 TARP – MANAGEMENT TOOL

The framework for the various components of the BFMP-OPTUS are summarised in the BFMP-OPTUS TARP shown in Table 7. The BFMP-OPTUS TARP illustrates how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions. The TARP comprises:

- baseline conditions;
- predicted subsidence impacts;
- trigger levels from monitoring to assess performance; and
- triggers that flag implementation of contingency measures.

The TARP system provides a simple and transparent snapshot of the monitoring of environmental performance and the implementation of management and/or contingency measures.

Table 7
Trigger Action Response Plan – Optical Fibres: 36, 72 & 144 SMOF

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
Safe, serviceable and repairable	Negligible transmission loss in fibre optic cables from mine subsidence impacts	Remote fibre monitoring system (RFMS).	Signal loss.	As per Optus program	Optus network monitoring program.		Pre-mining audit conducted prior to commencement of LW 301.	Level 1	Signal loss < 4.5 dB No movement about cable pits. No signs of conduit movement or reduction in freedom of movement of the cable conduit. At end of Longwall 303 subsidence is: Subsidence < 875 mm Tensile strain < 1.5 mm/m Compressive strain < 2.5 mm/m # At the end of Longwall 304 subsidence is: Subsidence < 1000 mm Tensile strain < 1.5 mm/m Compressive strain < 2.5 mm/m # (i.e. measured subsidence parameters generally in accordance with predicted).	Subsidence within predictions, cable functioning normally #Note: *In consultation with Optus the compressive strain indicator is set below prediction at level where impact was observed to occur on Optus Cable Fibres at another southern coalfield colliery.* Continue Monitoring
	The structural integrity of the cable line and associated joint housing pit is maintained.	Physical inspection of the cable pits.	Movement about cable pits Direct signs of conduit movement, and degree of freedom of cable in conduit where visible	Weekly when LW304 extraction is within 400m of cables until subsidence reduced below level of survey accuracy. Weekly when LW is within ±400m of being directly under cable and after LW 301, 302, 303 and 304	Visual inspection of cable pits by experienced person, In presence of Optus employee or approved contractor, or Approved Telstra contractor to open Telstra owned pits.					
	Subsidence parameters.	Survey lines along the adjacent transmission line corridor and the 300 XL subsidence monitoring line	Subsidence, Strain.		Evaluation of the general ground movements about the site by comparison between measured and predicted movements.	Subsidence measurement accuracy.		Level 2	Signal loss < 4.5 dB Subsidence up to 15% greater than predicted between 875 mm and 1000 mm (after Longwall 303) and between 1000 mm and 1150 mm (after Longwall 304) Tensile strain between 1.5 and 1.7 mm/m Compressive strain between 2.5 and 3.2 mm/m.	Subsidence up to 15% greater than predictions Metropolitan inform and report to Optus subsidence results. . Immediately resurvey subsidence line to confirm results. Engage subsidence expert to assess results. Confirm results are consistent with other subsidence lines. Compare and critically analyse measured versus predicted subsidence. . Collaboratively share information with Optus to monitor situation. **Optus** Assess information provided by Metropolitan Coal.
								Level 3	Signal loss > 4.5 dB Movement about cable pits identified. Restriction in movement of cable conduits identified. Tensile strain greater than 1.7mm/m. Compressive strain greater than 3.2mm/m.	Signal degradation or Subsidence exceeds predictions by 15% Implement actions in accordance with the Optus Network Mine Subsidence Management Plan Agreement (Appendix 1). **Optus** Inform Metropolitan Coal of signal degradation

Table 7 (Continued)
Trigger Action Response Plan – Optical Fibres: 36, 72 & 144 SMOF

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
Safe, serviceable and repairable (continued)								Level 4	Service outage occurs	Loss of service Implement Contingency Plan as per BFMP Section 9. General Manager to be involved in all decision making processes. Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwalls 304 Public Safety Management Plan. Report exceedance of the performance measure or indicators to the DP&E as soon as practicable. Update the 'Built Features Management Plan – Subsidence Impact Register'. **Optus** Optus to assess impacted area and complete restoration works Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.
	The serviceability of the access roads and tracks are maintained.	Access roads and tracks in the vicinity of the Optus assets.	Cracking about access road/tracks.	After LW 301, 302, 303 and 304	Visual Inspection. Visual observations of access roads/tracks will also be conducted by Metropolitan Coal as part of routine works and inspections within 600 m of Longwalls 301-304 secondary extraction as described in the Metropolitan Coal Longwall 304 Land Management Plan.		Pre-mining audit conducted prior to commencement of LW 301.	Level 1	Minor cracking.	**Continue monitoring.** Consider whether any actions are required (e.g. implementation of management measures as outlined in the Longwall 304 LMP, initiation of the Contingency Plan as outlined in the Longwall 304 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.).
								Level 2	Moderate cracking (i.e. cracking that requires implementation of management measures).	Implement management measures as outlined in the Longwall 304 LMP.
								Level 3	Greater than moderate cracking.	Implement contingency measures as outlined in the Longwall 304 LMP.

11 FUTURE EXTRACTION PLANS

In accordance with Condition 7, Schedule 3 of the Project Approval, Metropolitan Coal will collect baseline data for the next Extraction Plan (i.e. Longwalls 305-310 onward). However for the fibre optic cable, the baseline (and post-mining) data collected for Longwalls 301-304 will be used as baseline for Longwalls 305 onward as longwall mining progressively moves further away from the Optus assets.

In addition to the baseline data collection, consideration of the environmental performance and management measures in accordance with the review(s) conducted as part of this BFMP-OPTUS will inform the appropriate type and frequency of monitoring of the assets relevant to the next Extraction Plan.

12 ANNUAL REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

In accordance with Condition 3, Schedule 7 of the Project Approval, Metropolitan Coal will conduct an Annual Review of the environmental performance of the Project by the end of March each year.

The Annual Review will:

- describe the works carried out in the past year, and the works proposed to be carried out over the next year;
- include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the EA, Preferred Project Report and Extraction Plan;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

As described in Section 2, this BFMP-OPTUS will be reviewed within three months of the submission of an Annual Review, and revised where appropriate.

13 INCIDENTS

An incident is defined as a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval.

The reporting of incidents will be conducted in accordance with Condition 6, Schedule 7 of the Project Approval. Metropolitan Coal will notify the Director-General (now Secretary) of DP&E and any other relevant agencies of any incident associated with the Project as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of DP&E and any relevant agencies with a detailed report on the incident.

Optus will be notified within 24 hours of any access limitations or restrictions.

Optus is a licensed carrier under the Telecommunications Act 1997 (Cth) and has certain statutory rights to access its assets without notice to the owner of the land or persons of legal interest in the land.

14 COMPLAINTS

A protocol for the managing and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

The Environment & Community Superintendent is responsible for maintaining a system for recording complaints.

Metropolitan Coal will maintain public signage advertising the telephone number on which environmental complaints can be made. The Environment & Community Superintendent is responsible for ensuring that the currency and effectiveness of the service is maintained. Notifications of complaints received are to be provided as quickly as practicable to the Environment & Community Superintendent.

Complaints and enquiries do not have to be received via the telephone line and may be received in any other form. Any complaint or enquiry relating to environmental management or performance is to be relayed to the Environment & Community Superintendent as soon as practicable. All employees are responsible for ensuring the prompt relaying of complaints. All complaints will be recorded in a complaints register.

For each complaint, the following information will be recorded in the complaints register:

- date and time of complaint;
- method by which the complaint was made;
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- nature of the complaint;
- the action(s) taken by Metropolitan Coal in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken by Metropolitan Coal, the reason why no action was taken.

The Environment & Community Superintendent is responsible for ensuring that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary.

In accordance with Condition 10, Schedule 7 of the Project Approval, the complaints register will be made publicly available on the website and updated on a monthly basis. A summary of complaints received and actions taken will be presented to the Community Consultative Committee as part of the operational performance review.

15 NON-COMPLIANCES WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with Metropolitan Coal, and will be developed through promotion of Metropolitan Coal ownership under the direction of the General Manager.

The Manager - Technical Services and/or Environment & Community Superintendent will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 13, Metropolitan Coal will notify the Director-General (now Secretary) of the DP&E and any other relevant agencies of any incident associated with Metropolitan Coal as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of the DP&E and any relevant agencies with a detailed report on the incident.

A review of Metropolitan Coal's compliance with all conditions of the Project Approval, mining leases and all other approvals and licenses will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the Peabody website.

Additionally, in accordance with Condition 8, Schedule 7 of the Project Approval, an independent environmental audit was undertaken by the end of December 2011, and is undertaken a minimum of once every three years thereafter. A copy of the audit report will be submitted to the Director-General (now Secretary) of the DP&E and made publicly available on the Peabody website. The independent audit will be undertaken by an appropriately qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General (now Secretary) of the DP&E.

16 REFERENCES

Optus Pty Ltd (2018), *Optus Network Mine Subsidence Management Plan* OM 38395, *version 9*.

Department of Planning & Environment and Division of Resources and Energy (2015) *Guidelines for the Preparation of Extraction Plans*.

Heggies (2008) *Metropolitan Coal Project Noise Impact Assessment.* Appendix J in the Metropolitan Coal Project Environmental Assessment.

Helensburgh Coal Pty Ltd [HCPL] (2008) *Metropolitan Coal Project Environmental Assessment*.

Helensburgh Coal Pty Ltd [HCPL] (2009) *Metropolitan Coal Project Preferred Project Report.*

Mine Subsidence Engineering Consultants (2008) *Subsidence Assessment Report on the Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Surface Infrastructure Resulting from the Proposed Extraction of Longwalls 20 to 44 at Metropolitan Colliery in Support of a Part 3A Application.*

Mine Subsidence Engineering Consultants (2016) *Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Optus Infrastructure, dated 28 October 2016.*

Mine Subsidence Engineering Consultants (2019) *Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Optus Infrastructure.*

APPENDIX 1

MSEC (2016) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 301 TO 303 - SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE OPTUS INFRASTRUCTURE, DATED 28 OCTOBER 2016

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

23rd August 2018

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-05-a

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Optus Infrastructure Clarification

In accordance with Condition 6(f), Schedule 3 of the Project Approval, Metropolitan Coal developed a Built Features Management Plan – Optus (Longwalls 301-303 BFMP-OPTUS-R01-D) to manage the potential consequences of Longwalls 301-303 extraction on the Optus assets.

Appendix 1 of Longwalls 301-303 BFMP-OPTUS-R01-D is a letter report by Mine Subsidence Engineering Consultants (MSEC) on subsidence predictions and impact assessments for the Optus infrastructure for the extraction of Longwalls 301 to 303.

A recent review of Longwalls 301-303 BFMP-OPTUS-R01-D has identified that reference to Optus cables as direct buried is incorrect and that the cables are within buried conduits of various sizes. We provide the following comments to clarify impact assessments for the cables buried in conduits.

The effect of having cables buried in conduit reduces risk of ground strain transfer to the buried cables and hence reduces the risk of impact resulting from the extraction of Longwalls 301 to 303, when compared to direct buried cables. The conclusions of the letter report, that "*the potential impacts on the Optus infrastructure can be managed with the implementation of the appropriate monitoring and management strategies*", do not change.

Please contact myself if you wish to discuss any of the above information.

Yours sincerely

Peter DeBono

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

28th October 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-05

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Optus Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Optus infrastructure resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery.

The locations of the Optus infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC844-05. There is a main optical fibre cable (Optical Fibre Cable 1) within the Study Area that is located above the southern end of Longwall 301 and extends to the north and south in a similar orientation to the Longwall 301. A second optical fibre cable is located above the northern end of Longwall 303 and above Longwalls 302 and 301 (Optical Fibre Cable 2). A third optical fibre cable is located to the south of the longwalls extending from the main optical fibre cable along the alignment of the Old Princes Highway.

The predictions and impact assessments for the Optus infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the Optus Infrastructure

The following provides summaries of the maximum predicted conventional movements for the Optus infrastructure resulting from the extraction of Longwalls 301 to 303. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

The predicted profiles of incremental and total conventional subsidence, tilt and curvature along the alignment of Optical Fibre Cable 1 and 2, resulting from the extraction of Longwalls 301 to 303, are shown in the attached Fig. A.1 and Fig. A.2 respectively. The black dashed lines are the incremental profiles that represent the additional movements due to each of the longwalls. The solid blue lines represent the total or accumulated movements after the completion of each longwall. The range of predicted curvatures in any direction at any time during or after the extraction of the longwalls is shown by the grey shading. The third optical fibre cable is located a minimum distance of 190 m from Longwall 301 and will experience negligible predicted subsidence movements due to the extraction of Longwalls 301 to 303.

A summary of the maximum predicted values of incremental subsidence, tilt and curvature for Optical Fibre Cable 1 and 2, due to the extraction of each of the Longwalls 301 to 303, are provided in Table 1 and Table 2 respectively. The values are the maxima anywhere along the cables at any time during or after the extraction of each longwall.

Table 1 Maximum Predicted Incremental Subsidence, Tilt and Curvature for the Optus Optical Fibre Cable 1 Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
Due To LW301	70	< 0.5	< 0.01	< 0.01
Due To LW302	200	1.0	0.04	< 0.01
Due To LW303	60	< 0.5	< 0.01	< 0.01

Table 2 Maximum Predicted Incremental Subsidence, Tilt and Curvature for the Optus Optical Fibre Cable 2 Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
Due To LW301	80	0.5	< 0.01	0.01
Due To LW302	625	3.5	0.03	0.11
Due To LW303	400	2.5	0.06	0.06

The maximum predicted incremental subsidence for the optical fibre cables, due to the extraction of each of the Longwalls 301 to 303, varies from 60 mm to 625 mm. It is noted, that the maximum predicted incremental subsidence due to Longwall 302 is greater than that due to Longwall 301, as it is a second panel in the series and therefore results in higher magnitudes of subsidence above the mining area.

A summary of the maximum predicted values of total subsidence, tilt and curvature for Optical Fibre Cable 1 and 2, resulting from the extraction of Longwalls 301 to 303, are provided in Table 3 and Table 4. The values are the maxima anywhere along the cable at any time during or after the extraction of the longwalls.

Table 3 Maximum Predicted Total Subsidence, Tilt and Curvature for the Optus Optical Fibre Cable 1 Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	70	< 0.5	< 0.01	< 0.01
After LW302	275	1.5	0.03	< 0.01
After LW303	325	1.5	0.04	< 0.01

Table 4 Maximum Predicted Total Subsidence, Tilt and Curvature for the Optus Optical Fibre Cable 2 Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	80	0.5	< 0.01	0.01
After LW302	675	4.0	0.03	0.11
After LW303	875	4.5	0.04	0.13

The maximum predicted total subsidence for the optical fibre cables, resulting from the extraction of Longwalls 301 to 303, is 875 mm. The maximum predicted conventional tilt for this cable is 4.5 mm/m (i.e. 0.45 %, or 1 in 225). The maximum predicted total conventional curvatures are 0.04 km^{-1} hogging and 0.13 km^{-1} sagging, which equate to minimum radii of curvature of 25 kilometres and greater than 8 kilometres, respectively.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the Optus infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The Optus infrastructure is located above Longwalls 301 to 303. A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 1. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

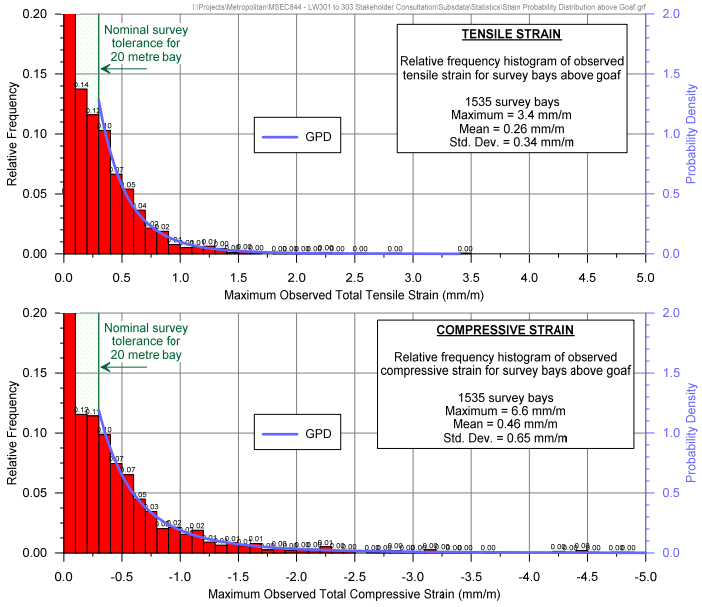

Figure 1 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based on the fitted GPDs, is provided in Table 5.

Table 5 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures and the streams are shown in Drawing No. MSEC844-05.

There are no mapped faults located within the extents of Longwalls 301 to 303. It is possible that the infrastructure located above the longwalls could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The optical fibre cables do not cross any major streams within the Study Area. The cables, therefore, are not expected to experience any measurable valley closure effects.

Impact Assessments for the Optical Fibre Cables

The optical fibre cables within the Study Area are direct buried and, therefore, will not be impacted by the tilts resulting from the extraction of Longwalls 301 to 303. The cables, however, are likely to experience the curvatures and ground strains resulting from the extraction of these longwalls.

The tensile strains in the optical fibre cable can be higher, however, where the cable connects to the support structures, which may act as anchor points, preventing any differential movements that may have been allowed to occur within the ground. Tree roots have also been known to anchor cables to the ground. The extent to which the anchor points affect the ability of the cable to tolerate the mine subsidence movements depends on the cable size, type, age, installation method and ground conditions.

In addition to this, optical fibre cables contain additional fibre lengths over the sheath lengths, where the individual fibres are loosely contained within tubes. Compression of the sheaths can transfer to the loose tubes and fibres and result in 'micro-bending' of the fibres constrained within the tubes, leading to higher attenuation of the transmitted signal. If the maximum predicted compressive strains were to be fully transferred into the optical fibre cable, they could be of sufficient magnitude to result in the reduction in capacity of the cable or transmission loss.

Localised and elevated curvatures could develop along the optical fibre cable due to non-conventional movements resulting from near surface geological structures (i.e. anomalies). It is possible that these non-conventional movements could be sufficient to result in the attenuation of signal.

The predicted curvatures and strains for the optical fibre cable are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar cables. It has been found from this previous experience that the potential impacts on optical fibre cables in the Southern Coalfield can be managed with the implementation of suitable monitoring and management strategies.

Some examples of mining beneath optical fibre cables in the Southern Coalfield are provided in Table 6.

Table 6 Examples of Mining Beneath Optical Fibre Cables in the Southern Coalfield

Colliery and Longwalls	Length of Optical Fibre Cables Directly Mined Beneath (km)	Observed Maximum Movements at Optical Fibre Cables	Pre-Mining Mitigation, Monitoring and Observed Impacts
Appin LW301 and LW302	0.8	650 mm Subsidence 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	600 metre aerial cable on standby. Ground survey, visual, OTDR. No reported impacts.
Appin LW703 to LW706	12.7 total for eight cables	1,200 mm Subsidence 2.1 mm/m Tensile Strain 4.5 mm/m Comp. Strain (Measured HW2, ARTC and MPR Lines)	New cable redirection to avoid potential impacts to old optical fibre cable. Ground survey, visual, OTDR. Strain concentrations detected in three cables, attenuation losses were relieved by locally exposing the cables or by building a bypass cable.
Tahmoor LW22 to LW29	1.9	775 mm Subsidence 0.8 mm/m Tensile Strain 3.9 mm/m Comp. Strain	Ground survey, visual, OTDR, SBS. No reported impacts.
Tower LW1 to LW10	1.7	400 mm Subsidence 3 mm/m Tilt 0.5 mm/m Tensile Strain 1 mm/m Comp. Strain	No reported impacts
West Cliff LW5A3, LW5A4 and LW29 to LW38	3.4	1,300 mm Subsidence 1.3 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	Survey, visual, OTDR, SBS. No reported impacts.

The strains transferred into the Optus optical fibre cables can be monitored using Optical Time Domain Reflectometry (OTDR). The ground movements can also be monitored using traditional survey lines and visual inspections. These monitoring methods can be used to identify the development of irregular ground movements. If non-conventional movements or signal attenuation are detected during active subsidence, then the cable can be relieved by locally exposing and then reburying the affected section of cable.

It is recommended that monitoring and management strategies are developed, in consultation with Optus, to manage the optical fibre cables for potential irregular ground movements. It is expected that this cables can be maintained in serviceable condition with the implementation of the appropriate monitoring and management strategies.

Summary

The Optus optical fibre cables are located above Longwalls 301 to 303. The previous experience from the Southern Coalfield has found that the potential impacts on optical fibre cables can be managed with the implementation of suitable monitoring and management strategies. These strategies could include Optical Time Domain Reflectometry (OTDR), traditional ground monitoring lines and visual inspections.

It is expected that the potential impacts on the Optus infrastructure can be managed with the implementation of the appropriate monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:

Drawing No. MSEC844-05 – Longwalls 301 to 303 – Optus Infrastructure

Fig. A.1 Predicted Profiles of Conventional Subsidence, Tilt and Curvature for the Optus Optical Fibre Cable 1 due to LW301 to LW303

Fig. A.2 Predicted Profiles of Conventional Subsidence, Tilt and Curvature for the Optus Optical Fibre Cable 2 due to LW301 to LW303

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
OPTUS INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
27 Oct 2016	1:12500	MSEC844-05	E

6 218 000
312 000
314 000
6 216 000

Grid to MGA co-ordinates

CAWLEY ROAD OVERPASS
CAWLEYS CK
M1 PRINCES MOTORWAY
OPTUS
METROPOLITAN FAULT
STUDY AREA
TELSTRA
PREDICTED 20mm SUBSIDENCE CONTOUR
20
WORONORA RESERVOIR
OLD PRINCES HWY
LW303
LW302
LW301
NEXTGEN
TELSTRA
OPTUS
WILSONS CK
PRINCES HIGHWAY UNDERPASS 2
20
FAULT
MAIN WEST FAULT
POWELL FAULT

GEOLOGICAL STRUCTURES
FAULTS
DYKES

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Optus Optical Fibre Cable 1 due to LW301 to LW303

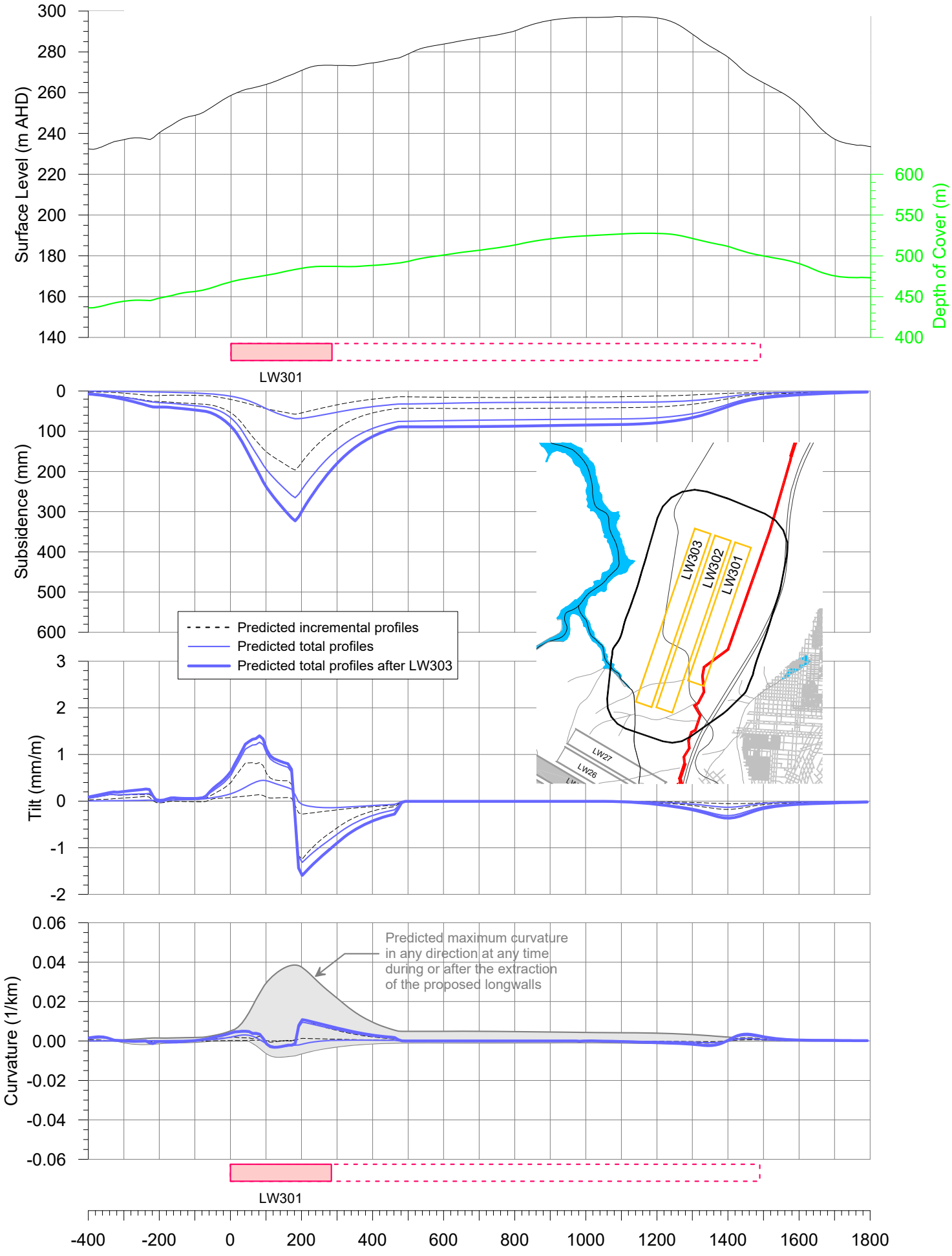

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Fig. A.1

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Optus Optical Fibre Cable 2 due to LW301 to LW303

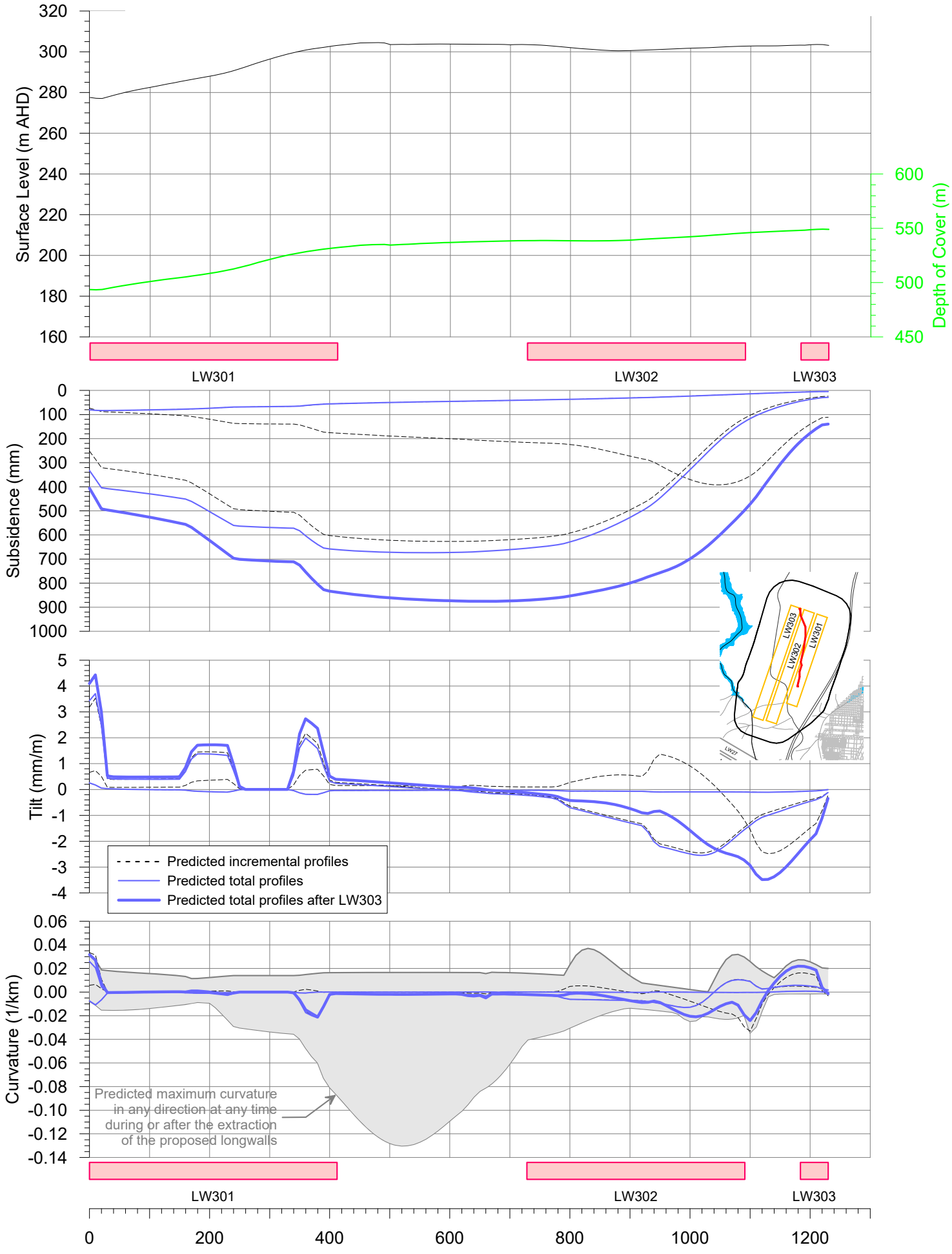

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Fig. A.2

APPENDIX 2

MSEC (2019) METROPOLITAN COLLIERY – PROPOSED LONGWALL 304 – SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTTS FOR THE OPTUS INFRASTRUCTURE

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

13th March 2019

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC1013-05

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Optus Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Optus infrastructure resulting from the extraction of the proposed Longwall 304 at Metropolitan Colliery.

The locations of the Optus infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC1013-05. A Study Area is shown in Drawing No. MSEC1013-05 and is based on the outer limits of a 35° angle of draw line from Longwall 304 and the predicted 20mm subsidence contour for Longwall 304.

The Optus infrastructure includes two optical fibre cables that are located within and adjacent to the Study Area but not directly above the proposed Longwall 304. A main optical fibre cable (*Optical Fibre Cable 1*) is located outside the eastern boundary of the Study Area and extends to the north and south in a similar orientation to Longwall 304. A second optical fibre cable is located to the east of the proposed Longwall 304, above Longwalls 301 and 302 (*Optical Fibre Cable 2*).

The predictions and impact assessments for the Optus infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the Optus Infrastructure

The following provides summaries of the maximum predicted conventional movements for the Optus infrastructure following the extraction of Longwall 303 and after the extraction of Longwall 304. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

Optical fibre Cable 1 is located outside the Study Area and is approximately 560 m to the east of Longwall 304 at its nearest point. At this distance, Cable 1 is not expected to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwall 304. The cable could experience low level far-field horizontal movement. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield, which tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain. It is unlikely that Cable 1 would experience adverse impacts as a result of Longwall 304.

The predicted profiles of total conventional subsidence, tilt and curvature along the alignment of Optical Fibre Cable 2, following the extraction of Longwall 303 and after the extraction of Longwall 304, are shown in the attached Fig. A.1. The solid blue lines represent the total or accumulated movements after the completion of each longwall.

The range of predicted curvatures in any direction at any time during or after the extraction of the longwalls is shown by the grey shading.

A summary of the maximum predicted values of total subsidence, tilt and curvature for Optical Fibre Cable 2, following the extraction of Longwall 303 and after the extraction of Longwall 304, are provided in Table 1. The values are the maxima anywhere along the cable at any time during or after the extraction of the longwalls.

Table 1 Maximum Predicted Total Subsidence, Tilt and Curvature for the Optus Optical Fibre Cable 2 after the Extraction of Longwalls 303 and 304

Longwall	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})
After LW303	925	4.5	0.03	0.13
After LW304	1000	4.5	0.04	0.13

The maximum predicted total subsidence for the optical fibre cable, following the extraction of Longwall 303 and after the extraction of Longwall 304, is 1000 mm. The maximum predicted conventional tilt for this cable is 4.5 mm/m (i.e. 0.45 %, or 1 in 225). The maximum predicted total conventional curvatures are 0.13 km^{-1} hogging and sagging, which equate to minimum radii of curvature of 8 kilometres.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the Optus infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The Optus infrastructure is located above existing Longwalls 301 and 302 but not directly above the proposed Longwall 304. A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 1. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

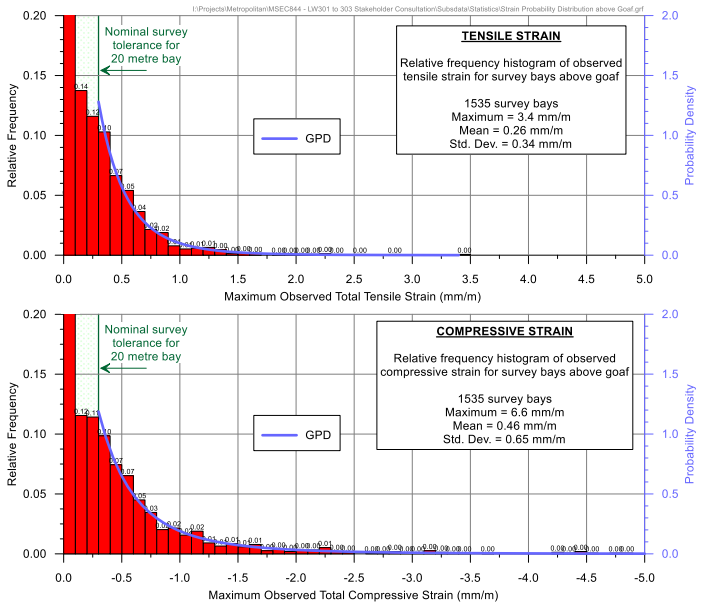


Figure 1 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based on the fitted GPDs, is provided in Table 2.

Table 2 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures at seam level and the major streams are shown in Drawing No. MSEC1013-05. There are no mapped faults located within the Study Area that extend beneath the Optus infrastructure. It is possible that the infrastructure located above the longwalls could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). Non-conventional or anomalous movements have not been identified during the extraction of Longwalls 301 and 302. The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The optical fibre cables do not cross any major streams within the Study Area. The cables, therefore, are not expected to experience any measurable valley closure effects.

Impact Assessments for the Optical Fibre Cables

The optical fibre cables are buried in conduits of various sizes. The cables will not be impacted by the tilts resulting from the extraction of proposed Longwall 304. The cables, however, are likely to experience the curvatures and ground strains resulting from the extraction of these longwalls. The effect of having cables buried in conduit reduces the risk of ground strain transfer to the cables and hence reduces the risk of impact resulting from the extraction of Longwall 304.

The tensile strains in the optical fibre cable can be higher where the cable connects to the support structures, which may act as anchor points, preventing any differential movements that may have been allowed to occur within the ground. Tree roots have also been known to anchor cables to the ground. The extent to which the anchor points affect the ability of the cable to tolerate the mine subsidence movements depends on the cable size, type, age, installation method and ground conditions.

In addition to this, optical fibre cables contain additional fibre lengths over the sheath lengths, where the individual fibres are loosely contained within tubes. Compression of the sheaths can transfer to the loose tubes and fibres and result in 'micro-bending' of the fibres constrained within the tubes, leading to higher attenuation of the transmitted signal. If the maximum predicted compressive strains were to be fully transferred into the optical fibre cable, they could be of sufficient magnitude to result in the reduction in capacity of the cable or transmission loss.

Localised and elevated curvatures could develop along the optical fibre cable due to non-conventional movements resulting from near surface geological structures (i.e. anomalies). It is possible that these non-conventional movements could be sufficient to result in the attenuation of signal.

The predicted curvatures and strains for the optical fibre cable are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar cables. It has been found from this previous experience that the potential impacts on optical fibre cables in the Southern Coalfield can be managed with the implementation of suitable monitoring and management strategies.

Some examples of mining beneath optical fibre cables in the Southern Coalfield are provided in Table 3.

Table 3 Examples of Mining Beneath Optical Fibre Cables in the Southern Coalfield

Colliery and Longwalls	Length of Optical Fibre Cables Directly Mined Beneath (km)	Observed Maximum Movements at Optical Fibre Cables	Pre-Mining Mitigation, Monitoring and Observed Impacts
Appin LW301 and LW302	0.8	650 mm Subsidence 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	600 metre aerial cable on standby. Ground survey, visual, OTDR. No reported impacts.
Appin LW703 to LW706	12.7 total for eight cables	1,200 mm Subsidence 2.1 mm/m Tensile Strain 4.5 mm/m Comp. Strain (Measured HW2, ARTC and MPR Lines)	New cable redirection to avoid potential impacts to old optical fibre cable. Ground survey, visual, OTDR. Strain concentrations detected in three cables, attenuation losses were relieved by locally exposing the cables or by building a bypass cable.
Tahmoor LW22 to LW29	1.9	775 mm Subsidence 0.8 mm/m Tensile Strain 3.9 mm/m Comp. Strain	Ground survey, visual, OTDR, SBS. No reported impacts.
Tower LW1 to LW10	1.7	400 mm Subsidence 3 mm/m Tilt 0.5 mm/m Tensile Strain 1 mm/m Comp. Strain	No reported impacts
West Cliff LW5A3, LW5A4 and LW29 to LW38	3.4	1,300 mm Subsidence 1.3 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	Survey, visual, OTDR, SBS. No reported impacts.

The strains transferred into the Optus optical fibre cables can be monitored using Optical Time Domain Reflectometry (OTDR). The ground movements can also be monitored using traditional survey lines and visual inspections. These monitoring methods can be used to identify the development of irregular ground movements. If non-conventional movements or signal attenuation are detected during active subsidence, then the cable can be relieved by locally exposing and then reburying the affected section of cable.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301 to 303 are updated and continued, in consultation with Optus, to manage the optical fibre cables for potential irregular ground movements. It is expected that these cables can be maintained in serviceable condition with the implementation of the appropriate monitoring and management strategies.

Summary

The Optus optical fibre cables are located to the south and east of the Study Area (Cable 1) and above Longwalls 301 and 302 within the Study Area (Cable 2) but not directly above the proposed Longwall 304. The previous experience from the Southern Coalfield has found that the potential impacts on optical fibre cables can be managed with the implementation of suitable monitoring and management strategies. These strategies could include Optical Time Domain Reflectometry (OTDR), traditional ground monitoring lines and visual inspections.

It is expected that the potential impacts on the Optus infrastructure can be managed with the implementation of the appropriate monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:

Drawing No. MSEC1013-05 – Longwall 304 – Optus Infrastructure

Fig. A.1 Predicted Profiles of Conventional Subsidence, Tilt and Curvature for the Optus Optical Fibre Cable 2 after LW303 and after LW304

I:\Projects\Metropolitan\MSEC1013 - LW304 Stakeholders Consultation\AcadData\MSEC1013-05 Optus.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COLLIERY
LONGWALL 304
OPTUS INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	1:10000	MSEC1013-05	02

6 218 000

312 000

Grid to MGA co-ordinates

CAWLEYS CK

WORONORA RESERVOIR

TELSTRA

STUDY AREA

PREDICTED 20mm SUBSIDENCE CONTOUR

LW304

OLD PRINCES HWY

LW303

LW302

LW301

VOCUS

TELSTRA

6 216 000

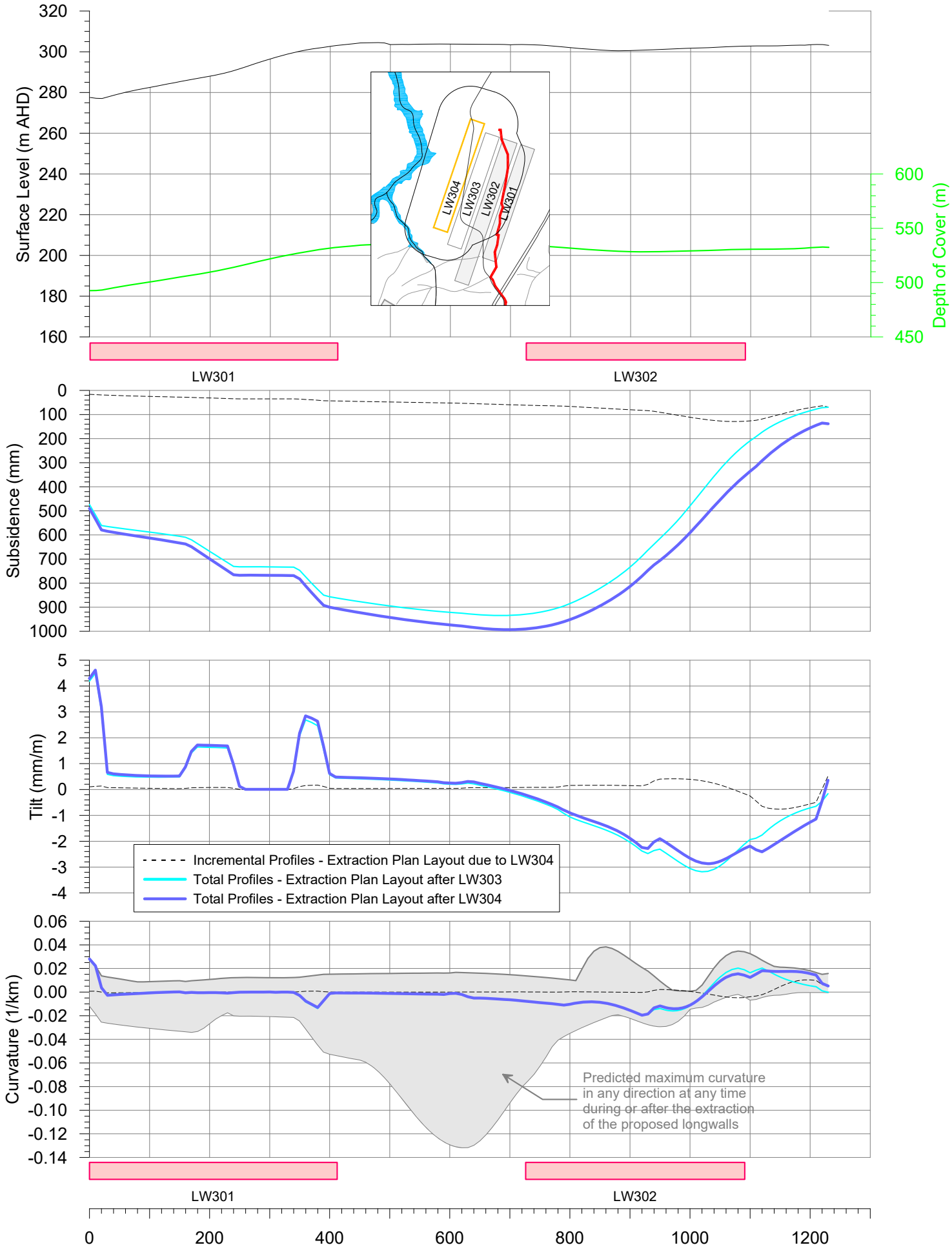
OPTUS

PRINCES MOTORWAY

WILSONS CK

GEOLOGICAL STRUCTURES
FAULTS
DYKES

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along the Optus Optical Fibre Cable due to LW304



msec

Fig. A.01

APPENDIX 3

BUILT FEATURES MANAGEMENT PLAN – SUBSIDENCE IMPACT REGISTER

Built Features Management Plan - Subsidence Impact Register

Impact Register Number[1]	Built Feature[2]	Impact Description	Does Impact Exceed the Built Feature Performance Measure/Indicators? (Yes/No)	Management Measures Implemented	Were Management Measures Effective? (Yes/No)

Notes:

1: Fill out all details in the Assessment Form and record the register number here.

2: Built feature (e.g. cable line, etc.).

3: Impacts to access roads/tracks to be included in the Land Management Plan – Subsidence Impact Register.

Built Feature Management Plan – Subsidence Impact Register
Assessment Form

Date:	
Observer (Name and position):	
Register Number (i.e. Number 1, 2, etc.):	
Longwall Number and Chainage:	

Location of Observed Impact:

(Examples: location of cable line, include GPS co-ordinates and a sketch)

Description of Observed Impact:

(Examples: nature and extent of impact - cracks in road etc any relevant information, attach photographs)

Person Notified:	Manager - Technical Services	☐

Description of Photographs:

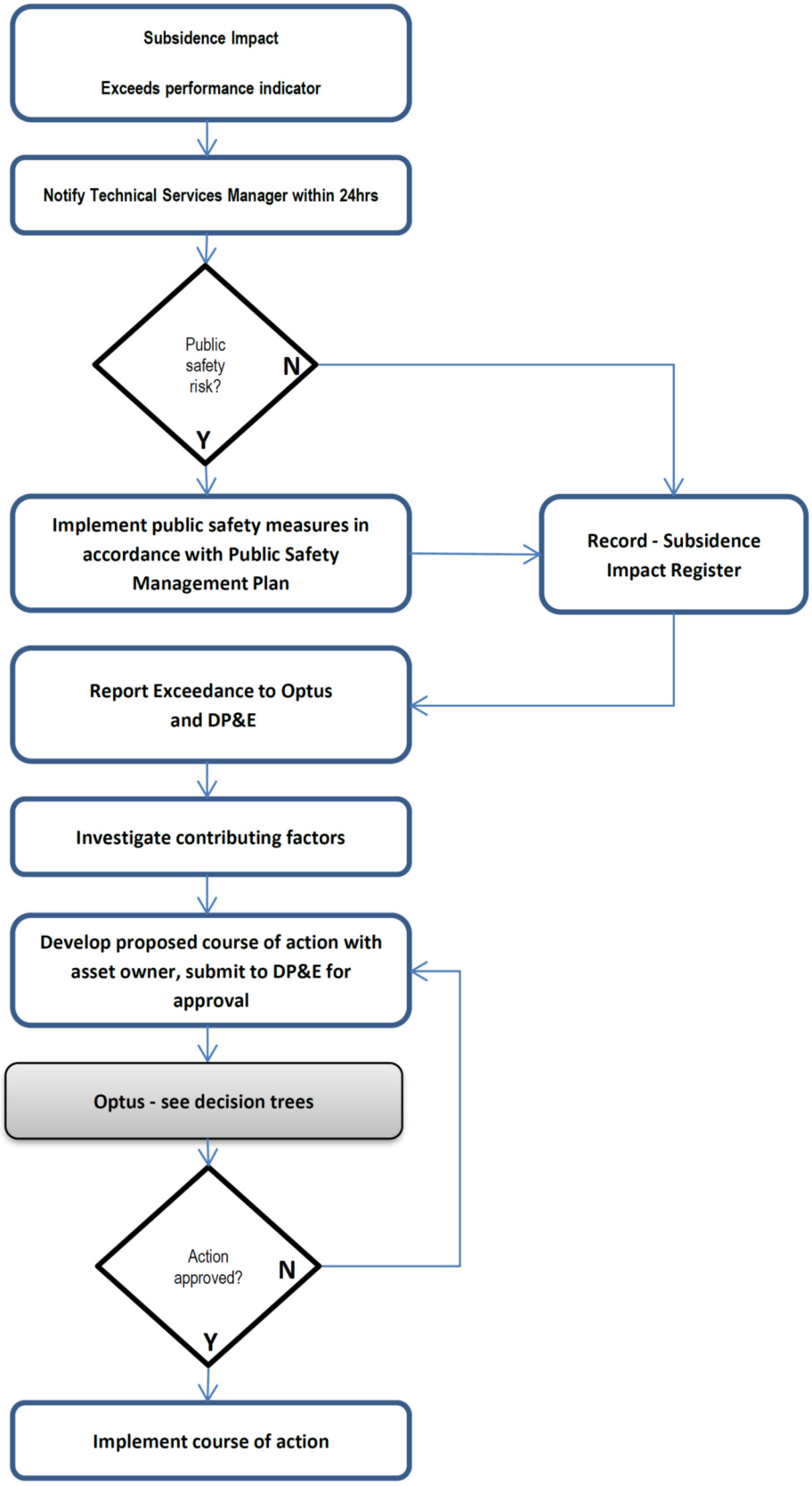
Actions Required:	Contingency Plan Initiated	☐
	Incident Notification	☐
	Safety Measures/Public Safety Management Plan Requirements	☐

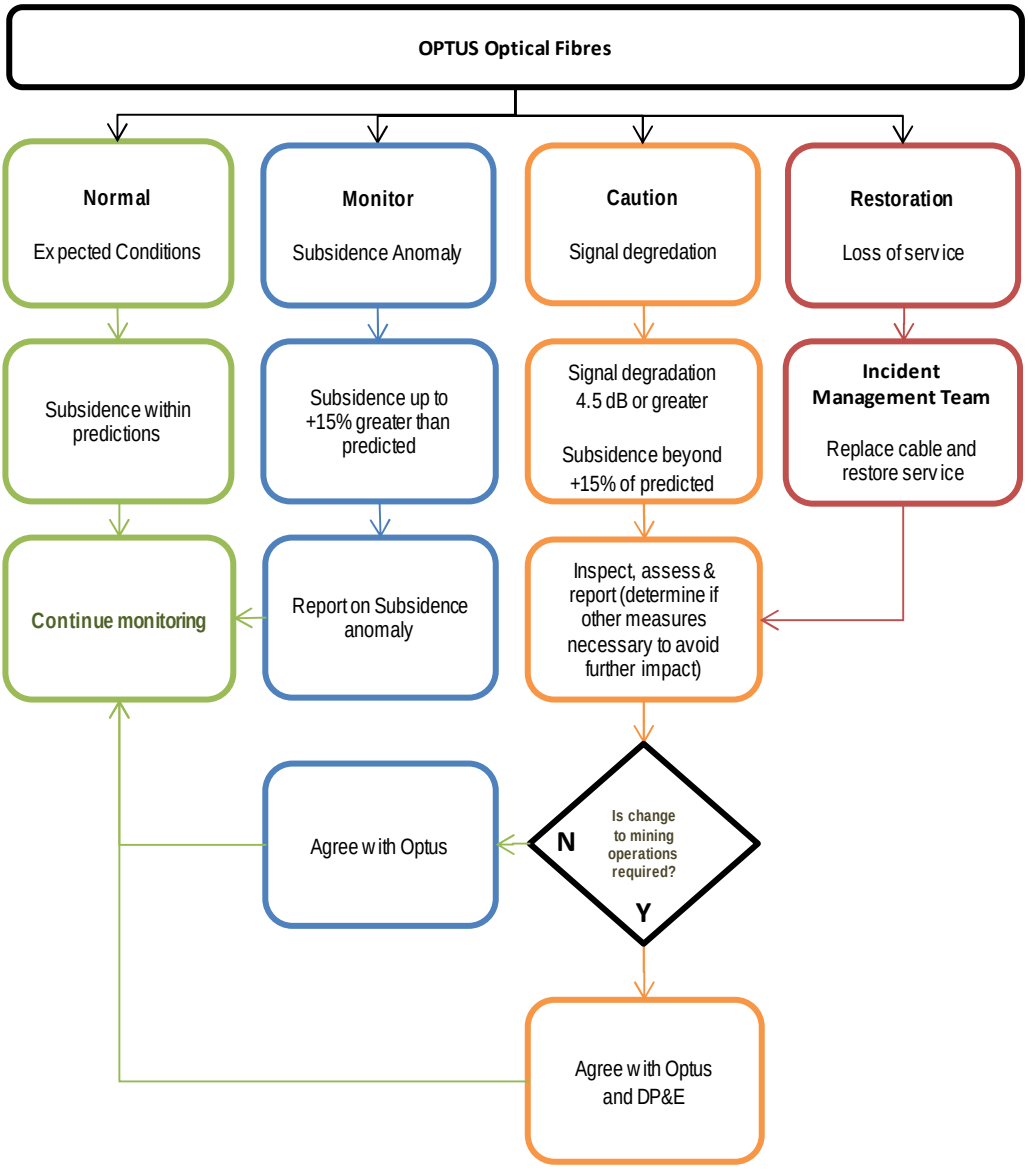
Management or Contingency Measures Implemented:

Effectiveness of Management or Contingency Measures:

APPENDIX 4

CONTINGENCY PLAN PROCEDURE AND DECISION TREES


Subsidence Impact
Exceeds performance indicator
Notify Technical Services Manager within 24hrs
Public safety risk?
N
Y
Implement public safety measures in accordance with Public Safety Management Plan
Record - Subsidence Impact Register
Report Exceedance to Optus and DP&E
Investigate contributing factors
Develop proposed course of action with asset owner, submit to DP&E for approval
Optus - see decision trees
Action approved?
N
Y
Implement course of action


OPTUS Optical Fibres
Normal
Expected Conditions
Monitor
Subsidence Anomaly
Caution
Signal degredation
Restoration
Loss of service
Subsidence within predictions
Subsidence up to +15% greater than predicted
Signal degradation 4.5 dB or greater
Subsidence beyond +15% of predicted
Incident Management Team
Replace cable and restore service
Continue monitoring
Report on Subsidence anomaly
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Agree with Optus
N
Is change to mining operations required?
Y
Agree with Optus and DP&E

Peabody

METROPOLITAN COAL

METROPOLITAN COAL

BUILT FEATURES MANAGEMENT PLAN
TELSTRA

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&E Approval Date
All	LW301-303 BFMP_TELSTRA-R01-A	Original – Draft for Consultation	Telstra, DRG and DP&E	-
Section 4.1.1, Figure 4, Tables 3, 5 & 6 and Appendix 3	LW301-303 BFMP_TELSTRA-R01-B	Revised – Incorporating Telstra Agreement and updates	Telstra, DRG and DP&E	11 May 2017*
Section 7.2.2, Tables 2, 5, 7, 8, 9 & 10 and Appendix 4	LW301-303 BFMP_TELSTRA-R01-C	Revised – Addressing DP&E and DRG requirements	Telstra, DRG and DP&E	-
All	LW301-303 BFMP_TELSTRA-R01-D	Revised TARP. Revised for LW303. Contact list added	Telstra and DRG	8 November 2018#
All	BFMP_TELSTRA-R01-E	Inclusion of Longwall 304 into BFMP	Telstra, DRG and DP&E	-

* The approval allows for the extraction of Longwalls 301 and 302 only.
# Approval for the extraction of Longwall 303.

April 2019

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Appendix 2 MSEC (2019) Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Telstra Infrastructure

Appendix 3 Built Features Management Plan – Subsidence Impact Register

Appendix 4 Telstra Management Plan Agreement (2016)

Appendix 5 Contingency Plan Procedure and Decision Trees

1 INTRODUCTION

Metropolitan Coal is a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under section 75J of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com).

The Project comprises the continuation, upgrade and extension of underground coal mining operations (Longwalls 20-27 and Longwalls 301-317) and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1. Following the completion of Longwall 27 in 2017, Longwalls 301, 302, 303 and 304 define the next mining sub-domains within the Project underground mining area (Figures 1 to 3).

1.1 PURPOSE AND SCOPE

In accordance with Condition 6(f), Schedule 3 of the Project Approval, this Built Features Management Plan – Telstra (BFMP-TELSTRA) has been developed to manage the potential consequences of longwall extraction on the Telstra assets.

The relationship of this BFMP-TELSTRA to the Metropolitan Coal Environmental Management Structure is shown on Figure 4.

In accordance with Condition 6 of Schedule 3, the suitably qualified and experienced experts that have prepared this BFMP-TELSTRA, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and Metropolitan Coal were endorsed by the Director-General (now Secretary) of the Department of Planning and Environment (DP&E) on 6 June 2016. This BFMP-TELSTRA has been prepared in consultation with Telstra including consideration of prior consultation during the development of the previously approved Built Features Management Plans.

1.2 STRUCTURE OF THE BFMP-TELSTRA

The remainder of the BFMP-TELSTRA is structured as follows:

Section 2: Describes the review and update of the BFMP-TELSTRA.

Section 3: Outlines the statutory requirements applicable to the BFMP-TELSTRA.

Section 4: Provides a revised assessment of the potential subsidence impacts and environmental consequences for Longwalls 301-304, including the results of a risk assessment.

Section 5: Details the performance measures and indicators that will be used to assess the Project.

Section 6: Provides the detailed baseline data.

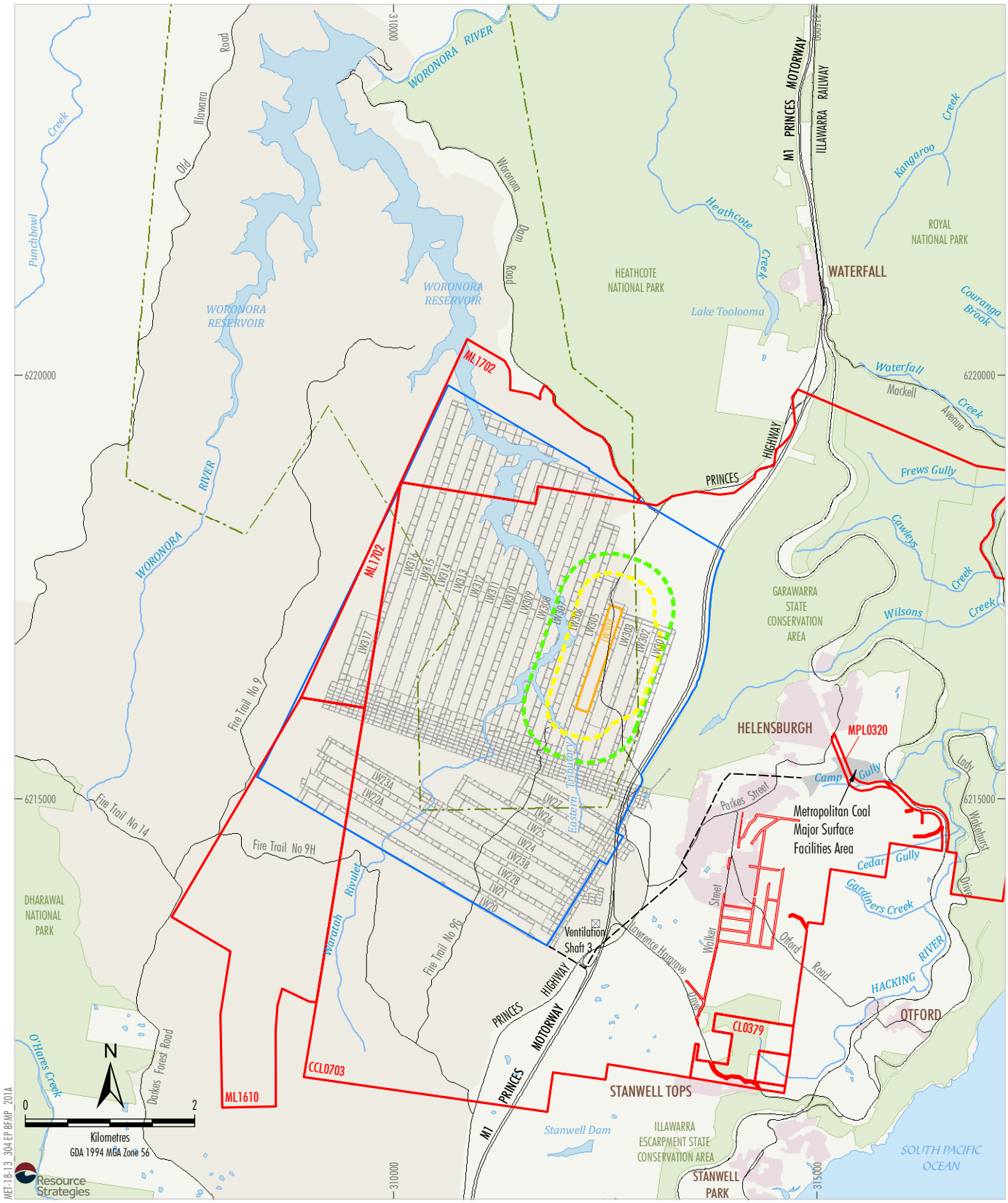
Section 7: Describes the monitoring program.

Section 8: Describes the management measures that will be implemented.

Section 9: Provides a contingency plan to manage any unpredicted impacts and their consequences.

Section 10: Describes the Trigger Action Response Plan (TARP) management tool.

Section 11: Describes the program to collect sufficient baseline data for future Extraction Plans.



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

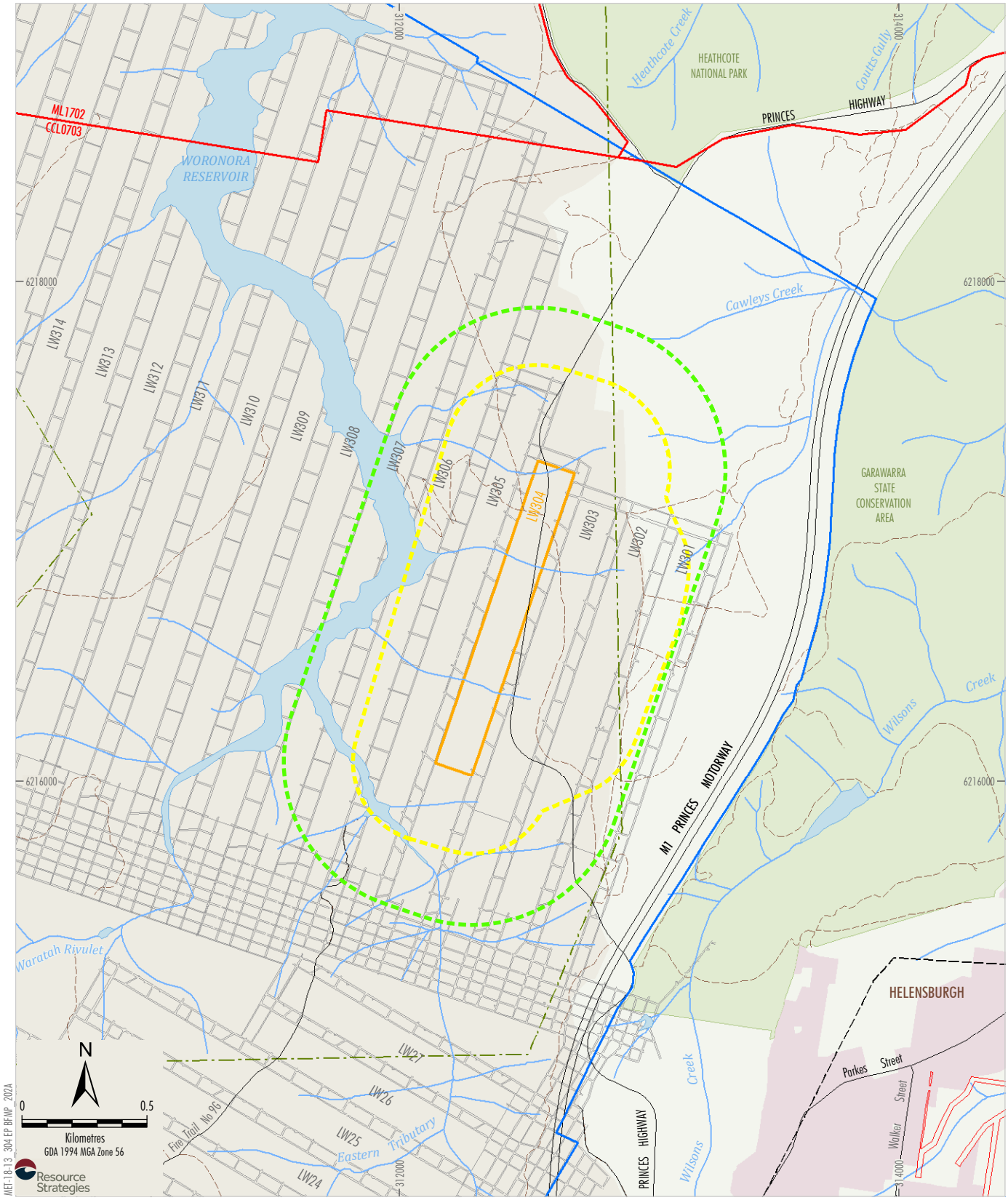
Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

Peabody

METROPOLITAN COAL

Longwalls 20-27 and Longwalls 301-317 Layout

Figure 1



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)
- Vehicular Track

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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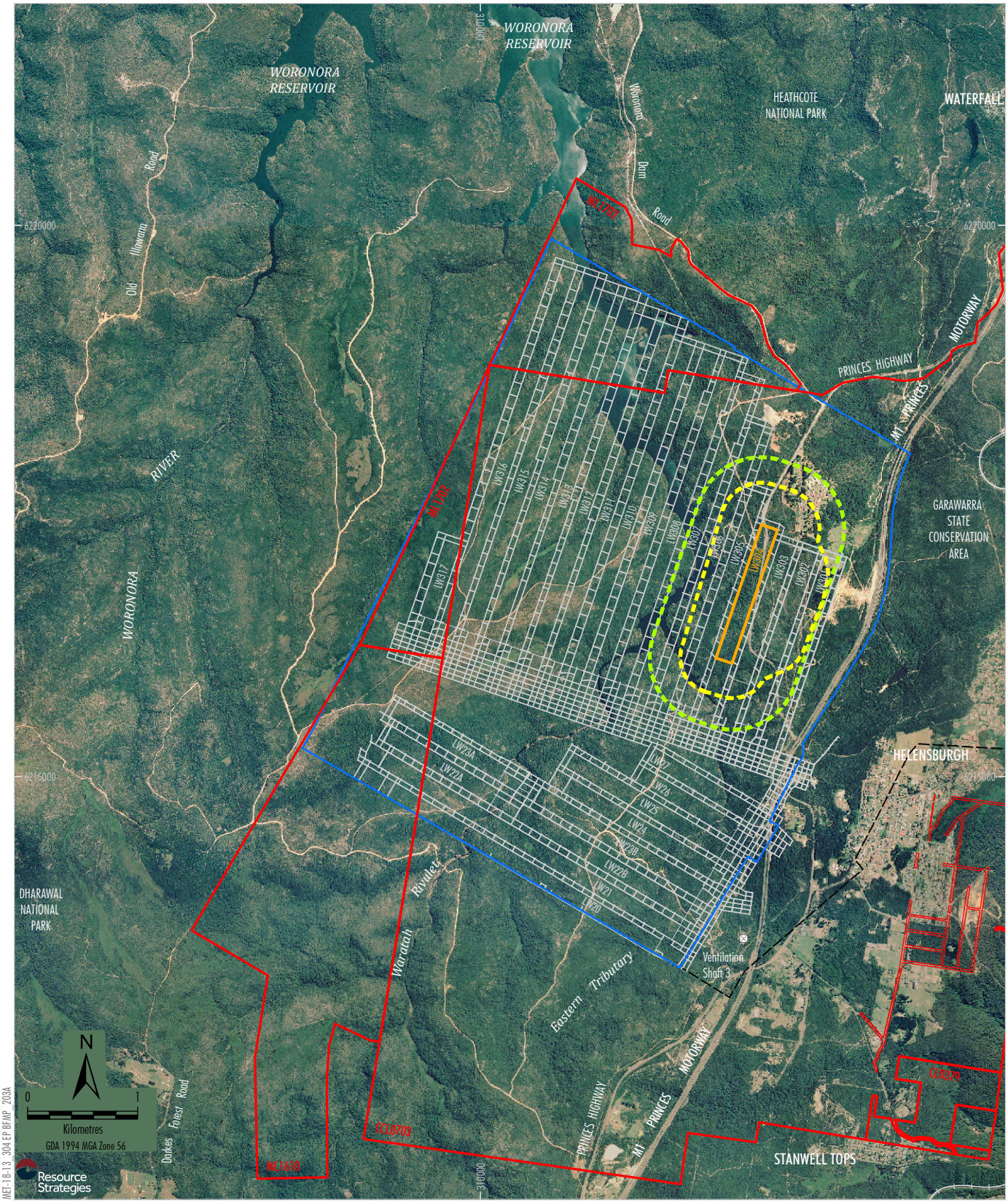
Longwalls 301-304 Layout

Figure 2



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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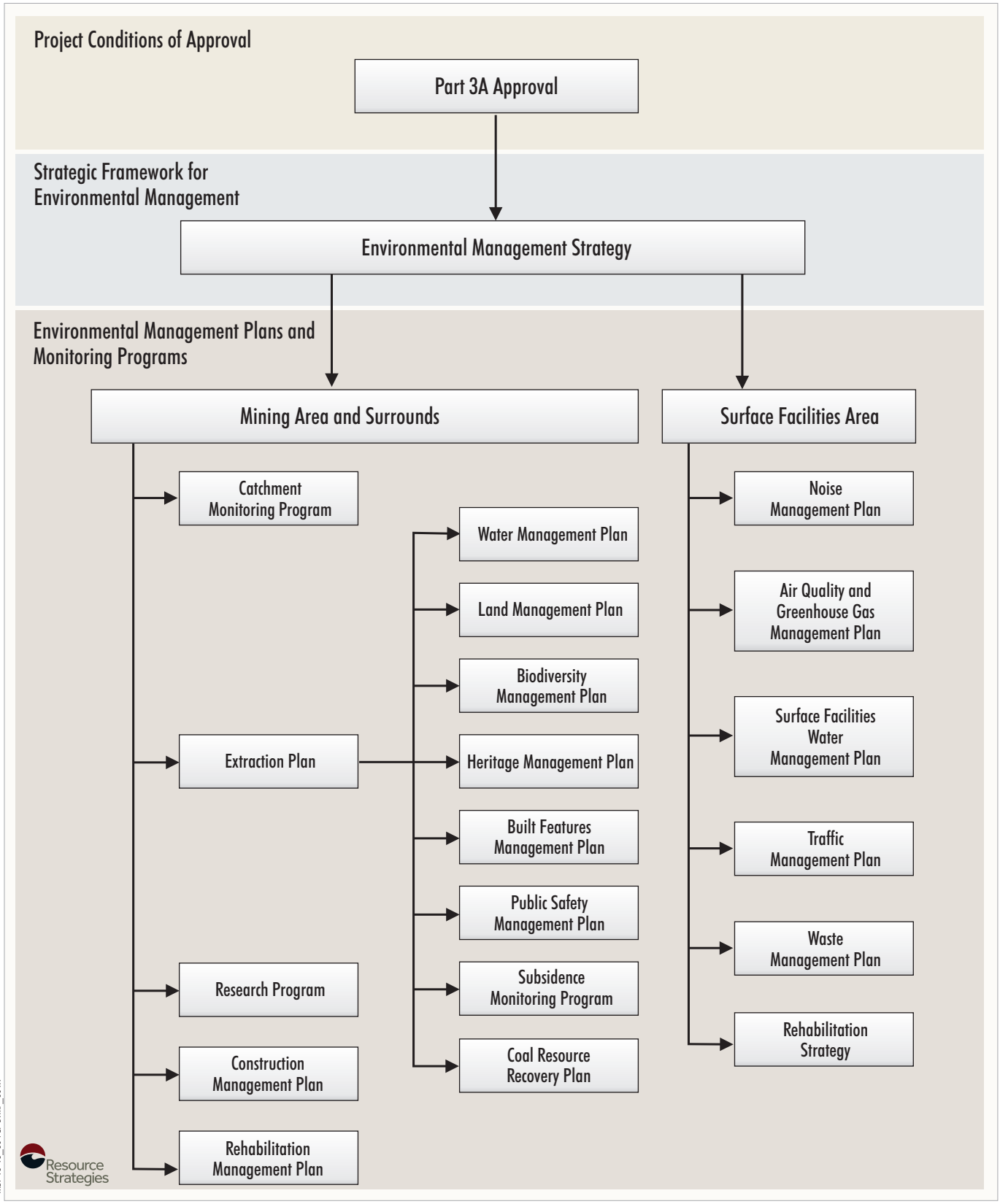
METROPOLITAN COAL

Longwalls 20-27 and Longwalls 301-317 Layout - Aerial Photograph

Figure 3



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Environmental Management Structure

Figure 4

Section 12: Describes the annual review and improvement of environmental performance.

Section 13: Outlines the management and reporting of incidents.

Section 14: Outlines the management and reporting of complaints.

Section 15: Outlines the management and reporting of non-compliances with statutory requirements.

Section 16: Lists the references cited in this BFMP-TELSTRA.

2 BFMP-TELSTRA REVIEW AND UPDATE

In accordance with Condition 4, Schedule 7 of the Project Approval, this BFMP-TELSTRA will be reviewed within three months of the submission of:

- an audit under Condition 8 of Schedule 7;
- an incident report under Condition 6 of Schedule 7;
- an annual review under Condition 3 of Schedule 7; and

if necessary, revised to the satisfaction of the Director-General (now Secretary) of DP&E, to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

This BFMP-TELSTRA will also be reviewed within three months of approval of any Project modification and if necessary, revised to the satisfaction of the DP&E.

The revision status of this plan is indicated on the title page of each copy of the BFMP-TELSTRA. The distribution register for controlled copies of the BFMP-TELSTRA is described in Section 2.1.

Revisions to any documents listed within this BFMP-TELSTRA will not necessarily constitute a revision of this document.

2.1 DISTRIBUTION REGISTER

In accordance with Condition 10, Schedule 7 'Access to Information', Metropolitan Coal will make the BFMP-TELSTRA publicly available on the Peabody website. A hard copy of the BFMP-TELSTRA will also be maintained at the Metropolitan Coal site.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format. An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom the Metropolitan Coal plans and programs, such as the BFMP-TELSTRA, will be distributed;
- the format (i.e. electronic or hard copy) of distribution; and
- the format of revision notification.

Metropolitan Coal will make the Distribution Register publicly available on the Peabody website.

Metropolitan Coal will be responsible for maintaining the Distribution Register and for ensuring that the notification of revisions is sent by email or post as appropriate.

In addition, Metropolitan Coal employees with local computer network access will be able to view the controlled electronic version of this BFMP-TELSTRA on the Metropolitan Coal local area network. Metropolitan Coal will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on the Metropolitan Coal computer system and Peabody website.

3 STATUTORY REQUIREMENTS

Metropolitan Coal's statutory obligations are contained in:

(i) the conditions of the Project Approval;

(ii) relevant licences and permits, including conditions attached to mining leases; and

(iii) other relevant legislation.

These are described below.

3.1 EP&A ACT APPROVAL

Condition 6(f) of Schedule 3 of the Project Approval requires the preparation of a BFMP as a component of Extraction Plan(s) for second workings. Project Approval Condition 6(f), Schedule 3 states:

> ***SECOND WORKINGS***
>
> ***Extraction Plan***
>
> *6. The Proponent shall prepare and implement an Extraction Plan for all second workings in the mining area to the satisfaction of the Director-General. This plan must:*
>
> *…*
>
> *(f) include a:*
>
> *…*
>
> - *Built Features Management Plan, which has been prepared in consultation with the owner of the relevant feature, to manage the potential environmental consequences of the Extraction Plan on any built features;*

In addition, Condition 2, Schedule 7 and Condition 7, Schedule 3 of the Project Approval outline management plan requirements that are applicable to the preparation of the BFMP-TELSTRA. Table 1 indicates where each component of the conditions is addressed within this BFMP-TELSTRA.

Table 1
Management Plan Requirements

Project Approval Condition	BFMP-TELSTRA Section
Condition 2 of Schedule 7	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Section 6
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 3
• any relevant limits or performance measures/criteria;	Section 5
• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 5
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Sections 7, 8, 9 and 10
d) a program to monitor and report on the:	Sections 7, 8 and 12
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 9 and Appendix 5
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Sections 7 and 12
g) a protocol for managing and reporting any;	
• incidents;	Section 13
• complaints;	Section 14
• non-compliances with statutory requirements; and	Section 15
• exceedances of the impact assessment criteria and/or performance criteria; and	Section 9 and Appendix 5
h) a protocol for periodic review of the plan.	Section 2
Condition 7 of Schedule 3	
7. In addition to the standard requirements for management plans (see condition 2 of schedule 7), the Proponent shall ensure that the management plans required under condition 6(f) above include:	
a) a program to collect sufficient baseline data for future Extraction Plans;	Section 11
b) a revised assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval;	Section 4
c) a detailed description of the measures that would be implemented to remediate predicted impacts; and	Section 8
d) a contingency plan that expressly provides for adaptive management.	Section 9 and Appendix 5

3.2 LICENCES, PERMITS AND LEASES

In addition to the Project Approval, all activities at or in association with Metropolitan Coal will be undertaken in accordance with the following licences, permits and leases which have been issued or are pending issue:

- The conditions of mining leases issued by the NSW Division of Resources and Geoscience (DRG), under the NSW Mining Act, 1992 (e.g. Consolidated Coal Lease [CCL] 703, Mining Lease [ML] 1610, ML 1702, Coal Lease [CL] 379 and Mining Purpose Lease [MPL] 320).
- The *Metropolitan Coal Mining Operations Plan 1 October 2012 to 30 September 2019* approved by the DRG.
- The conditions of Environment Protection Licence (EPL) No. 767 issued by the NSW Environment Protection Authority (EPA) under the NSW Protection of the Environment Operations Act, 1997. Revision of the EPL will be required prior to the commencement of Metropolitan Coal activities that differ from those currently licensed.
- The prescribed conditions of specific surface access leases within CCL 703 for the installation of surface facilities as required.
- Water Access Licences (WALs) issued by the NSW Department of Primary Industries – Water (now the Department of Industry –Water) under the NSW *Water Management Act, 2000*, including WAL 36475 under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* and WAL 25410 under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*.
- Mining and workplace health and safety related approvals granted by the NSW Resources Regulator and WorkCover NSW.
- Supplementary approvals obtained from WaterNSW for surface activities within the Woronora Special Area (e.g. fire road maintenance activities).

3.3 OTHER LEGISLATION

Metropolitan Coal will conduct the Project consistent with the Project Approval and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to the conduct of the Project (Helensburgh Coal Pty Ltd [HCPL], 2008)[1]:

- *Biodiversity Conservation Act, 2016;*
- *Biosecurity Act, 2015;*
- *Contaminated Land Management Act, 1997;*
- *Crown Land Management Act, 2016;*
- *Dams Safety Act, 2015;*
- *Dangerous Goods (Road and Rail Transport) Act, 2008;*
- *Energy and Utilities Administration Act, 1987;*
- *Fisheries Management Act, 1994;*

[1] The list of potentially applicable Acts has been updated to reflect changes to the Acts that were in force at the time of submission of the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008).

- *Mining Act, 1992;*
- *Protection of the Environment Operations Act, 1997;*
- *Rail Safety (Adoption of National Law) Act, 2012;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Water NSW Act, 2014;*
- *Work Health and Safety Act, 2011; and*
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

Relevant licences or approvals required under these Acts will be obtained as required.

4 REVISED ASSESSMENT OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

4.1 EXTRACTION LAYOUT

Longwalls 301-304 and the area of land within 600 metres (m) of Longwall 304 secondary extraction are shown on Figures 2 and 3. Longwall extraction occurs from north to south. The longwall layouts includes 163 m panel widths (void) with 45 m pillars (solid).

The provisional extraction schedule for Longwalls 301-304 is provided in Table 2.

Table 2
Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
301	June 2017	6 months	February 2018
302	March 2018	7 months	October 2018
303	November 2018	7 months	May 2019
304	July 2019	6 months	December 2019

The future Extraction Plans will consider the cumulative subsidence effects, subsidence impacts and/or environmental consequences. Note that the total cumulative predicted subsidence effects, subsidence impacts and/or environmental consequences at the completion of the Project are considered in the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008) and the Preferred Project Report (HCPL, 2009).

4.1.1 Telstra Assets

Figure 5 illustrates the Telstra assets in relation to Longwalls 301-304 extraction. The assets include (Appendix 4):

- Telecommunications Tower and Compound (including equipment hut, security fencing and optical fibre cable entries which terminate at the mobile telephone tower);
- Major Interstate Trunk Cable F KNST 2005 ENGA-HBGH 80f Sydney-Melbourne No.3 optical fibre cable (labelled as Cable 1);
- Customer Access Network (CAN) Cable F ENGA 3001 6f Engadine-Garrawarra-Mobile Phone Tower optical fibre cable (labelled as Cable 2);
- Customer Access Network (CAN) Cable F ENGA 3005 12f Engadine-Garrawarra-RIM and Garrawarra Hospital customer cable (labelled as Cable 2);
- copper telecommunications cables supplying customer services throughout Garrawarra Hospital and residential area (including buried and aerial copper cables); and
- associated pits, conduits and poles supporting the above cable network.

4.2 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

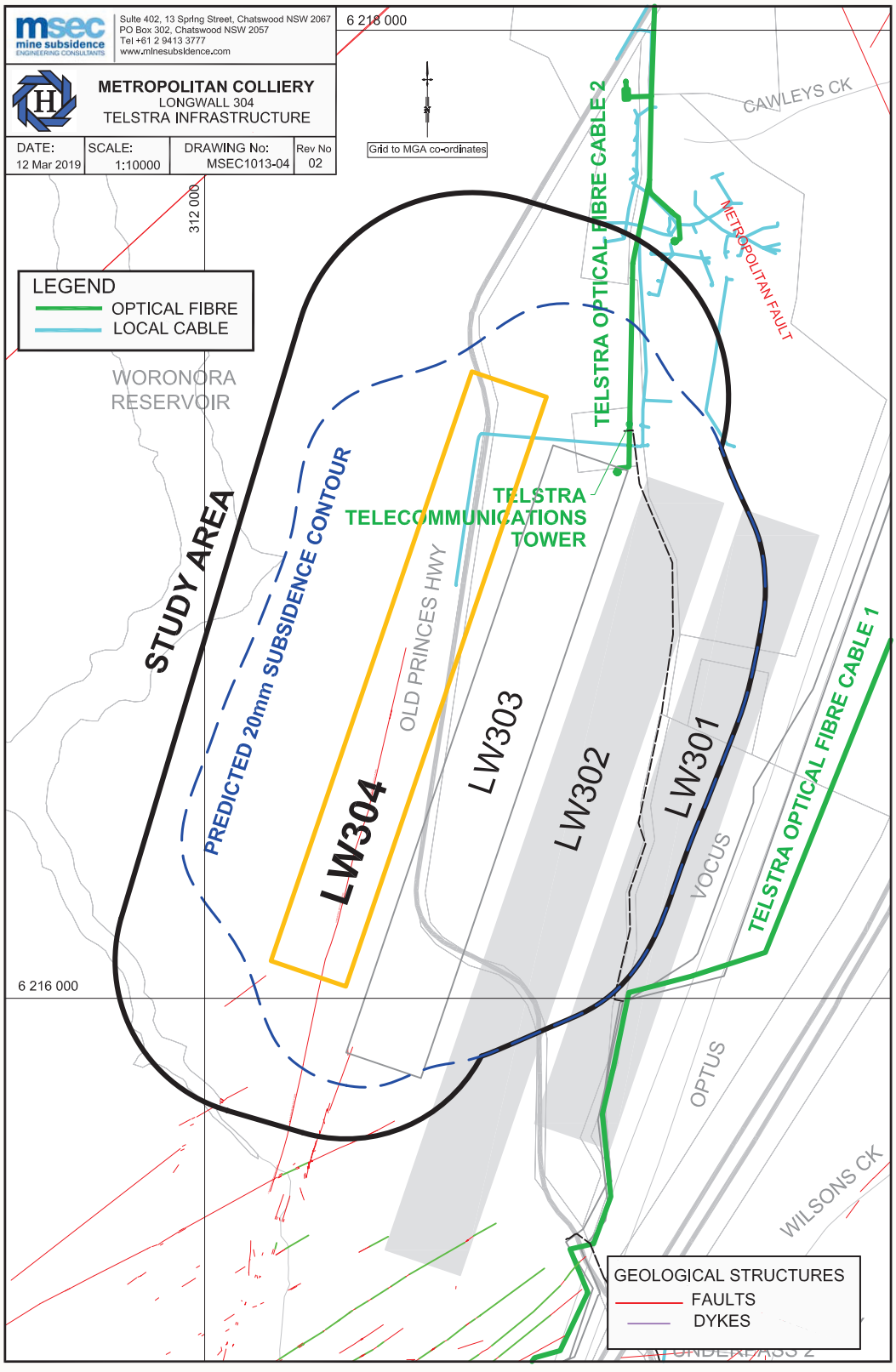
4.2.1 Revised Subsidence Predictions

Subsidence predictions for Longwalls 20-44 in relation to the Telstra assets was conducted by MSEC (2008) as part of the Metropolitan Coal Project EA. MSEC (2008) includes a table summarising the incremental systematic subsidence parameters for the extraction of each longwall from Longwalls 20-44. These include:

- maximum predicted incremental subsidence (vertical movement);
- maximum predicted incremental tilt along alignment;
- maximum predicted incremental tilt across alignment;
- maximum predicted incremental tensile strain; and
- maximum predicted incremental compressive strain.

Revised subsidence and impact predictions for the extraction of Longwalls 301-303 on Telstra assets were conducted by MSEC and reported in MSEC (2016) (Appendix 1). In relation to subsidence predictions, MSEC (2016) make the following conclusions:

- The optical fibre cables are direct buried and, therefore, will not be impacted by the tilts resulting from the extraction of Longwalls 301-303.
- The buried optical fibre cables are likely to experience curvatures and ground strains resulting from the extraction of Longwalls 301-303. The predicted curvatures and strains for the optical fibre cables are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar cables.
- Based on the predicted curvatures and strains, it is unlikely the copper telecommunications cables would experience adverse impacts.
- The magnitude of tilt predicted at the telecommunications tower (and compound) is very small (less than 1%) and is unlikely to be adversely impacted.



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Source: MSEC (2019)

Peabody
METROPOLITAN COAL
Telstra Assets

Figure 5

- Due to its lightweight construction, it is unlikely the steel framed building enclosure would experience any adverse impacts.
- It is expected that the building enclosure would remain in safe and serviceable conditions during and after mining.

It is important to note that the above predictions and conclusions are for total subsidence after extraction of the three Longwalls 301, 302 and 303. Subsidence effects predicted for the optical fibre cable 2, telecommunications tower and compound and copper cable network during mining of Longwall 301 alone are minimal to nil as the total subsidence profile does not develop until after commencement of Longwall 302.

Revised subsidence and impact predictions for the extraction of Longwall 304 on Telstra assets were conducted by MSEC and reported in MSEC (2019) (Appendix 2). In relation to subsidence predictions and impact assessments, MSEC (2019) make the following conclusions:

- Cable 1 is located 560 m to the east of Longwall 304 and is not expected to experience measurable conventional vertical subsidence, tilts or curvatures, and would unlikely experience adverse impacts, due to the extraction of Longwall 304. Cable 1 could experience low level far-field horizontal movement.
- Cable 2 will not be impacted by tilts and there is no change to the predicted strains or subsidence previously advised between Longwall 303 and Longwall 304.
- The buried copper cables are predicted to have an increase in vertical subsidence from 425 mm to 650 mm but are not predicted to have a change in ground strains between Longwall 303 and 304. The peak prediction for the copper cable is on a redundant cable feeding west from Garrawarra to the old Princes Highway. It is unlikely that the copper cables would experience adverse impacts as a result of the extraction of Longwall 304.
- The telecommunications tower is predicted to see an increase in subsidence to 175 mm and increase in predicted tilt to 2 mm/m or 0.11 degrees, however this prediction remains well within the Telstra Management Plan level set at 1.0 degree for the monopole. It is unlikely that adverse impacts would occur for the compound or monopole tower.

It is expected that the potential impacts on the Telstra infrastructure can be managed with the implementation of the appropriate monitoring and management strategies.

4.2.2 Risk Assessment Meeting

In accordance with the *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) a risk assessment meeting was held on 11 August 2016 for Longwalls 301-303. Attendees at the risk assessment meeting included representatives from Metropolitan Coal, Telstra (Comms Network Solutions Pty Ltd), MSEC, Resource Strategies and Axys Consulting (risk assessment facilitator). The investigation and analysis methods used during the risk assessment included:

- preliminary identification of Telstra assets;
- review of the revised subsidence predictions and potential impacts on Telstra assets (including consideration of past experience in the Southern Coalfield); and
- development of a preliminary monitoring plan.

A number of risk control measures and procedures were identified during the risk assessment which considered the extraction of coal beneath the Telstra assets, and are summarised as follows:

Baseline Data / Validation

1. Obtain information from Telstra Structural Engineering Group (StrucTel) on the effect of mining under the Mobile Tower may have based on the revised subsidence predictions and have Telstra confirm that it is within the limitation of the current Tower.
2. Obtain from Telstra the Mobile Tower Footing details to assist with a review of the potential for Horizontal Sheer that mining would have on the tower footings.
3. Conduct a review of the Horizontal Shear impact on the structural integrity / footings of the Tower due to mining of Longwalls 301 to 303 and provide this information to StrucTel.
4. Obtain from Telstra if there is any impact on the proposed tilt of the tower after the mining of Longwalls 301 to 303 has completed to confirm if there is any impact on services supplied by the tower.
5. Obtain from Telstra an audit to confirm that all services (including any vulnerabilities due to age, installation process, etc.) of optical fibre cables, cables entering the tower hut and copper cables that may be affected by mining of Longwalls 301 to 303 have been identified and document in the BFMP.
6. Carry out an audit of the physical location of the Sydney to Melbourne Optic Fibre Cable within the Study area prior to any mining to confirm that physical access is available.
7. Provide survey information on the Optic Fibre Cable run within the Study area for the main cable between Sydney to Melbourne (Cable 1) and have Telstra confirm that this is correct to validate the current studies.

Management / Monitoring / Response Measures

8. Develop a Trigger Action Response Plan (TARP) and include a trigger to confirm that the Optical Fibre Cables monitoring is being carried out when the mining of Longwalls 301 to 303 may impact on the main Optic Fibre Cable run between Sydney to Melbourne.
9. Include in the TARP a trigger to conduct physical audits of the Optic Fibre Cable between Sydney to Melbourne when mining is likely to affect the cable so that rectification work can commence if required based on the TARP Conditions.
10. Develop a TARP and include a trigger to confirm that the Optical Fibre Cables monitoring is being carried out when the mining of Longwalls 301 to 303 may impact on the Optic Fibre Cable to the mobile tower hut.
11. Include in the TARP a trigger to conduct physical audits of the Optic Fibre Cable to the mobile tower hut when mining is likely to affect the cable so that rectification work can commence if required based on the TARP Conditions.
12. Include a pre and post inspection in the BFMP of the Telstra Compound (including the hut, fencing, etc.) to document if there has been any damage to the Telstra infrastructure as a result from the mining of Longwalls 301 to 303.

Contingency Planning

13. Include in the BFMP contact information from Telstra to mobilise Auxiliary Mobile Towers if the existing Telstra Mobile Tower was to become unserviceable.
14. Obtain an understanding from Telstra of the time involved that it would take to mobilise an Auxiliary Mobile Towers.

15. Carry out an investigation on the Telstra customers (e.g. Garrawarra Centre) that would be affected if the copper cabling became unserviceable and what service would be need to be provided while copper cabling repairs were carried out.
16. Include in the BFMP that if the copper cabling becomes unserviceable a plan to resolve issues with affected customers (e.g. mobile solution).

Metropolitan Coal considers all risk control measures and procedures to be feasible to manage all identified risks. The proposed risk control measures and procedures have been incorporated where relevant in this BFMP and the program for implementation is summarised in Table 3.

Table 3
Program for Implementation of Proposed Risk Control Measures and Procedures

	Risk Control Measure / Procedure	BFMP Section	Timing
Baseline Data / Validation			
1	Obtain tower details from Telstra (StrucTel)	Appendix 4	Complete
2	Obtain tower footings details from Telstra (StrucTel)	Appendix 4	Complete
3	Provide horizontal sheer impact information to Telstra (StrucTel)	Section 4.2.1	Complete
4	Obtain tower tilt details from Telstra to confirm if any impact on services supplied by the tower	Appendix 4	Complete
5	Obtain from Telstra an audit to confirm that all services (including any vulnerabilities due to age, installation process, etc.) of optical fibre cables, cables entering the tower hut and copper cables have been identified and document in the BFMP	Appendix 4	Complete
6	Carry out an audit of the physical location of the Sydney to Melbourne Optic Fibre Cable within the Study area to confirm that physical access is available	Section 6	Complete
7	Provide survey information to Telstra on the Optic Fibre Cable run within the Study area for the main cable between Sydney to Melbourne	Section 6	Complete
Management / Monitoring / Response Measures			
8	Develop a TARP and include a trigger to confirm that the Optical Fibre Cables monitoring is being carried out when mining is likely to affect the main Optic Fibre Cable run between Sydney to Melbourne	Appendix 4 / Section 10 / Table 8	Complete
9	Include in the TARP a trigger to conduct physical audits of the Optic Fibre Cable between Sydney to Melbourne when mining is likely to affect the cable	Appendix 4 / Section 10 / Table 8	Complete
10	Develop a TARP and include a trigger to confirm that the Optical Fibre Cables monitoring is being carried out when mining is likely to affect the cable to the mobile tower hut	Appendix 4 / Section 10 / Table 8	Complete
11	Include in the TARP a trigger to conduct physical audits of the Optic Fibre Cable to the mobile tower hut when mining is likely to affect the cable	Appendix 4 / Section 10 / Table 8	Complete
12	Include a pre and post inspection of the Telstra hut and fencing at the compound	Appendix 4 / Section 7.2.3	Complete
Contingency Planning			
13	Include Contact Information from Telstra to mobilise auxiliary mobile towers and include in BFMP	Appendix 4 / Section 9.1	Complete
14	Obtain timing estimate from Telstra to mobilise auxiliary towers	Section 9.1	If required
15	Carry out an investigation on the Telstra customers (e.g. Garrawarra Centre) that would be affected if the copper cabling became unserviceable	Appendix 4	Complete
16	Include plan to resolve issues for copper cabling (e.g. mobile solution) in the BFMP	Appendix 4 / Section 9.1	Complete

The risk control measures and procedures identified during the risk assessment for Longwalls 301-303 will be implemented for the extraction of Longwall 304.

5 PERFORMANCE MEASURES AND INDICATORS

The Project Approval requires Metropolitan Coal not to exceed the subsidence impact performance measures outlined in Table 1 of Condition 1, Schedule 3. The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.

The performance indicators proposed to ensure that the above performance measure is achieved include:

- negligible transmission loss in fibre optic cables from mine subsidence impacts;
- the structural integrity of the cable line and associated facilities is maintained;
- the structural integrity of the telecommunications tower and compound is maintained; and
- the serviceability of the access roads/tracks is maintained.

Section 7 of this BFMP-TELSTRA describes the monitoring that will be conducted to assess the Project against the above performance measure. Section 9 of this BFMP-TELSTRA provides a Contingency Plan in the event the performance measure is exceeded.

6 BASELINE DATA

An audit of the physical location of the Optic Fibre Cables was conducted within the Study Area to confirm that physical access is available. Survey information was provided to Telstra.

The telecommunications tower and compound are shown on Plates 1 and 2.

Plates 1 & 2 – Telecommunications Tower and Compound (Source: MSEC, 2016)

An audit and site inspection of the Telstra assets including inspection of the cable lines and entries to the hut and condition of the cable was conducted.

6.1 STATE OF ASSET BEFORE MINING

In consultation with Telstra (and similar to the approach adopted for other optical fibre cables), Metropolitan Coal assessed and determined the state of the Telstra optical fibre cables before mining of Longwall 301.

For example, the state of nearby IOF cables was previously assessed before mining commenced in Longwall 20. The amplifier outputs and fibre loss between nominated end points O2WF Waterfall CEV and O2WM Wollongong CEV were measured. Measurement points O2WF and O2WM were located on the SM2 IOF at either end of the planned mining area.

Table 4 below shows the loss measured between O2WF and O2WM from amplifier to amplifier.

Table 4
Measured Loss in O2WF Waterfall – O2WM Wollongong SM-2 IOF Section

Location	Tx Level (dBm)	Rx Level (dBm)	Loss (dBm)
O2WF 1B	14.3	-	-
O2WM 1A	-	-3.8	18.1
O2WM 2B	14.0	-	-
O2WF 2A	-	-3.8	17.8

dBm = decibel-milliwatt.

7 BASELINE DATA

7.1 KEY CONTACTS LIST

The list of key contacts for Peabody and Telstra the development and implementation of this BFMP are provided in Table 5.

Table 5
List of Key Contacts

Company	Position	Name
Peabody (Metropolitan Coal)	Manager – Technical Services Jon Degotardi	Metropolitan Coal Control Room 24hr 02 4294 7333
Telstra	Project Specialist Network Integrity Mark Schneider	Telstra 24hr Contact 13 22 00
Telstra	Network Integrity Damian Bonser	
Telstra (Contractor)	Consultant Engineer to Telstra Network Integrity Colin Dove	

8 MONITORING

A program is monitoring the impacts of Longwalls 301-304 on the Telstra assets.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts for comparison with baseline photographic records.

Telstra or their delegates will conduct the various visual inspections. Metropolitan Coal will be notified of the timing of inspections and accompany Telstra or delegates if considered necessary. All personnel will complete necessary inductions or orientation relevant to the tasks required.

Table 6 summarises the BFMP-TELSTRA monitoring components.

The frequency of monitoring will be reviewed either:

- in accordance with the Annual Review outlined in Section 12; or
- if triggered as a component of the Contingency Plan as outlined in Section 9 of this BFMP-TELSTRA.

Table 6
BFMP-TELSTRA Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Baseline	Optical Fibre	Survey	Adjacent subsidence lines - points at approximately 20 m spacing	Establish base conditions	Prior to Longwall 301 extraction	Complete
		Visual Inspection	Photography of cable pits			
		Remote Fibre Monitoring System (RFMS)	Optical Time Domain Reflectometer (OTDR) monitoring data	Establish signal integrity	Prior to Longwall 301 extraction	Complete
	Access roads/tracks (to optical fibre)	Visual inspection (including notes on general condition of access roads/tracks)		Establish base condition	Prior to Longwall 301 extraction	Complete
	Telecommunications Towers (and compounds)	Survey	Adjacent optic / water subsidence line points at approximately 20 m spacing	Establish base conditions – to track general land movement*	Prior to Longwall 301 extraction	Complete
			Survey marks at Tower	Establish base conditions – to track 3D movement*	Prior to Longwall 302 extraction	Complete
		Condition photography (including infrastructure, services and cables)		Establish base condition	Prior to Longwall 302 extraction	Complete
	Access roads/tracks (to towers and compound)	Visual inspection (including notes on general condition of access roads/tracks)		Establish base condition	Prior to Longwall 302 extraction	Complete

Table 6 (Continued)
BFMP-TELSTRA Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
During Mining	Optical Fibre	Survey	GPS survey of subsidence lines	Determine subsidence, tilt, tensile strain, compressive strain	Survey to commence when longwall face within 400 m of passing under the cables,	Weekly, until movement stabilises
		RFMS	Automated alarm. Initial loss level set at ±1.0 dB	Monitor fibre signal integrity (loss signal)	Monitoring to occur when longwall face approaches within 400 m of the cables	Continuous
		Visual inspection	Cable pits - record any movement or changes evident	Direct signs of conduit movement, and degree of freedom of cable in conduit	Commence when longwall face is at 100m prior to cable and finish 400m past cable line	Weekly, when in nominated zone
	Telecommunications Tower (and compounds)	Survey (subsidence, tilt, strain)	Adjacent optic / water subsidence line points at approximately 20 m spacing	Monitor subsidence effects during mining (including validation of Longwall 301 effects alone are minimal to nil)*	At the completion of longwall 301 On commencement of 302, 303 and 304	301 – Once 302, 303 and 304 - Weekly until effects of subsidence no longer detectable
		Survey - Tilt Meter	Warning alarm set at 1 degree Sensitivity: 0.1 degrees	Monitor tower tilt	Real-time, from commencement of Longwall 302	Continuous
		Visual inspection (for evidence of subsidence effects on compounds – movement of building / cables entering compounds)		Monitor structural integrity of compounds	After 600m retreat for Longwalls 302,303 & 304	Once per longwall
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Monitor for surface cracks, buckling and general safety	At the completion of each longwall	Once per Longwall 301, 302,303 and 304.
					As per Longwall 304 LMP	
Post Mining	Optical Fibre	Visual Inspection	Photography of cable pits	Determine level of impact of mining (if any)	Within 3 months of the completion of each Longwall	Once per Longwall
		RFMS	Record any changes to OTDR monitoring data			
	Telecommunications Towers (and compounds)	Condition Report (including infrastructure, services and cables)		Determine level of impact of mining (if any)	Within 3 months of the completion of each Longwall	Once per Longwall
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Determine level of impact of mining (if any)	Within 3 months of the completion of each Longwall	Once per Longwall

* Subsidence effects predicted for the telecommunications tower (and compound) during mining of Longwall 301 alone are minimal to nil as the total subsidence profile does not develop until after commencement of Longwall 302.

8.1 SUBSIDENCE PARAMETERS

Subsidence parameters (i.e. subsidence, tilt, tensile strain, compressive strain, absolute horizontal translation, and differential leg movement) associated with mining will be measured in accordance with the Longwall 304 Subsidence Monitoring Program (Figure 6).

In summary, surveys are conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence movements (i.e. subsidence, tilt, tensile strain and compressive strain) is measured along subsidence lines that have been positioned across the general landscape.

Monitoring of subsidence parameters specific to the Telstra assets include the survey lines along the Optic / Water Line, the 330 kilovolt (kV) and 132 kV transmission lines and the M1 Princes Motorway. These surveys monitor the general movement about the longwalls and allow evaluation of the likely ground movements about the cable lines (by comparison between measured and predicted movements). Monitoring of subsidence parameters also occurs at the telecommunication tower.

8.2 SUBSIDENCE IMPACTS

8.2.1 Fibre Optic Cables

Visual inspections will be conducted of the cable lines in accordance with the Telstra inspection system or if triggered by a transmission fault detected by the Telstra monitoring system (Appendix 4).

Specific details that will be noted and/or photographed include:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- assessment against the performance indicators and performance measure;
- whether any actions are required (e.g. initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

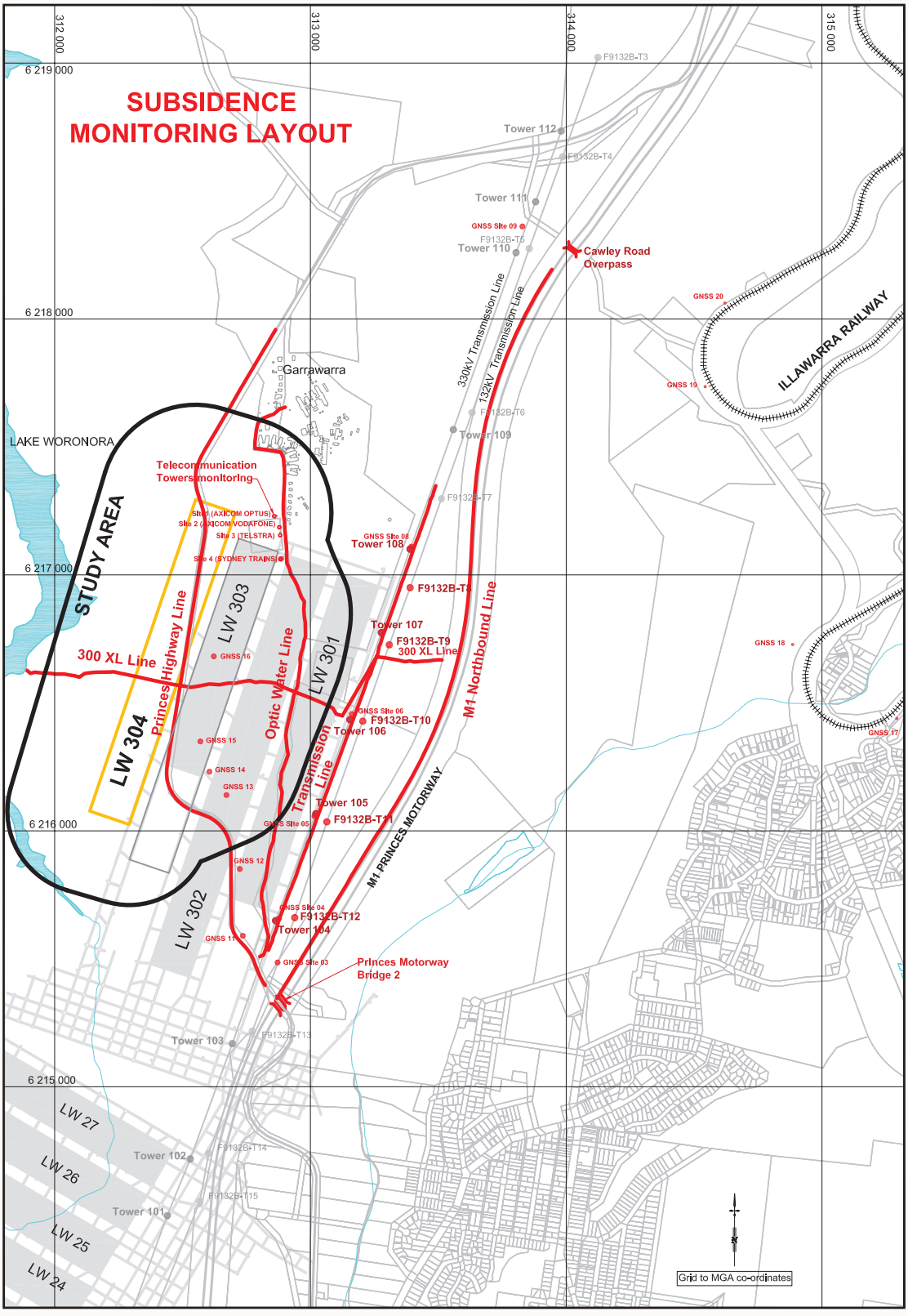
The information will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 3) and reported in accordance with the Project Approval conditions.

8.2.2 Copper Telecommunication Cables

Visual inspections will be conducted as required in accordance with the Telstra Management Plan Agreement (2016) for the area.

8.2.3 Telecommunications Tower and Compound

A pre and post-mining inspection of the Telstra hut and fencing at the compound will be undertaken. Visual inspections will be conducted as required in accordance with the Telstra Management Plan Agreement (2016) for the area.



MET-18-13_304 EP BFMP_017A

Source: MSEC (2019)

Peabody

METROPOLITAN COAL

Subsidence Monitoring Layout

Figure 6

8.2.4 Access Roads/Tracks

Visual inspection of the access roads/tracks to the relevant Telstra assets will occur prior to the commencement of Longwall 301 (i.e. optic fibre cable run), and following extraction of each longwall panel.

Visual observations of access roads/tracks would occur as part of routine works and inspections within 600 m of Longwall 304 secondary extraction as described in the Metropolitan Coal Longwall 304 Land Management Plan (Longwall 304 LMP).

Specific details that will be noted and/or photographed that are relevant to the Telstra access roads/tracks include:

- the location, approximate dimensions (length, width and depth), and orientation of surface tension cracks;
- the location of the surface tension crack in relation to access road/track to the Telstra asset;
- whether any actions are required (e.g. implementation of management measures as outlined in the Longwall 304 LMP, initiation of the Contingency Plan as outlined in the Longwall 304 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The date of the observation, details of the observer and the location of longwall extraction will also be documented.

The information obtained will be recorded in the Longwall 304 LMP - Subsidence Impact Register and reported in accordance with the Project Approval conditions.

The information obtained will be used to assess the potential environmental consequences of the subsidence impact (described in the Longwall 304 LMP) and to identify required management measures. Management measures are discussed in the Longwall 304 LMP.

In the event the subsidence impacts are deemed to present a safety hazard (i.e. regardless of the nature or extent of the subsidence impact), actions will be implemented in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan.

8.3 ENVIRONMENTAL CONSEQUENCES

Metropolitan Coal and Telstra will compare the results of the subsidence impact monitoring against the built features performance measure and indicators. In the event the observed subsidence impacts exceed the performance measure or indicators, Metropolitan Coal and Telstra will assess the consequences of the exceedance in accordance with the Contingency Plan described in Section 9.

9 MANAGEMENT MEASURES

A number of potential management measures in relation to cable lines are considered to be applicable. These are described in the Telstra Management Plan Agreement (Appendix 4).

Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.

Management measures will be reported in the Annual Review (Section 12).

10 CONTINGENCY PLAN

In the event the subsidence impacts observed exceed the performance measure or indicators detailed in Section 5 of this BFMP-TELSTRA, Metropolitan Coal will implement the following Contingency Plan (Appendix 5):

- The observation will be reported to the Manager - Technical Services within 24 hours.
- With the exception of access roads/tracks, the observation will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 3) consistent with the monitoring program described in Section 7 of this BFMP-TELSTRA.
- If relating to an access road/track, the observation will be recorded in the Metropolitan Coal LW304 Land Management Plan – Subsidence Impact Register.
- Metropolitan Coal will report any exceedance of the performance measure or indicators to the DP&E and Telstra as soon as practicable after Metropolitan Coal becomes aware of the exceedance.
- Metropolitan Coal will assess public safety and where appropriate implement safety measures in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan;
- Metropolitan Coal will conduct an investigation to evaluate the potential contributing factors. The investigation will:
  - include the re-survey of relevant subsidence monitoring lines;
  - compare and critically analyse measured versus predicted subsidence parameters;
  - review measured subsidence parameters against the observed impact; and
  - review the subsidence monitoring program and update the program where appropriate.
- The course of action with respect to the identified impact(s), in consultation with specialists and relevant agencies, will include:
  - a program to review the effectiveness of the contingency measures; and
  - consideration of adaptive management.

  Contingency measures are provided in Section 9.1.
- Metropolitan Coal will submit the proposed course of action to the DP&E for approval.
- Metropolitan Coal will implement the approved course of action to the satisfaction of the DP&E.

In accordance with Condition 6, Schedule 6 of the Project Approval, Metropolitan Coal will provide a suitable offset to compensate for the impact to the satisfaction of the Director-General (now Secretary) of DP&E if either the contingency measures implemented by Metropolitan Coal have failed to remediate the impact or the Director-General (now Secretary) determines that it is not reasonable or feasible to remediate the impact.

Metropolitan Coal will comply with the NSW *Coal Mine Subsidence Compensation Act, 2017* in the event that property damages occur as a result of mining Longwalls 301-304.

10.1 CONTINGENCY MEASURES

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of environmental consequences).

Contingency measures are provided in the Telstra Management Plan Agreement (Appendix 4) and are summarised in Table 6. The decision trees for the contingency measures are shown in Appendix 5.

It is understood that there may be opportunities to deploy temporary broadcast/receiving tower as per special event infrastructure that could be used as a contingency. If required, Metropolitan Coal would consult with Telstra to obtain contact details and timeframes for mobilisation.

Table 6
Contingency Measures

Asset	Contingency Measures / Description	
Phone Tower (Pole Type)	Stabilisation	• Installation of tower supports such as guy wires in response to tilt.
	Rebuilding	• Construction of new tower and foundations.
	Contingency	• Deployment of temporary broadcast/receiving tower as per special event infrastructure (temporary mobile tower systems available).
	Redundancy	• Telstra has three alternate phone towers nearby (two at Helensburgh and one at Waterfall).
Main Fibre 120 Core	Stabilisation	• Automatic monitoring detects degradation in signal. Trench fill material is removed from the identified degradation zone, allows fibre to flex, and relieve compression forces.
	Emergency	• Certain bandwidth is redeployed to other cores within this cable and/or to other two (2) Telstra interconnectors between Sydney / Melbourne.
	Rebuilding	• Fibre heat treatment to soften compression point on core and return affected cores to operation.
	Redundancy	• Telstra has cable at this location plus 2 additional cables further west in NSW as alternate connectors between NSW and Victoria. The cable at this location has 120 cores (each core is independent for data communication). [*NB: alternative potentially undermined concurrently at Douglas Park*].
Spur Line Tower Fibre 12 Core	Stabilisation	• Technician travels to tower and undertakes localised monitoring to identify location of issue. Soil removed at location to allow fibre to flex.
	Emergency	• Spare cores available in cable. Bypass affected cores to re-establish functionality.
	Rebuilding	• Fibre heat treatment to soften compression point and return affected cores to operation.
	Redundancy	• Phone tower operation requires 2 cores; fibre supplying tower has 12 cores, 10 spare.
Copper Cable	Emergency	• Failure in local phone cables at Garrawarra Centre Complex rectified by repairs. If extended duration outage then temporary mobile phone connection to be provided to Garrawarra Centre Complex commercial user by Telstra.
	Redundancy	• Mobile phone coverage to replace landlines, all commercial carriers have towers located at Garrawarra Centre Complex.

11 TARP – MANAGEMENT TOOL

The framework for the various components of the BFMP-TELSTRA are summarised in the BFMP-TELSTRA TARPs shown in Tables 7, 8, 9 and 10.

The BFMP-TELSTRA TARPs illustrate how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions. The TARP comprises:

- baseline conditions;
- predicted subsidence impacts;
- trigger levels from monitoring to assess performance; and
- triggers that flag implementation of contingency measures.

The TARP system provides a simple and transparent snapshot of the monitoring of environmental performance and the implementation of management and/or contingency measures.

Table 7
Trigger Action Response Plan – Optical Fibre Major Interstate Trunk Cable: F KNST 2005 ENGA-HBGH 80f

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
Safe, serviceable and repairable	Negligible transmission loss in fibre optic cables from mine subsidence impacts The structural integrity of the cable line and associated joint housing pit is maintained. Subsidence parameters.	Remote fibre monitoring system (RFMS). Physical inspection of the cable pits. Survey lines including: Optic / Water Line; 330 kilovolt (kV) and 132 kV transmission lines; and M1 Princes Motorway	OTDR Signal loss. Movement about cable pits Direct signs of conduit movement, and degree of freedom of cable in conduit Subsidence, Strain.	Continuous Weekly when LW is between 100m before and 400m after the cable. Weekly when LW is within ±400m of being directly under cable and After LW 301, 302, and 303	Automated alarm set at 1.0 dB Visual inspection by experienced person. Evaluation of the general ground movements about the site by comparison between measured and predicted movements.	Subsidence measurement accuracy.	Pre-mining audit conducted prior to commencement of LW 301.	Level 1	Signal loss <1.0 dB Negligible movement about cable pits. Negligible signs of conduit movement or reduction in freedom of movement of the cable conduit. At end of LW302 Subsidence < 300 mm Tensile strain , <0.9 mm/m Compressive strain <1.6 mm/m At end of LW303 and LW304 Subsidence < 375 mm Tensile strain , <0.9 mm/m Compressive strain <1.6 mm/m (ie measured subsidence parameters generally in accordance with predicted).	Continue monitoring.
								Level 2	Signal loss < 1.0 dB Negligible movement about cable pits detected. Negligible restriction in movement of cable conduits identified. Subsidence effects up to 15% greater than predicted. e.g. Subsidence between 375 and 430 mm.	Report subsidence anomaly. Immediately resurvey subsidence line to confirm results. Engage subsidence expert to assess results. Confirm results are consistent with other subsidence lines. Compare and critically analyse measured versus predicted subsidence. Inform and provide report to Telstra of subsidence results. Collaboratively share information with Telstra to monitor situation. **<u>Telstra</u>** Assess information provided by Metropolitan Coal. If mining within 400m, increase frequency of OTDR assessments to weekly for signs of signal loss.

Table 7 (Continued)
Trigger Action Response Plan – Optical Fibre Major Interstate Trunk Cable: F KNST 2005 ENGA-HBGH 80f

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
								Level 3	Signal loss > 1.0 dB Subsidence effects > 15% of predictions. E.g. Subsidence > 430 mm Movement about cable pits detected. Restriction in movement of cable conduits identified.	Increase frequency of subsidence line surveys to weekly in affected area. In conjunction with Telstra identify degradation location and work with Telstra to resolve. Review the subsidence monitoring program and update the program where appropriate. Provide report on issue to both Telstra and DP&E. **Telstra** Inform Metropolitan Coal of anomalous signal degradation from continuous monitoring. Physically audit cable pits in area. In conjunction with Metropolitan Coal identify signal loss location; expose cable to investigate if tension/compression being imposed on cable. Relieve cable tension or compression by adjusting the trench geometry, the outer conduit, the fill material or by heat treatment of cable. Make determination if necessary to leave trench open for remainder of longwall extraction to avoid further stress build-up.
								Level 4	Signal fault detected	Implement Contingency Plan as per BFMP Section 9. General Manager to be involved in all decision making processes. Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwall 304 Public Safety Management Plan. Report exceedance of the performance measure or indicators to the DP&E as soon as practicable. Update the 'Built Features Management Plan – Subsidence Impact Register'. **Telstra** Telstra to enact emergency transmission cutover of affected fibres at exchange and transmit on alternate fibres in bundle and/or on alternate routes. Expose the affected section of cable and determine appropriate course of action for cable restoration being straightening/ heat treatment or full joint to joint replacement depending on severity of physical cable fault. Complete restoration works. Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.
	The serviceability of the access roads and tracks are maintained.	Access roads and tracks in the vicinity of the Telstra assets.	Cracking about access road/tracks.	After LW 301, 302, 303 and 304.	Visual Inspection. Visual observations of access roads/tracks will also be conducted by Metropolitan Coal as part of routine works and inspections within 600 m of Longwalls 301-304 secondary extraction as described in the Metropolitan Coal Longwall 304 Land Management Plan.		Pre-mining audit conducted prior to commencement of LW 301.	Level 1	Minor cracking.	**Continue monitoring.** Consider whether any actions are required (e.g. implementation of management measures as outlined in the Longwall 304 LMP, initiation of the Contingency Plan as outlined in the Longwall 304 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.).
								Level 2	Moderate cracking (i.e. cracking that requires implementation of management measures).	Implement management measures as outlined in the Longwall 304 LMP.
								Level 3	Greater than moderate cracking.	Implement contingency measures as outlined in the Longwall 304 LMP.

Table 8
Trigger Action Response Plan – Optical Fibre Customer Access Network Cables: F ENGA 3001 6f & F ENGA3005 12f

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
Safe, serviceable and repairable	Negligible transmission loss in fibre optic cables from mine subsidence impacts The structural integrity of the cable line and associated joint housing pit is maintained. Subsidence parameters.	Remote fibre monitoring system (RFMS). Physical inspection of the cable pits. Survey lines including: Optic / Water Line; 330 kilovolt (kV) and 132 kV transmission lines; and M1 Princes Motorway	OTDR Signal loss. Movement about cable pits Direct signs of conduit movement, and degree of freedom of cable in conduit Subsidence, Strain.	Continuous Weekly when LW is between 100 m before and 400 m after the cable. Weekly when LW is within ±400 m of being directly under cable and After LW 301, 302, 303 and 304.	Automated alarm set at 1.0 dB Visual inspection by experienced person. Evaluation of the general ground movements about the site by comparison between measured and predicted movements.	Subsidence measurement accuracy.	Pre-mining audit conducted prior to commencement of LW 301.	Level 1	Signal loss <1.0 dB Negligible movement about cable pits. Negligible signs of conduit movement or reduction in freedom of movement of the cable conduit. At end of LW302 Subsidence < 70 mm Tensile strain , <0.9 mm/m Compressive strain < 1.6 mm/m At end of LW303 & 304 Subsidence < 350 mm Tensile strain , <0.9 mm/m Compressive strain < 1.6 mm/m (i.e. measured subsidence parameters generally in accordance with predicted).	Continue monitoring.
								Level 2	Signal loss < 1.0 dB Negligible movement about cable pits detected. Negligible restriction in movement of cable conduits identified. Subsidence effects up to 15% greater than predicted. e.g. Subsidence between 350 and 405 mm.	Report subsidence anomaly. Immediately resurvey subsidence line to confirm results. Engage subsidence expert to assess results. Confirm results are consistent with other subsidence lines. Compare and critically analyse measured versus predicted subsidence. Inform and provide report to Telstra of subsidence results. Collaboratively share information with Telstra to monitor situation. **<u>Telstra</u>** Assess information provided by Metropolitan Coal. If mining within 400 m, increase frequency of OTDR assessments to weekly for signs of signal loss.

Table 8 (Continued)
Trigger Action Response Plan – Optical Fibre Customer Access Network Cables: F ENGA 3001 6f & F ENGA3005 12f

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
								Level 3	Signal loss> 1.0 dB Subsidence effects > 15% predicted. E.g. Subsidence > 405 mm Movement about cable pits detected. Restriction in movement of cable conduits identified.	Increase frequency of subsidence line surveys to weekly in affected area. In conjunction with Telstra identify degradation location and work with Telstra to resolve. Review the subsidence monitoring program and update the program where appropriate. Provide report on issue to both Telstra and DP&E. **<u>Telstra</u>** Inform Metropolitan Coal of anomalous signal degradation from continuous monitoring. Physically audit cable pits in area. In conjunction with Metropolitan Coal identify signal loss location; expose cable to investigate if tension/compression being imposed on cable. Relieve cable tension or compression by adjusting the trench geometry, the outer conduit, the fill material or by heat treatment of cable. Make determination if necessary to leave trench open for remainder of longwall extraction to avoid further stress build-up.
								Level 4	Signal fault detected	Implement Contingency Plan as per BFMP Section 9. General Manager to be involved in all decision making processes. Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwall 304 Public Safety Management Plan. Report exceedance of the performance measure or indicators to the DP&E as soon as practicable. Update the 'Built Features Management Plan – Subsidence Impact Register'. **<u>Telstra</u>** Telstra to enact emergency transmission cutover of affected fibres at exchange and transmit on alternate fibres in bundle and/or on alternate routes. Expose the affected section of cable and determine appropriate course of action for cable restoration being straightening/ heat treatment or full joint to joint replacement depending on severity of physical cable fault. Complete restoration works. Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.
	The serviceability of the access roads and tracks are maintained.	Access roads and tracks in the vicinity of the Telstra assets.	Cracking about access road/tracks.	After LW 301, 302, 303 and 304	Visual Inspection. Visual observations of access roads/tracks will also be conducted by Metropolitan Coal as part of routine works and inspections within 600 m of Longwalls 301-304 secondary extraction as described in the Metropolitan Coal Longwall 304 Land Management Plan.		Pre-mining audit conducted prior to commencement of LW 301.	Level 1	Minor cracking.	**<u>Continue monitoring.</u>** Consider whether any actions are required (e.g. implementation of management measures as outlined in the Longwall 304 LMP, initiation of the Contingency Plan as outlined in the Longwall 304 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.).
								Level 2	Moderate cracking (i.e. cracking that requires implementation of management measures).	Implement management measures as outlined in the Longwall 304 LMP.
								Level 3	Greater than moderate cracking.	Implement contingency measures as outlined in the Longwall 304 LMP.

Table 9
Trigger Action Response Plan – Customer Access Network Copper Cables

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
Safe, serviceable and repairable	The structural integrity of the copper cable and associated infrastructure is maintained. Subsidence parameters.	Physical inspection of the copper cable. Survey lines including: Optic / Water Line; 330 kilovolt (kV) and 132 kV transmission lines; and M1 Princes Motorway	Direct signs of movement. Subsidence, Strain.	Within 3 months after completion of each longwall. After LW 301, 302, 303 and 304	Visual inspection. Evaluation of the general ground movements about the site by comparison between measured and predicted movements.	Subsidence measurement accuracy.	Pre-mining audit conducted prior to commencement of LW 301.	Level 1	Negligible signs of impact to copper cables. At end of LW302 Subsidence < 325 mm Tensile strain < 0.9 mm/m Compressive strain < 1.6 mm/m At end of LW303 Subsidence < 425 mm Tensile strain < 0.9 mm/m Compressive strain < 1.6 mm/m At end of LW304 Subsidence < 650 mm Tensile strain < 0.9 mm/m Compressive strain < 1.6 mm/m (i.e. measured subsidence parameters generally in accordance with predicted).	Continue monitoring.
								Level 2	Negligible signs of impact to copper cables. Subsidence effects up to 15% greater than predicted. e.g. Subsidence between 425 and 490 mm.	Report subsidence anomaly. Immediately resurvey subsidence line to confirm results. Engage subsidence expert to assess results. Confirm results are consistent with other subsidence lines. Compare and critically analyse measured versus predicted subsidence. Inform and provide report to Telstra of subsidence results. Collaboratively share information with Telstra to monitor situation. **<u>Telstra</u>** Assess information provided by Metropolitan Coal.

Table 9 (Continued)
Trigger Action Response Plan – Customer Access Network Copper Cables

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
								Level 3	Subsidence effects > 15% predicted. E.g. Subsidence > 490 mm Anomalous service condition detected. Complaint (verified).	Increase frequency of subsidence line surveys to weekly in affected area. In conjunction with Telstra identify degradation location and work with Telstra to resolve. Review the subsidence monitoring program and update the program where appropriate. Provide report on issue to both Telstra and DP&E. **<u>Telstra</u>** Inform Metropolitan Coal of anomalous signal degradation from complaint (verified). Physically audit cable pits in area. In conjunction with Metropolitan Coal identify signal loss location; expose cable to investigate if tension/compression being imposed on cable. Test and repair copper cable. Make determination if necessary to leave trench open for remainder of longwall extraction to avoid further stress build-up. Make determination if necessary to leave trench open for remainder of longwall extraction to avoid further stress build-up.
								Level 4	Fault detected	Implement Contingency Plan as per BFMP Section 9. General Manager to be involved in all decision-making processes. Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwall 304 Public Safety Management Plan. Report exceedance of the performance measure or indicators to the DP&E as soon as practicable. Update the 'Built Features Management Plan – Subsidence Impact Register'. **<u>Telstra</u>** Telstra to divert to other pairs within the copper cable bundle. Expose the affected section of cable and determine appropriate course of action for cable restoration depending on severity of physical cable fault. If Garrawarra services impacted, switch to mobile phones during period of cable repair. Complete restoration works. Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.

Table 10
Trigger Action Response Plan – Telecommunication Tower and Compound

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
Safe, serviceable and repairable	The safety serviceability of the telecommunications tower and building compound is maintained. Tilt. Subsidence parameters.	Physical inspection of the telecommunications tower and buildings. Tower tilt meter. Survey lines including: Optic / Water Line; 330 kilovolt (kV) and 132 kV transmission lines; and M1 Princes Motorway	Direct signs of impact. Tilt. Subsidence, Strain.	Within 3 months after completion of each longwall. Real time. Continuous. Weekly on commencement of LW302, LW303 and LW304 until effects of subsidence no longer evident. And After LW 301, 302, 303 and 304	Visual inspection. Analysis of tilt. Alarm set at 1 deg of sensitivity (0.1 deg). Evaluation of the general ground movements about the site by comparison between measured and predicted movements.	Subsidence measurement accuracy.	Pre-mining audit conducted prior to commencement of LW 301.	Level 1	Negligible signs of impact to tower and buildings. At end of LW302: Subsidence < 30 mm Tensile strain < 0.9 mm/m Compressive strain < 1.6 mm/m Tilt < 0.5 mm/m (0.03 deg) At end of LW303 Subsidence < 70 mm Tensile strain < 0.9 mm/m Compressive strain < 1.6 mm/m Tilt < 1.0 mm/m (0.06 deg) At end of LW304 Subsidence < 175 mm Tensile strain < 0.9 mm/m Compressive strain < 1.6 mm/m Tilt < 2.0 mm/m (0.11 deg) (i.e. measured subsidence parameters generally in accordance with predicted).	Continue monitoring.
								Level 2	Negligible signs of impact to tower and buildings. Tilt between 0.11 and 1 degree. Subsidence effects up to 15% greater than predicted. e.g. Subsidence between 175 and 201 mm.	Implement actions in accordance with the Telstra Management Plan Agreement (Appendix 4). Report subsidence anomaly. Immediately resurvey subsidence line to confirm results. Engage subsidence expert to assess results. Confirm results are consistent with other subsidence lines. Compare and critically analyse measured versus predicted subsidence. Inform and provide report to Telstra of subsidence results. Collaboratively share information with Telstra to monitor situation.
								Level 3	Indication of subsidence impact to tower or buildings. Tilt > 1.0 deg. Subsidence effects > 15% predicted. E.g. Subsidence > 201 mm Anomalous service condition detected. Complaint (verified).	Increase frequency of subsidence line surveys to weekly in affected area. In conjunction with Telstra identify degradation location and work with Telstra to resolve. Review the subsidence monitoring program and update the program where appropriate. Provide report on issue to both Telstra and DP&E. **<u>Telstra</u>** In conjunction with Metropolitan Coal identify impact location and install guy wires in response to tilt. Make determination if necessary to leave trench open for remainder of longwall extraction to avoid further stress build-up.

Table 10 (Continued)
Trigger Action Response Plan – Telecommunication Tower and Compound

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
								Level 4	Fault detected	Implement Contingency Plan as per BFMP Section 9. General Manager to be involved in all decision making processes. Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwall 304 Public Safety Management Plan. Report exceedance of the performance measure or indicators to the DP&E as soon as practicable. Update the 'Built Features Management Plan – Subsidence Impact Register'. **<u>Telstra</u>** Telstra to enact automatic partial redundancy and use alternate phone towers nearby to share load. Determine appropriate course of action for restoration of service (e.g. deploy temporary tower as per special event infrastructure) and rebuilding (e.g. construct new tower and foundations). Complete restoration/rebuilding works. Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.

12 FUTURE EXTRACTION PLANS

In accordance with Condition 7 of Schedule 3, Metropolitan Coal will collect baseline data for the next Extraction Plan (i.e. Longwalls 305-310). The collection of baseline data will be consistent with the baseline data collected for Longwalls 301-304. Specifically, baseline data obtained will include pre-mining inspection of the telecommunications lines, tower and/or compound.

In addition to the baseline data collection, consideration of the environmental performance and management measures in accordance with the review(s) conducted as part of this BFMP-TELSTRA will inform the appropriate type and frequency of monitoring of the assets relevant to the next Extraction Plan.

13 ANNUAL REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

In accordance with Condition 3, Schedule 7 of the Project Approval, Metropolitan Coal will conduct an Annual Review of the environmental performance of the Project by the end of March each year.

The Annual Review will:

- describe the works carried out in the past year, and the works proposed to be carried out over the next year;
- include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the EA, Preferred Project Report and Extraction Plan;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

As described in Section 2, this BFMP-TELSTRA will be reviewed within three months of the submission of an Annual Review, and revised where appropriate.

14 INCIDENTS

An incident is defined as a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval.

The reporting of incidents will be conducted in accordance with Condition 6, Schedule 7 of the Project Approval. Metropolitan Coal will notify the Director-General (now Secretary) of DP&E and any other relevant agencies of any incident associated with the Project as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of DP&E and any relevant agencies with a detailed report on the incident.

Telstra will be notified within 24 hours of any access limitations or restrictions.

15 COMPLAINTS

A protocol for the managing and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

The Environment & Community Superintendent is responsible for maintaining a system for recording complaints.

Metropolitan Coal will maintain public signage advertising the telephone number on which environmental complaints can be made. The Environment & Community Superintendent is responsible for ensuring that the currency and effectiveness of the service is maintained. Notifications of complaints received are to be provided as quickly as practicable to the Environment & Community Superintendent.

Complaints and enquiries do not have to be received via the telephone line and may be received in any other form. Any complaint or enquiry relating to environmental management or performance is to be relayed to the Environment & Community Superintendent as soon as practicable. All employees are responsible for ensuring the prompt relaying of complaints. All complaints will be recorded in a complaints register.

For each complaint, the following information will be recorded in the complaints register:

- date and time of complaint;
- method by which the complaint was made;
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- nature of the complaint;
- the action(s) taken by Metropolitan Coal in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken by Metropolitan Coal, the reason why no action was taken.

The Environment & Community Superintendent is responsible for ensuring that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary.

In accordance with Condition 10, Schedule 7 of the Project Approval, the complaints register will be made publicly available on the website and updated on a monthly basis. A summary of complaints received and actions taken will be presented to the Community Consultative Committee as part of the operational performance review.

16 NON-COMPLIANCES WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with Metropolitan Coal, and will be developed through promotion of Metropolitan Coal ownership under the direction of the General Manager.

The Manager - Technical Services and/or Environment & Community Superintendent will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 13, Metropolitan Coal will notify the Director-General (now Secretary) of the DP&E and any other relevant agencies of any incident associated with Metropolitan Coal as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of the DP&E and any relevant agencies with a detailed report on the incident.

A review of Metropolitan Coal's compliance with all conditions of the Project Approval, mining leases and all other approvals and licenses will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the Peabody website.

Additionally, in accordance with Condition 8, Schedule 7 of the Project Approval, an independent environmental audit was undertaken by the end of December 2011, and is undertaken a minimum of once every three years thereafter. A copy of the audit report will be submitted to the Director-General (now Secretary) of the DP&E and made publicly available on the Peabody website. The independent audit will be undertaken by an appropriately qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General (now Secretary) of the DP&E.

17 REFERENCES

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Mine Subsidence Engineering Consultants (2016) *Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Telstra Infrastructure, 30 August 2016.*

Mine Subsidence Engineering Consultants (2019) *Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Telstra Infrastructure.*

APPENDIX 1

MSEC (2016) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 301 TO 303 - SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE TELSTRA INFRASTRUCTURE, DATED 30 AUGUST 2016

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

30th August 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-04

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Telstra Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Telstra infrastructure resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery.

The locations of the Telstra infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC844-04. There are two optical fibre cables within the Study Area that are located above the southern end of Longwall 301 and above the northern end of Longwall 303. Copper telecommunications cables are also located above the northern ends of Longwalls 302 and 303 and these cables service the Garrawarra Complex.

A telecommunications tower and compound are located above Longwall 303. Photographs of this installation are provided in Figure 1.

Figure 1 Telecommunications Tower and Compound

The predictions and impact assessments for the Telstra infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the Telstra Infrastructure

The following provides summaries of the maximum predicted conventional movements for the Telstra infrastructure resulting from the extraction of Longwalls 301 to 303. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

The optical fibre cable located above the southern end of Longwall 301 is referred to as *Cable 1* and the optical fibre cable located above the northern end of Longwall 303 is referred to as *Cable 2* in this letter report.

The predicted profiles of incremental and total conventional subsidence, tilt and curvature along the alignment of the Telstra optical fibre cables, resulting from the extraction of Longwalls 301 to 303, are shown in the attached Figs. A.1 and A.2. The black dashed lines are the incremental profiles that represent the additional movements due to each of the longwalls. The solid blue lines represent the total or accumulated movements after the completion of each longwall. The range of predicted curvatures in any direction at any time during or after the extraction of the longwalls is shown by the grey shading.

Summaries of the maximum predicted values of incremental subsidence, tilt and curvature for the optical fibre cables, due to the extraction of each of the Longwalls 301 to 303, are provided in Table 1 and Table 2. The values are the maxima anywhere along the cables at any time during or after the extraction of each longwall.

Table 1 Maximum Predicted Incremental Subsidence, Tilt and Curvature for the Telstra Optical Fibre Cable 1 Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
Due To LW301	80	< 0.5	< 0.01	< 0.01
Due To LW302	225	2.0	0.04	< 0.01
Due To LW303	70	< 0.5	< 0.01	< 0.01

Table 2 Maximum Predicted Incremental Subsidence, Tilt and Curvature for the Telstra Optical Fibre Cable 2 Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
Due To LW301	< 20	< 0.5	< 0.01	< 0.01
Due To LW302	50	0.5	< 0.01	< 0.01
Due To LW303	275	2.5	0.02	0.01

The maximum predicted incremental subsidence for the optical fibre cables, due to the extraction of each of the Longwalls 301 to 303, varies from less than 20 mm to 275 mm. It is noted, that the maximum predicted incremental subsidence for Cable 1 due to Longwall 302 is greater than that due to Longwall 301, as it is a second panel in the series and therefore results in higher magnitudes of subsidence above the mining area.

Summaries of the maximum predicted values of total subsidence, tilt and curvature for the optical fibre cables, resulting from the extraction of Longwalls 301 to 303, are provided in Table 3 and Table 4. The values are the maxima anywhere along the cables at any time during or after the extraction of the longwalls.

Table 3 Maximum Predicted Total Subsidence, Tilt and Curvature for the Telstra Optical Fibre Cable 1 Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	80	< 0.5	< 0.01	< 0.01
After LW302	300	2.5	0.03	< 0.01
After LW303	375	3.0	0.04	< 0.01

Table 4 Maximum Predicted Total Subsidence, Tilt and Curvature for the Telstra Optical Fibre Cable 2 Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	< 20	< 0.5	< 0.01	< 0.01
After LW302	70	0.5	< 0.01	< 0.01
After LW303	350	3.0	0.03	< 0.01

The maximum predicted total subsidence for the optical fibre cables, resulting from the extraction of Longwalls 301 to 303, are 375 mm for Cable 1 and 300 mm for Cable 2. The maximum predicted conventional tilt for these cables is 3.0 mm/m (i.e. 0.3 %, or 1 in 335). The maximum predicted conventional curvatures are 0.04 km^{-1} hogging and < 0.01 km^{-1} sagging, which equate to minimum radii of curvature of 25 kilometres and 100 kilometres, respectively.

The copper telecommunications cables are located above the northern end of Longwalls 303. A summary of the maximum predicted values of total subsidence, tilt and curvature for these copper cables, resulting from the extraction of Longwalls 301 to 303, is provided in Table 5.

Table 5 Maximum Predicted Total Subsidence, Tilt and Curvature for the Telstra Copper Cables Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	20	< 0.5	< 0.01	< 0.01
After LW302	325	3.0	0.02	0.02
After LW303	425	4.0	0.03	0.03

The maximum predicted conventional tilt for the copper cables is 4.0 mm/m (i.e. 0.4 %, or 1 in 250). The maximum predicted conventional curvatures are 0.03 km^{-1} hogging and sagging, which equate to minimum radii of curvature of 33 kilometres.

The telecommunications tower and compound are located adjacent to the tailgate of Longwall 303. A summary of the maximum predicted values of total subsidence, tilt and curvature for this installation, resulting from the extraction of Longwalls 301 to 303, is provided in Table 6.

Table 6 Maximum Predicted Total Subsidence, Tilt and Curvature for the Telecommunications Tower and Compound Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	< 20	< 0.5	< 0.01	< 0.01
After LW302	30	< 0.5	< 0.01	< 0.01
After LW303	150	1.5	0.02	< 0.01

The maximum predicted conventional tilt for the telecommunications tower and compound is 1.5 mm/m (i.e. 0.15 %, or 1 in 667). The maximum predicted conventional curvatures are 0.02 km^{-1} hogging and < 0.01 km^{-1} sagging, which equate to minimum radii of curvature of 50 kilometres and greater than 100 kilometres, respectively.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the Telstra infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The Telstra infrastructure is partially located above Longwalls 301 to 303. A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 2. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

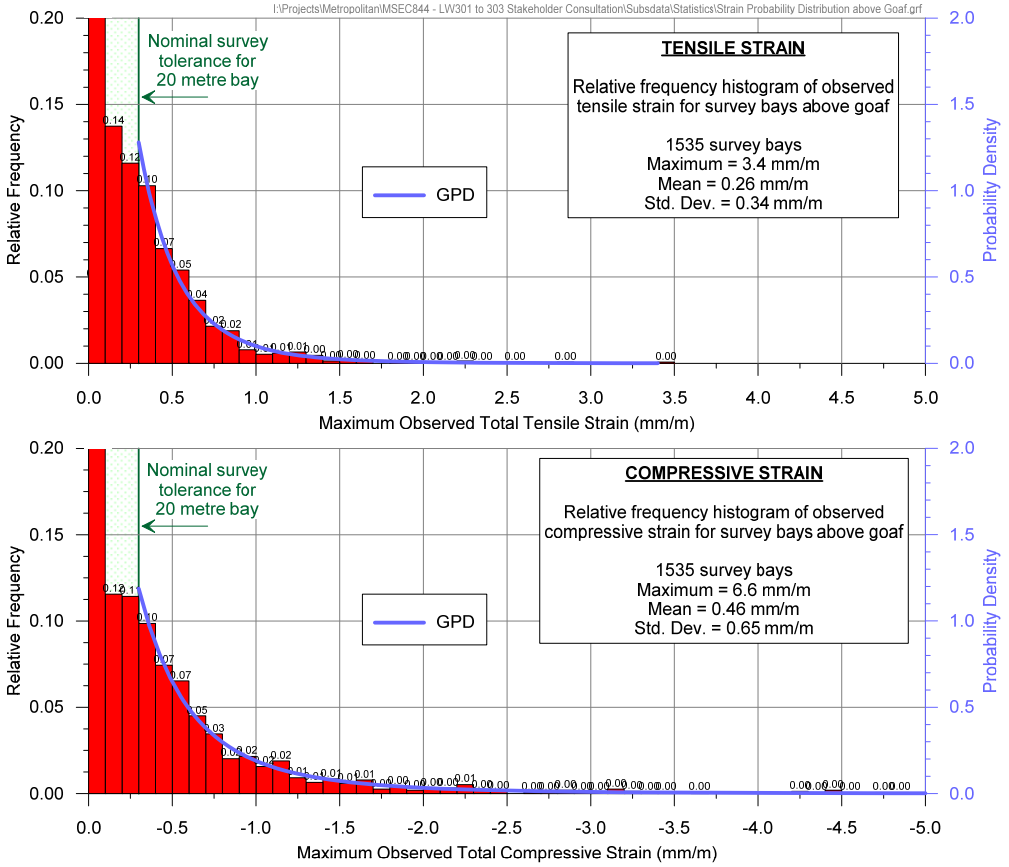

Figure 2 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based on the fitted GPDs, is provided in Table 7.

Table 7 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures and the streams are shown in Drawing No. MSEC844-04.

There are no mapped faults located within the extents of Longwalls 301 to 303. It is possible that the infrastructure located above the longwalls could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The optical fibre cables do not cross any major streams within the Study Area. These cables, therefore, are not expected to experience any measurable valley closure effects.

Impact Assessments for the Optical Fibre Cables

The optical fibre cables within the Study Area are direct buried and, therefore, will not be impacted by the tilts resulting from the extraction of Longwalls 301 to 303. The cables, however, are likely to experience the curvatures and ground strains resulting from the extraction of these longwalls.

The tensile strains in the optical fibre cables can be higher, however, where the cables connect to the support structures, which may act as anchor points, preventing any differential movements that may have been allowed to occur within the ground. Tree roots have also been known to anchor cables to the ground. The extent to which the anchor points affect the ability of the cable to tolerate the mine subsidence movements depends on the cable size, type, age, installation method and ground conditions.

In addition to this, optical fibre cables contain additional fibre lengths over the sheath lengths, where the individual fibres are loosely contained within tubes. Compression of the sheaths can transfer to the loose tubes and fibres and result in 'micro-bending' of the fibres constrained within the tubes, leading to higher attenuation of the transmitted signal. If the maximum predicted compressive strains were to be fully transferred into the optical fibre cables, they could be of sufficient magnitude to result in the reduction in capacities of the cables or transmission loss.

Localised and elevated curvatures could develop along the optical fibre cables due to non-conventional movements resulting from near surface geological structures (i.e. anomalies). It is possible that these non-conventional movements could be sufficient to result in the attenuation of signal.

The predicted curvatures and strains for the optical fibre cables are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar cables. It has been found from this previous experience that the potential impacts on optical fibre cables in the Southern Coalfield can be managed with the implementation of suitable monitoring and management strategies.

Some examples of mining beneath optical fibre cables in the Southern Coalfield are provided in Table 8.

Table 8 Examples of Mining Beneath Optical Fibre Cables in the Southern Coalfield

Colliery and Longwalls	Length of Optical Fibre Cables Directly Mined Beneath (km)	Observed Maximum Movements at Optical Fibre Cables	Pre-Mining Mitigation, Monitoring and Observed Impacts
Appin LW301 and LW302	0.8	650 mm Subsidence 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	600 metre aerial cable on standby. Ground survey, visual, OTDR. No reported impacts.
Appin LW703 to LW706	12.7 total for eight cables	1,200 mm Subsidence 2.1 mm/m Tensile Strain 4.5 mm/m Comp. Strain (Measured HW2, ARTC and MPR Lines)	New cable redirection to avoid potential impacts to old optical fibre cable. Ground survey, visual, OTDR. Strain concentrations detected in three cables, attenuation losses were relieved by locally exposing the cables or by building a bypass cable.
Tahmoor LW22 to LW29	1.9	775 mm Subsidence 0.8 mm/m Tensile Strain 3.9 mm/m Comp. Strain	Ground survey, visual, OTDR, SBS. No reported impacts.
Tower LW1 to LW10	1.7	400 mm Subsidence 3 mm/m Tilt 0.5 mm/m Tensile Strain 1 mm/m Comp. Strain	No reported impacts
West Cliff LW5A3, LW5A4 and LW29 to LW38	3.4	1,300 mm Subsidence 1.3 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	Survey, visual, OTDR, SBS. No reported impacts.

The strains transferred into the Telstra optical fibre cables can be monitored using Optical Time Domain Reflectometry (OTDR). The ground movements can also be monitored using traditional survey lines and visual inspections. These monitoring methods can be used to identify the development of irregular ground movements. If non-conventional movements or signal attenuation are detected during active subsidence, then the cable can be relieved by locally exposing and then reburying the affected section of cable.

It is recommended that monitoring and management strategies are developed, in consultation with Telstra, to manage the optical fibre cables for potential irregular ground movements. It is expected that these cables can be maintained in serviceable condition with the implementation of the appropriate monitoring and management strategies.

Impact Assessments for the Copper Telecommunications Cables

The copper telecommunications cables within the Study Area include both buried and aerial cables. The buried cables can be affected by curvatures and ground strains and the aerial cables can be affected by the changes in cable catenaries. Copper telecommunications cables are flexible and it has been found that these types of cables can typically tolerate strains up to 20 mm/m without adverse impacts.

Extensive experience of mining beneath copper telecommunications cables in the NSW Coalfields, where the observed strains were similar or greater than those predicted for the longwalls, indicates that incidences of impacts is very low and generally of a minor nature. Some remedial measures have been required, which include adjustments to cable catenaries, pole tilts and consumer cables which connect between the poles and building structures. The incidence of these impacts, however, was very low.

It is unlikely that the copper telecommunications cables would experience adverse impacts as a result of the extraction of Longwalls 301 to 303.

Impact Assessments for the Telecommunications Tower

The telecommunications tower and compound are located adjacent to the tailgate of Longwall 303.

The maximum predicted tilt for this installation is 1.5 mm/m (i.e. 0.15 %, or 1 in 667). The magnitude of tilt is very small (i.e. less than 1 %) and therefore is unlikely to adversely impact on the tower or compound. Tilt can potentially effect directional antennas (i.e. microwave dishes) and therefore it is recommended that the radio engineer reviews the predicted change in alignment. If adverse impacts were anticipated, the alignments of the directional antennas could be adjusted during active subsidence.

The maximum predicted conventional curvatures are 0.02 km^{-1} hogging and < 0.01 km^{-1} sagging, which equate to minimum radii of curvature of 50 kilometres and greater than 100 kilometres, respectively. The predicted strains are 0.9 mm/m tensile and 1.6 mm/m compressive based on the 95 % confidence level and 1.5 mm/m tensile and 3.2 mm/m compressive based on the 99 % confidence level.

It is recommended that the structural engineer reviews the structural integrity of the tower structure based on the predicted conventional subsidence, tilt and curvatures and the predicted distributions of strain. If adverse impacts were anticipated, then preventive measures should be implemented that could include the installation of additional bracing members and/or strengthening members to the existing frame.

The building enclosure is a steel framed structure founded on a concrete ground slab. It is unlikely that the enclosure would experience adverse impacts due to its lightweight construction and its separation from the ground due to the ground slab.

Summary

The optical fibre cables are located above the southern end of Longwall 301 and above the northern end of Longwall 303. The previous experience from the Southern Coalfield has found that the potential impacts on optical fibre cables can be managed with the implementation of suitable monitoring and management strategies. These strategies could include Optical Time Domain Reflectometry (OTDR), traditional ground monitoring lines and visual inspections.

The Telstra copper telecommunications cables are located above the northern ends of Longwalls 302 and 303. It is unlikely that these copper cables would experience adverse impacts as a result of Longwalls 301 to 303.

A telecommunications tower and compound is located adjacent to the tailgate of Longwall 303. It is recommended that the predicted movements are reviewed by the radio and structural engineers. Preventive measures for the tower should be installed if adverse impacts are anticipated. It is unlikely that adverse impacts would occur for the lightweight building enclosure.

It is expected that the potential impacts on the Telstra infrastructure can be managed with the implementation of the appropriate monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:

Drawing No. MSEC844-04 – Longwalls 301 to 303 – Telstra Infrastructure

Fig. A.1 Predicted Profiles of Conventional Subsidence, Tilt and Curvature for the Telstra Optical Fibre Cable (1) due to LW301 to LW303

Fig. A.2 Predicted Profiles of Conventional Subsidence, Tilt and Curvature for the Telstra Optical Fibre Cable (2) due to LW301 to LW303

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
TELSTRA INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
26 Aug 2016	1:12500	MSEC844-04	D

Grid to MGA co-ordinates

6 218 000
312 000
314 000
6 216 000

LEGEND
OPTICAL FIBRE
LOCAL CABLE

STUDY AREA
PREDICTED 20mm SUBSIDENCE CONTOUR
20
20
LW303
LW302
LW301
TELSTRA OPTICAL FIBRE CABLE 2
TELSTRA OPTICAL FIBRE CABLE 1
TELSTRA TELECOMMUNICATIONS TOWER
METROPOLITAN FAULT
CAWLEY ROAD OVERPASS
CAWLEYS CK
M1 PRINCES MOTORWAY
WORONORA RESERVOIR
OLD PRINCES HWY
NEXTGEN
OPTUS
OPTUS
WILSONS CK
PRINCES HIGHWAY UNDERPASS 2
FAULT
MAIN WEST FAULT
POWELL FAULT

GEOLOGICAL STRUCTURES
FAULTS
DYKES

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along the Telstra Optical Fibre Cable (1) due to LW301 to LW303

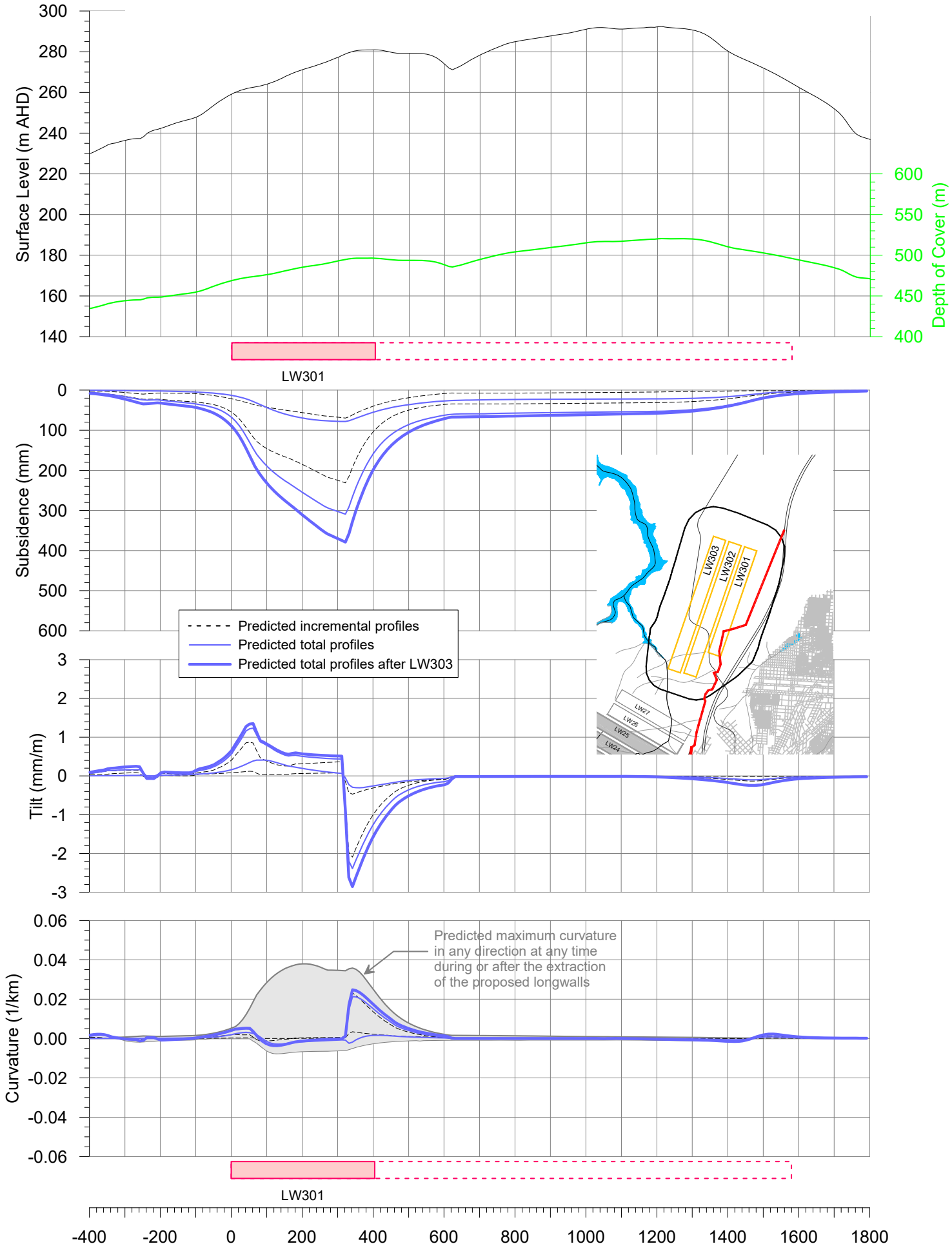

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Fig. A.1

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along the Telstra Optical Fibre Cable (2) due to LW301 to LW303

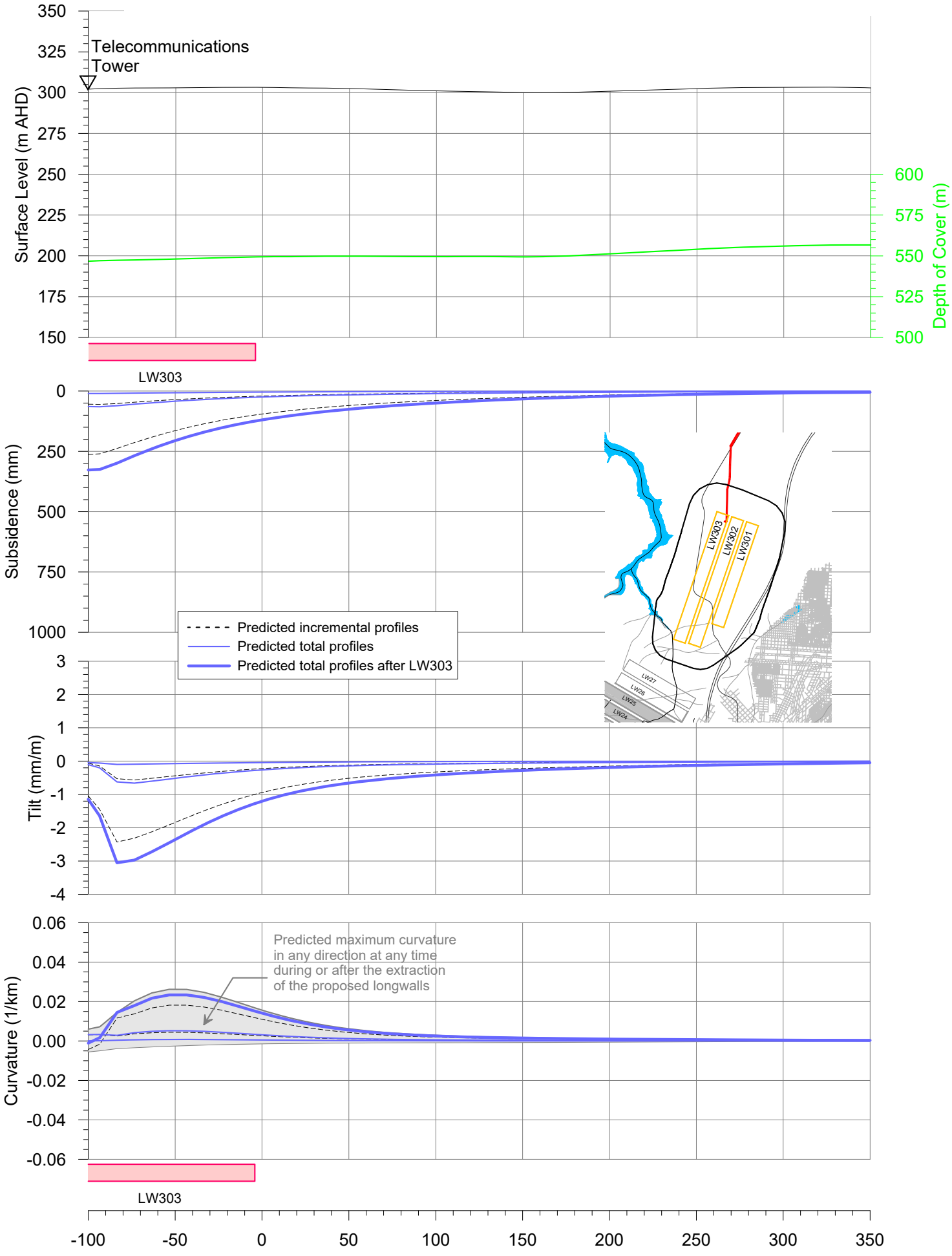


Fig. A.2

APPENDIX 2

MSEC (2019) METROPOLITAN COLLIERY – PROPOSED LONGWALL 304 - SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE TELSTRA INFRASTRUCTURE

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

13th March 2019

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC1013-04

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Telstra Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Telstra infrastructure resulting from the extraction of the proposed Longwall 304 at Metropolitan Colliery.

The locations of the Telstra infrastructure and the proposed and existing longwalls are shown in the attached Drawing No. MSEC1013-04. A Study Area is shown in Drawing No. MSEC1013-04 and is based on the outer limits of a 35° angle of draw line from Longwall 304 and the predicted 20mm subsidence contour for Longwall 304. There are two optical fibre cables within or immediately adjacent to the Study Area, but neither is located directly above the proposed Longwall 304. Copper telecommunications cables owned by Telstra are also located above Longwall 304 and to the north of Longwalls 302 and 303 and these cables service the Garrawarra Complex.

A telecommunications tower and compound are located within the Study Area, to the east of Longwall 304. The tower is located approximately 180 m to the east of Longwall 304 and 90 m to the north of Longwall 303. Photographs of this installation are provided in Figure 1.

Figure 1 Telecommunications Tower and Compound

The predictions and impact assessments for the Telstra infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the Telstra Infrastructure

The following provides summaries of the maximum predicted conventional movements for the Telstra infrastructure following the extraction of LW303 and after the extraction of LW304. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

The optical fibre cable located to the south and east of the Study Area is referred to as *Cable 1* and the optical fibre cable located in northern part of the Study Area is referred to as *Cable 2* in this letter report.

Cable 1 is located outside the Study Area and is approximately 560 m to the east of Longwall 304 at its nearest point. At this distance, Cable 1 is not expected to experience measurable conventional vertical subsidence, tilts or curvatures due to the extraction of Longwall 304. The cable could experience low level far-field horizontal movement. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield, which tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain. It is unlikely that Cable 1 would experience adverse impacts as a result of Longwall 304.

The predicted profiles of total conventional subsidence, tilt and curvature along the alignment of Telstra optical fibre Cable 2, following the extraction of Longwall 303 and after extraction of Longwall 304, are shown in the attached Fig. A.1. The predicted incremental profiles for the cable, due to the extraction of Longwall 304, are shown as dashed black lines. The predicted total profiles for the cables, after the extraction of Longwalls 303 and 304, are shown as solid blue lines. The range of predicted curvatures in any direction at any time during or after the extraction of the longwalls is shown by the grey shading.

Summaries of the maximum predicted values of total subsidence, tilt and curvature for Cable 2, following the extraction of Longwall 303 and after extraction of Longwall 304, are provided in Table 1. The values are the maxima anywhere along the cable at any time during or after the extraction of the longwalls.

Table 1 Maximum Predicted Total Subsidence, Tilt and Curvature for the Telstra Optical Fibre Cable 2 after the Extraction of Longwalls 303 and 304

Longwall	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})
After LW303	150	1.0	0.02	< 0.01
After LW304	300	2.5	0.02	< 0.01

The maximum predicted total subsidence for Cable 2 following the extraction of Longwall 303 and after the extraction of Longwall 304, is 300 mm. The maximum predicted conventional tilt is 2.5 mm/m (i.e. 0.3 %, or 1 in 400). The maximum predicted conventional curvatures are 0.02 km^{-1} hogging and < 0.01 km^{-1} sagging, which equate to minimum radii of curvature of 50 kilometres and 100 kilometres, respectively.

The copper telecommunications cables are located above the northern end of Longwall 304. A summary of the maximum predicted values of total subsidence, tilt and curvature for these copper cables, following the extraction of Longwall 303 and after extraction of Longwall 304, is provided in Table 2.

Table 2 Maximum Predicted Total Subsidence, Tilt and Curvature for the Telstra Copper Cables after the Extraction of Longwalls 303 and 304

Longwall	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})
After LW303	175	2.0	0.03	< 0.01
After LW304	650	3.5	0.03	0.03

The maximum predicted conventional tilt for the copper cables is 3.5 mm/m (i.e. 0.35 %, or 1 in 285). The maximum predicted conventional curvatures are 0.03 km^{-1} hogging and sagging, which equate to minimum radii of curvature of 33 kilometres.

The telecommunications tower and compound are located within the Study Area but not directly above the proposed Longwall 304. A summary of the maximum predicted values of total subsidence, tilt and curvature for this installation, following the extraction of Longwall 303 and after extraction of Longwall 304, is provided in Table **3**.

Table 3 Maximum Predicted Total Subsidence, Tilt and Curvature for the Telecommunications Tower and Compound after the Extraction of Longwalls 303 and 304

Longwall	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})
After LW303	100	1.0	< 0.01	< 0.01
After LW304	175	2.0	0.02	< 0.01

The maximum predicted conventional tilt for the telecommunications tower and compound is 2.0 mm/m (i.e. 0.2 %, or 1 in 500). The maximum predicted conventional curvatures are 0.02 km^{-1} hogging and < 0.01 km^{-1} sagging, which equate to minimum radii of curvature of 50 kilometres and greater than 100 kilometres, respectively.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the Telstra infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The Telstra infrastructure is partially located above the proposed Longwall 304 and Longwall 303. A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 2. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

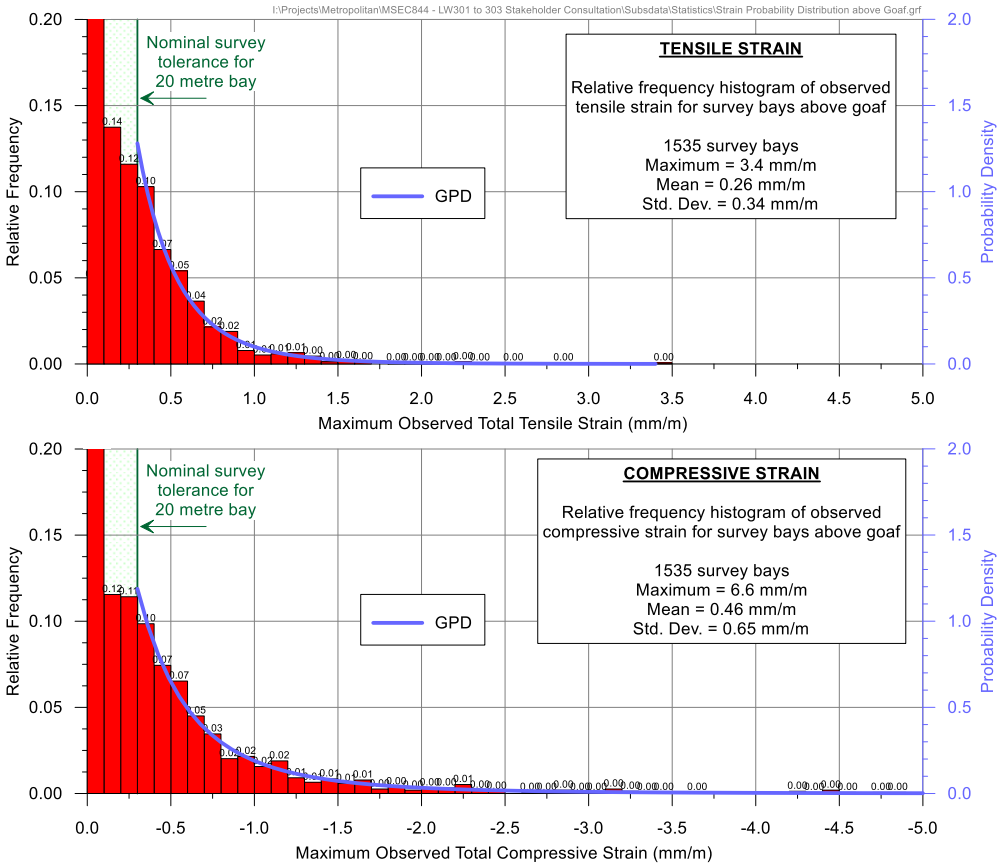


Figure 2 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based on the fitted GPDs, is provided in Table 4.

Table 4 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures at seam level and the major streams are shown in Drawing No. MSEC1013-04. There are no mapped faults located within the Study Area that extend beneath the Telstra infrastructure. It is possible that the infrastructure located above the longwalls could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). Non-conventional or anomalous movements have not been identified during the extraction of Longwalls 301 and 302. The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The optical fibre cables do not cross any major streams within the Study Area. These cables, therefore, are not expected to experience any measurable valley closure effects.

Impact Assessments for the Optical Fibre Cables

The optical fibre Cable 2 within the Study Area is conservatively assumed to be direct buried and will not be impacted by the tilts resulting from the extraction of Longwall 304. The cable, however, is likely to experience the minor curvatures and ground strains resulting from the extraction of this longwall.

The tensile strains in the optical fibre cables can be higher, however, where the cables connect to the support structures, which may act as anchor points, preventing any differential movements that may have been allowed to occur within the ground. Tree roots have also been known to anchor cables to the ground. The extent to which the anchor points affect the ability of the cable to tolerate the mine subsidence movements depends on the cable size, type, age, installation method and ground conditions.

In addition to this, optical fibre cables contain additional fibre lengths over the sheath lengths, where the individual fibres are loosely contained within tubes. Compression of the sheaths can transfer to the loose tubes and fibres and result in 'micro-bending' of the fibres constrained within the tubes, leading to higher attenuation of the transmitted signal. If the maximum predicted compressive strains were to be fully transferred into the optical fibre cables, they could be of sufficient magnitude to result in the reduction in capacities of the cables or transmission loss.

Localised and elevated curvatures could develop along the optical fibre cables due to non-conventional movements resulting from near surface geological structures (i.e. anomalies). It is possible that these non-conventional movements could be sufficient to result in the attenuation of signal.

The predicted curvatures and strains for the optical fibre cable are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar cables. It has been found from this previous experience that the potential impacts on optical fibre cables in the Southern Coalfield can be managed with the implementation of suitable monitoring and management strategies.

Some examples of mining beneath optical fibre cables in the Southern Coalfield are provided in Table **5**.

Table 5 Examples of Mining Beneath Optical Fibre Cables in the Southern Coalfield

Colliery and Longwalls	Length of Optical Fibre Cables Directly Mined Beneath (km)	Observed Maximum Movements at Optical Fibre Cables	Pre-Mining Mitigation, Monitoring and Observed Impacts
Appin LW301 and LW302	0.8	650 mm Subsidence 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	600 metre aerial cable on standby. Ground survey, visual, OTDR. No reported impacts.
Appin LW703 to LW706	12.7 total for eight cables	1,200 mm Subsidence 2.1 mm/m Tensile Strain 4.5 mm/m Comp. Strain (Measured HW2, ARTC and MPR Lines)	New cable redirection to avoid potential impacts to old optical fibre cable. Ground survey, visual, OTDR. Strain concentrations detected in three cables, attenuation losses were relieved by locally exposing the cables or by building a bypass cable.
Tahmoor LW22 to LW29	1.9	775 mm Subsidence 0.8 mm/m Tensile Strain 3.9 mm/m Comp. Strain	Ground survey, visual, OTDR, SBS. No reported impacts.
Tower LW1 to LW10	1.7	400 mm Subsidence 3 mm/m Tilt 0.5 mm/m Tensile Strain 1 mm/m Comp. Strain	No reported impacts
West Cliff LW5A3, LW5A4 and LW29 to LW38	3.4	1,300 mm Subsidence 1.3 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	Survey, visual, OTDR, SBS. No reported impacts.

The strains transferred into the Telstra optical fibre cables can be monitored using Optical Time Domain Reflectometry (OTDR). The ground movements can also be monitored using traditional survey lines and visual inspections. These monitoring methods can be used to identify the development of irregular ground movements. If non-conventional movements or signal attenuation are detected during active subsidence, then the cable can be relieved by locally exposing and then reburying the affected section of cable.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301 to 303 are updated and continued, in consultation with Telstra, to manage the optical fibre cables for potential irregular ground movements. It is expected that these cables can be maintained in serviceable condition with the implementation of the appropriate monitoring and management strategies.

Impact Assessments for the Copper Telecommunications Cables

The copper telecommunications cables within the Study Area include both buried and aerial cables. The buried cables can be affected by curvatures and ground strains and the aerial cables can be affected by the changes in cable catenaries. Copper telecommunications cables are flexible and it has been found that these types of cables can typically tolerate strains up to 20 mm/m without adverse impacts.

Extensive experience of mining beneath copper telecommunications cables in the NSW Coalfields, where the observed strains were similar or greater than those predicted for the longwalls, indicates that incidences of impacts is very low and generally of a minor nature. Some remedial measures have been required, which include adjustments to cable catenaries, pole tilts and consumer cables which connect between the poles and building structures. The incidence of these impacts, however, was very low.

It is unlikely that the copper telecommunications cables would experience adverse impacts as a result of the extraction of Longwall 304.

Impact Assessments for the Telecommunications Tower

The telecommunications tower and compound are located to the east of Longwall 304. The maximum predicted tilt for this installation is 2.0 mm/m (i.e. 0.2 %, or 1 in 500). The magnitude of tilt is very small (i.e. less than 1 %) and therefore is unlikely to adversely impact on the tower or compound. Tilt can potentially effect directional antennas (i.e. microwave dishes) and therefore it is recommended that the radio engineer reviews the predicted change in alignment. If adverse impacts were anticipated, the alignments of the directional antennas could be adjusted during active subsidence.

The maximum predicted conventional curvatures are 0.02 km^{-1} hogging and < 0.01 km^{-1} sagging, which equate to minimum radii of curvature of 50 kilometres and greater than 100 kilometres, respectively. The predicted strains are 0.9 mm/m tensile and 1.6 mm/m compressive based on the 95 % confidence level and 1.5 mm/m tensile and 3.2 mm/m compressive based on the 99 % confidence level.

The steel framed building structure is supported on piers above a concrete ground slab. It is unlikely that the structure would experience adverse impacts due to the lightweight construction and elevation above natural ground. It is expected that these enclosures would remain in safe and serviceable conditions during and after mining. Adverse impacts could be remediated using normal building maintenance techniques.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301 to 303 are updated and continued, in consultation with Telstra, to manage the tower for potential irregular ground movements. Structural assessments undertaken for the extraction of Longwalls 301 to 303 should also be reviewed for the extraction of Longwall 304.

Summary

The optical fibre cables are located to the south and east of the Study Area (Cable 1) and in the northern part of the Study Area (Cable 2) but not directly above the proposed Longwall 304. Previous experience from the Southern Coalfield has found that the potential impacts on optical fibre cables can be managed with the implementation of suitable monitoring and management strategies. These strategies could include Optical Time Domain Reflectometry (OTDR), traditional ground monitoring lines and visual inspections.

The Telstra copper telecommunications cables are located above the northern end of Longwalls 304. It is unlikely that these copper cables would experience adverse impacts as a result of Longwall 304.

A telecommunications tower and compound are located to the east of Longwall 304. It is recommended that the predicted movements for these structures are reviewed by the radio and structural engineers for the extraction of Longwall 304. It is unlikely that adverse impacts would occur for the lightweight building enclosure.

It is expected that the potential impacts on the Telstra infrastructure can be managed with the implementation of the appropriate monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:

Drawing No. MSEC1013-04 – Longwall 304 – Telstra Infrastructure

Fig. A.1 Predicted Profiles of Conventional Subsidence, Tilt and Curvature for the Telstra Optical Fibre Cable (2) after LW303 and after LW304

I:\Projects\Metropolitan\MSEC1013 - LW304 Stakeholders Consultation\AcadData\MSEC1013-04 Telstra.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COLLIERY
LONGWALL 304
TELSTRA INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	1:10000	MSEC1013-04	02

Grid to MGA co-ordinates

6 218 000

312 000

6 216 000

CAWLEYS CK

METROPOLITAN FAULT

TELSTRA OPTICAL FIBRE CABLE 2

TELSTRA OPTICAL FIBRE CABLE 1

TELSTRA TELECOMMUNICATIONS TOWER

WORONORA RESERVOIR

STUDY AREA

PREDICTED 20mm SUBSIDENCE CONTOUR

LW304

LW303

LW302

LW301

OLD PRINCES HWY

VOCUS

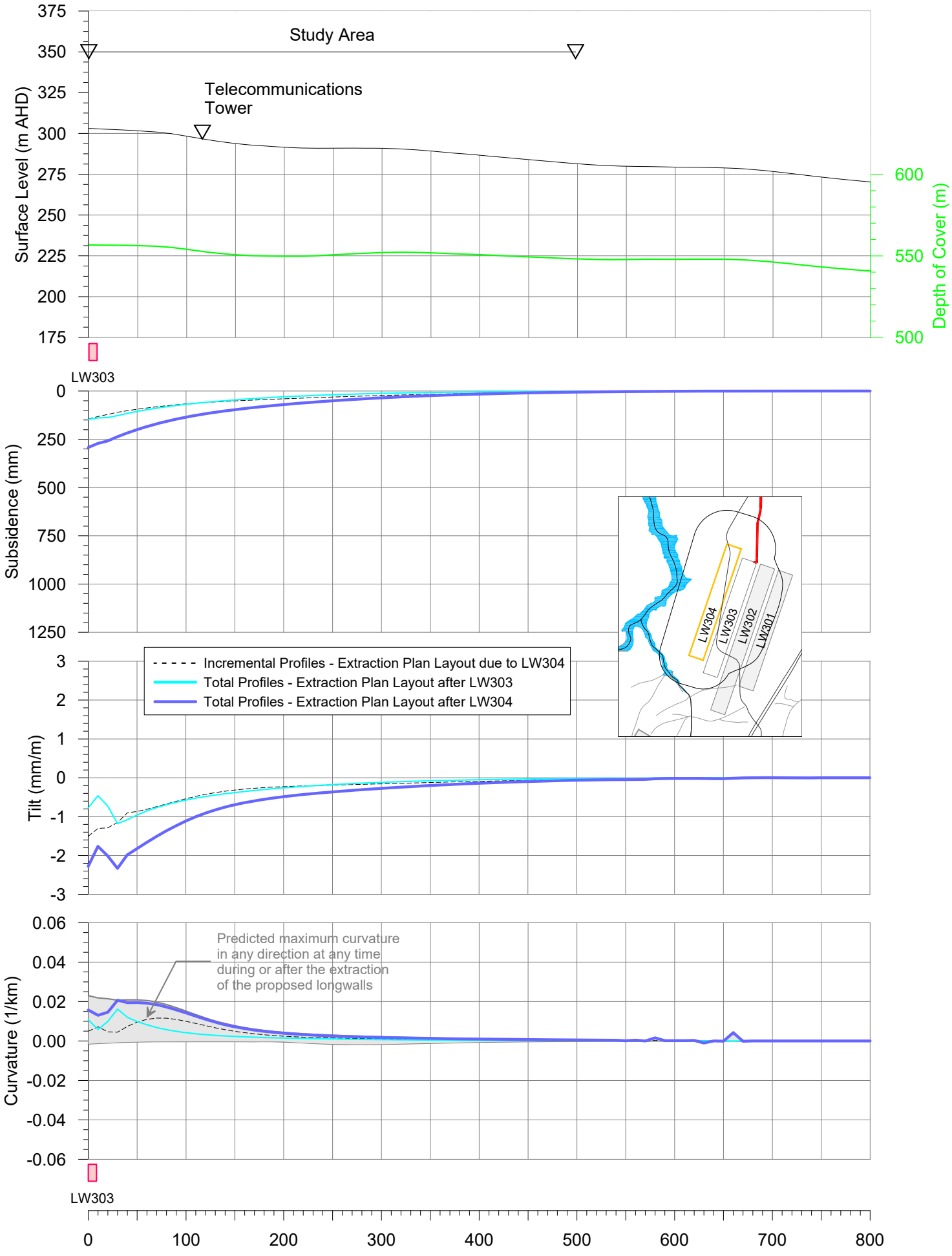
OPTUS

WILSONS CK

LEGEND
- OPTICAL FIBRE
- LOCAL CABLE

GEOLOGICAL STRUCTURES
- FAULTS
- DYKES

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along the Telstra Optical Fibre Cable due to LW304



msec

Fig. A.1

APPENDIX 3

BUILT FEATURES MANAGEMENT PLAN – SUBSIDENCE IMPACT REGISTER

Built Features Management Plan - Subsidence Impact Register

Impact Register Number[1]	Built Feature[2,3]	Impact Description	Does Impact Exceed the Built Feature Performance Measure/Indicators? (Yes/No)	Management Measures Implemented	Were Management Measures Effective? (Yes/No)

Notes:

1: Fill out all details in the Assessment Form and record the register number here.

2: Built feature (e.g. cable line, etc.).

3: Impacts to access roads/tracks to be included in the Land Management Plan – Subsidence Impact Register.

Built Feature Management Plan – Subsidence Impact Register
Assessment Form

Date:

Observer (Name and position):

Register Number (i.e. Number 1, 2, etc.):

Longwall Number and Chainage:

Location of Observed Impact:

(Examples: location of cable line, include GPS co-ordinates and a sketch)

Description of Observed Impact:

(Examples: nature and extent of impact - cracks in road etc any relevant information, attach photographs)

Person Notified:	Manager - Technical Services	☐

Description of Photographs:

Actions Required:	Contingency Plan Initiated	☐
	Incident Notification	☐
	Safety Measures/Public Safety Management Plan Requirements	☐

Management or Contingency Measures Implemented:

Effectiveness of Management or Contingency Measures:

APPENDIX 4

TELSTRA MANAGEMENT PLAN AGREEMENT (2016)

Telstra Corporation Ltd

Telstra Network Integrity Group
Network Integrity

Metropolitan Coal,
Peabody Energy Pty Ltd
Helensburgh, N.S.W

Management Plan

Metropolitan Coal,
Peabody Energy Pty Ltd
Longwall Coal Extraction LW301 toLW303,
Below Telstra's Network,
@ Garrawarra, N.S.W.

Authorised on behalf of
Telstra Corporation Ltd

…….

(Name:…….)
(Position:…….)
(Date: …….)

Authorised on behalf of
Metropolitan Coal,

……..

(Name:……)
(Position…….)
(Date: …….)

Issue Date: **DRAFT 21-10-16**

Revision No. & Date:

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1.0 Introduction

The Metropolitan Mine is owned and operated by Metropolitan Coal Pty Ltd (MCPL), a wholly owned subsidiary of Peabody Energy Australia Pty Ltd. MCPL was granted approval for the Metropolitan Coal Project under Section 75J of the New South Wales (NSW) Environmental Planning and Assessment Act, 1979 on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com.au).

Metropolitan Mine is an underground coal mine located at Helensburgh NSW and is about to commence extraction of coal in a new longwall series, longwalls LW301 to LW303 following completion of longwall LW27 in December 2017. The new longwall extraction area is located approximately 2000m north west of Helensburgh and immediately west of the Southern Freeway and to the east of the Princes Highway. The longwalls run approximately 2000m in a north east, south west direction within the Approved Project underground mining area. See Plate 1 on the following page and the Predicted 20mm Subsidence Contour outlined on Appendix B.

MCPL has identified surface assets which may potentially be affected by the mining operations during the longwall extraction. Some of the assets in the area are owned by Telstra, and there is a possibility of subsidence impacts, on these assets. Refer to Mine Subsidence Engineering Consultants (MSEC) Report " Metropolitan Colliery – Proposed Longwalls 301 to 303 – Subsidence Predictions and Impact Assessments for the Telstra Infrastructure" dated 12th July 2016 Reference No 1, for subsidence predictions affecting Telstra infrastructure within the Study Area. Following preliminary identification of the Telstra network within the subsidence zone and in consultation with Telstra, Mark Schneider, Team Manager Telstra Network Integrity, advised to MCPL that Comms Network Solutions Pty Ltd (CNS) be engaged to carry out a survey and audit of the Telstra network and to then prepare a management plan for the Telstra network in the proposed mining area.

The audit by CNS of the Telstra network was completed on 8th, 9th and 21st September 2016 covering the Telstra network installed within the Study Area, defined by the 35 degree angle of draw outlined in yellow shown on Plate 1, following page. The area of the audit is also shown in the attached Google Earth Plan, Appendix A,"Telstra & Nextgen Cable Route -Longwalls LW301 to LW303". Following the audit of the Telstra network, the information is presented in this management plan for MCPL and Telstra to review and if found acceptable then sign off, by both parties, as acceptance of the management plan. The management plan will only consider the potential impact on the Telstra network located within the SMP investigation area as shown in Appendix A and Appendix B.

The Telstra network located in the Study Area and the 600m Secondary Extraction Area has been identified from the field audit as follows :-

a) Inter Exchange Network (IEN) Optical fibre cable:- Major Interstate Trunk Cable F KNST 2005 ENGA-HBGH 80f Sydney-Melbourne No 3 optical fibre cable. Includes 16 dedicated fibres in this cable to provide IEN Services Engadine-Helensburgh.
b) Customer Access Network (CAN) Cable F ENGA 3001 6f Engadine-Garrawarra -Mobile Phone Tower.
c) Customer Access Network (CAN) Cable F ENGA 3005 12f Engadine-Garrawarra RIM and Garrawarra Hospital customer cable.
d) Copper Cable Network supplying customer services throughout Garrawarra Hospital and residential area
    i) Buried copper cable
    ii) Aerial copper cable
e) Mobile Telephone Tower and associated Infrastructure

f) Associated pits, conduits and poles supporting the cable network in a) to e) above.

However the items within 35 degree angle of draw and 20mm subsidence contour Plate 1, the yellow outlined area, are limited to Items a) and b) and a small section of d) and item e) above. Refer to Appendix A for details of the Telstra main optical fibre cable route installed within investigation area.

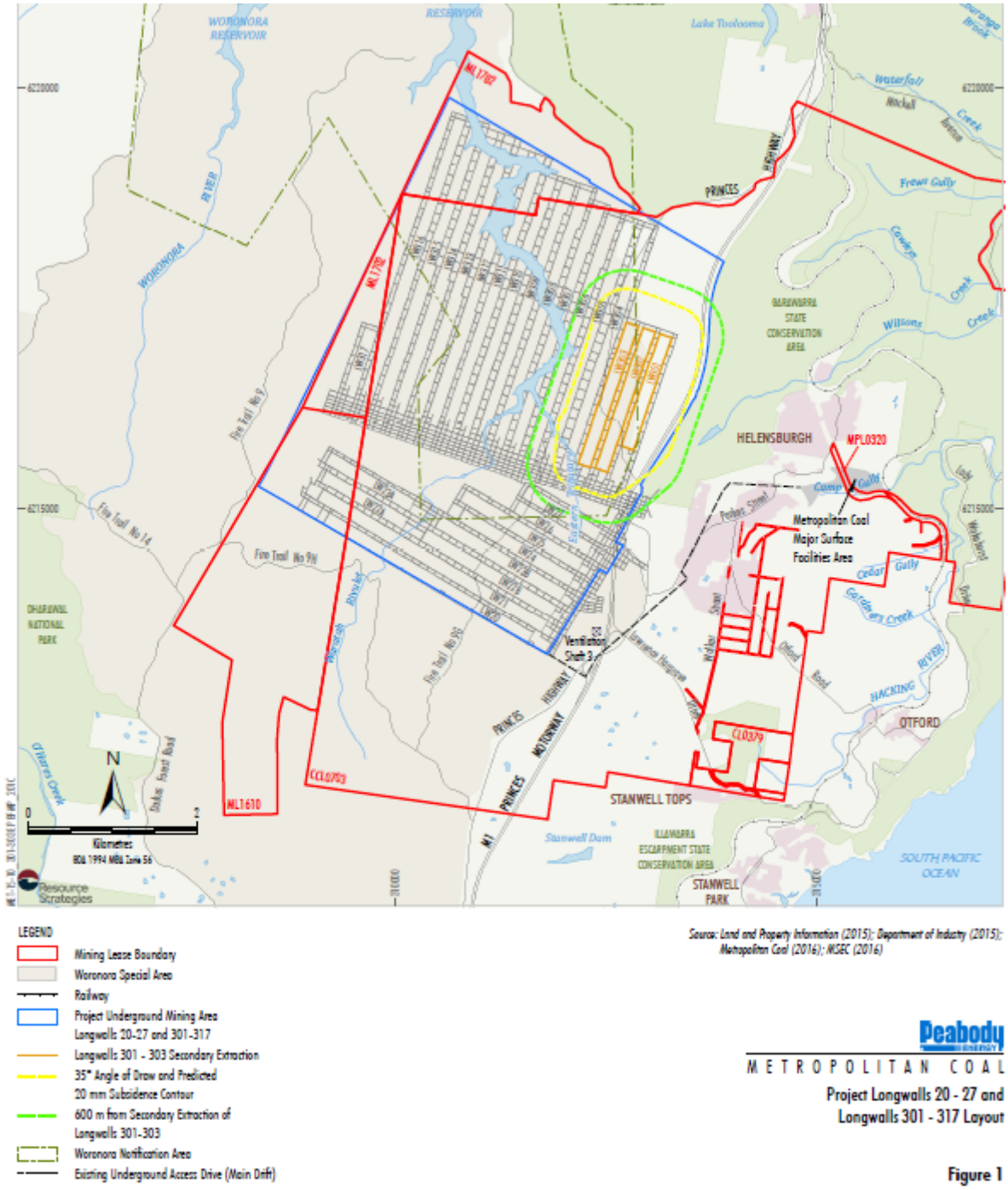

Plate 1:
Extract from Figure 1 Reference No 1:
General Arrangement of the Metropolitan Mine longwall mining area showing area under consideration for this management Plan, Longwalls LW301-303. Yellow outline around extraction area is the 20mm Subsidence Contour line and green outline is the 600m limit from Secondary Extraction.

The optical fibre cables identified as a) above cross the southern corner of LW301. The other optical fibre cable Item c), majority of copper cables d) and the RIM are located in the northern end of the study area and are only impacted by the northern ends of LW302 and LW303. Refer to Appendix B.

The Telstra Built Features Management Plan (Telstra BFMP) August 2016 has been prepared and references this document as Appendix 3. Therefore the aim of this document is to cover the detailed assessment of the Telstra network impacted by mining and recommended monitoring actions for the items of plant identified above.

1.1) Predicted Ground Movements:

As discussed in Reference No 1 predictions have been made for ground movements related to the various items of Telstra infrastructure as identified above, items a) to f). The degree of ground subsidence and curvature generally provides an indication of the impact anticipated on the network however ground strain has the greatest impact on buried cables and on the conduit and pit network, items a), b), c), d) i) & f). The other relevant ground movement factor is tilt and for above ground structures such as the Tower e) and aerial cables d) ii) they are more susceptable to tilts occuring in the area around the base of the poles or tower.

Therefore for the local copper aerial cable as identified in Table 5 below, Reference 1 show the maximum predicted tilt is 4mm/m

Table 5 Maximum Predicted Total Subsidence, Tilt and Curvature for the Telstra Copper Cables Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	20	< 0.5	< 0.01	< 0.01
After LW302	325	3.0	0.02	0.02
After LW303	425	4.0	0.03	0.03

The maximum predicted conventional tilt for the copper cables is 4.0 mm/m (i.e. 0.4 %, or 1 in 250). The maximum predicted conventional curvatures are 0.03 km^{-1} hogging and sagging, which equate to minimum radii of curvature of 33 kilometres.

The tilt predictions for the Telstra tower as identified in Table 6, reference 1, show the maximum predicted tilt is less than for the aerial cable at 1.5mm/m

Table 6 Maximum Predicted Total Subsidence, Tilt and Curvature for the Telecommunications Tower and Compound Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	< 20	< 0.5	< 0.01	< 0.01
After LW302	30	< 0.5	< 0.01	< 0.01
After LW303	150	1.5	0.02	< 0.01

The maximum predicted conventional tilt for the telecommunications tower and compound is 1.5 mm/m (i.e. 0.15 %, or 1 in 667). The maximum predicted conventional curvatures are 0.02 km^{-1} hogging and < 0.01 km^{-1} sagging, which equate to minimum radii of curvature of 50 kilometres and greater than 100 kilometres, respectively.

As mentioned above the majority of the Telstra network is affected by ground strain which is able to be predicted for the Telstra network from previous data gathered @ MCPL and at the Southern Coalfields for survey bays located above previously extracted longwalls.

The predicted compressive and tensile strain levels from Reference 1 are as per extract below:-

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

1.2) Anomalous Movement & Valley Closure:

There is also the potential for anomalous ground movement occurring during mine subsidence however this is minimised by the exclusion of known geological faults within the study area and also including an allowance for valley upsidence and closure within the predictions for ground strain. As indicated in the extract from Reference 1 below there are no known geological faults present in the study area as it is located just south of the east-west Metropolitan Fault line and to the north of the Main West Fault line. See Appendix A for location of known fault lines.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures and the streams are shown in Drawing No. MSEC844-04.

There are no mapped faults located within the extents of Longwalls 301 to 303. It is possible that the infrastructure located above the longwalls could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The optical fibre cables do not cross any major streams within the Study Area. These cables, therefore, are not expected to experience any measurable valley closure effects.

2.0) Scope

The predicted systematic strains at 99% confidence levels of 1.5mm/m tensile and 3.2mm/m compression are relatively high particularly for optical fibre cables however the limited extent of the cable projection at the north western areas of LW303 indicates that these cables are not in a location to sustain these levels of strain for a long period of time. The Sydney-Melbourne cable at the south eastern finishing end of LW301 will develop tensile travelling and compressive strains and then will also develop systematic compressive and tensile strains due to the location of the cable line along and then across the longwall. Therefore it is anticipated that particularly for this cable it may sustain the high levels of compressive strain predicted.

The audit that has been completed and this management plan will identify the assets at risk and propose a monitoring regime on the performance of the Telstra's plant, installed through this relatively rough undulating sandstone plateau, particularly in the south eastern area. In this instance as identified in Section 1) above there is the Sydney-Melbourne optical fibre cable F KNST 2005 present within the south eastern study area of LW301. This cable carries the majority of telephone, data and internet traffic between the two major capital cities in Australia and the IEN fibres also present in the cable provide all the telephone, data and internet services between Engadine and Helensburgh to the south. The network, identified in Section 1.0) has been assessed, in relation to the predicted subsidence impact, based on previous experience with telecommunication cables in mine subsidence areas. Since there are many variables involved with the installation conditions through the varying terrain traversed, it is considered that Optical Time Domain Reflectometer (OTDR) monitoring of the cable, combined

with a specific physical monitoring of the cable line, will offer a high level of protection to the Telstra assets during mining operations.

Monitoring of this cable Sydney-Melbourne No 3 is particularly important in this instance since 50% of Telstra's Sydney Melbourne network is potentially impacted concurrently by other mining operations. This includes also F NEWT 2001 Sydney Melbourne No 1 cable, subject to mining impacts at Douglas Park from LW707. So with mining concurrent in two geographic areas the combined risk to the network increases dramatically. Hence the management plan will put in place some actions to monitor the condition of the cable and associated manhole and pipe network, during the extraction of coal from longwalls LW301 to LW303.

2.1) Limitations.

It must be understood that the mechanism of mine subsidence and its impact on the telecommunications network has only been studied recently in some detail. Generally it has been considered that impacts were only possible on optical fibre cables in tension, as tension applied to the cable sheath would then transmit to the fibres within the sheath, causing attenuation of transmission signal and interruption to services. However experience has shown that cable compression can also lead to transmission failure due to micro bending of the fibres contained within the loose tube that supports the fibres. Since cable installation is continuous through varying ground conditions it is possible that cumulative strains or physical constraints within the trench line can cause high localised stress concentrations on the cable at specific locations from unpredicted ground movement.

Once the mine subsidence is initiated there is no method of halting the subsidence event. Hence if the degree of ground movement begins to affect the Telstra network then there are limited options available to relieve the stresses on the cable, without exposing the cables to high risk of damage from the remedial work undertaken. The aim of the management plan is to identify any vulnerability present in the network and monitor the performance of that part of the network during and after subsidence impacts. This action will not prevent the remote possibility of damage but provides a risk assessment and a method for monitoring that risk and offering protection to the cable.

2.2) Objectives & Risk

The objectives of this management plan in relation to Telstra's plant are to initially audit the network and then identify risks associated with the existing network components and to provide a strategy for monitoring this risk.

In relation to the assets identified in 1.0) above and 2.3) below, the following are the assessed relative risks associated with existing Telstra plant within the proposed mine subsidence area. The main items of plant at risk have been assessed according to the probability of damage and the consequences resulting from that damage. The Risk Factors are shown in the following table, Table 1.

Table 1
Relative Risk Factor **(RF)** for Telecommunications Plant

Risk Assessment Matrix		**Consequence**				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Almost Certain	Significant	Significant	High	High	High
	Likely	Moderate	Significant	Significant	High	High
	Moderate	Low	Moderate	Significant	High	High
	Unlikely	Low	Low	Moderate	Significant	High
	Rare	Low	Low	Moderate	Significant	Significant
	Very Rare	Low	Low	Low	Moderate	Significant

Refer to Appendix A for cable locations identified in the field audit.

2.3) Telstra Network & Audit Details - Risk Assessment

2.3.1) a) Major Interstate Trunk Optical Fibre Cable F KNST 2005 ENGA-HBGH 80f, Sydney-Melbourne No 3. Includes 16 dedicated fibres in this cable to provide IEN Services Engadine-Helensburgh
(Likelihood – Moderate, Consequence- Major, Risk Assessment - **High)**

This trunk optical fibre cable is a standard construction optical fibre cable installed in the early 1990's. The cable is hard jacketed with glass reinforced central strength member with Kevlar wrapping. However the early design of optical fibre cables only had an allowable haul tension of 1000kN and low crush resistance of 250 Newtons so the cable construction is not equivalent to the more modern design of High Strength optical fibre cables, capable of resisting uniformly applied ground strains of the order of 2-3mm/ metre without impacts on transmission capacity.
This early design cable however is installed in 32mm diameter sub-duct and then installed in 100mm PVC pipe across LW301 it is therefore relatively isolated from ground movement that may impact primarily on the conduit installation. However due to the relatively high risk presented from high strain

levels predicted, combined with the presence of sub-duct and conduit, it is possible that there may be some impact on this sensitive cable. Additionally since the cable is installed in very rocky isolated terrain where anomalous surface movement may damage the network, as a precautionary measure it is recommended that the cable line is physically inspected to ensure that there are no adverse ground impacts occurring as subsidence develops at the south-east finishing end of LW301. The added precaution of using OTDR monitoring of the cable condition over the relevant cable section from Engadine to Helensburgh exchanges is also recommended.

Plate 2
View of optical fibre cables through manhole at approximately 650m north of the Princes Highway underpass of the Southern Freeway M1. There is no joint at this location and the next joint north of the Princess Highway is in the Motocross Track area approximately 800m north and outside the mining area to the east of LW301.

2.3.1) b) Customer Access Network (CAN) Cable F ENGA 3001 6f Engadine-Garrawarra -Mobile Phone Tower.

c) Customer Access Network (CAN) Cable F ENGA 3005 12f Engadine-Garrawarra RIM and Garrawarra Hospital customer cable.

(Likelihood – Unlikely, Consequence- Moderate, Risk Assessment **- Moderate)**

These two cables originate from Engadine exchange and both provide services to the Telstra mobile Telephone Tower located just inside the commencing end of LW303. Additionally F ENGA 3005 also has fibres terminated in the Remote Connection Multiplex cabinet (RCM) identified as ‘EGMW’ located at the entry to the Hospital Site. This cabinet operates as a remote switching point from Engadine exchange to provide copper customer services from an optical fibre cable connection. The RCM supplies the copper customer services to the Hospital and the residential area surrounding the Hospital. These cables are vulnerable to ground movement particularly F ENGA 3001 as it is a standard construction optical fibre cable, F ENGA 3005 is a larger diameter High Strength / Rodent Proof cable sheath.

Plate 3:
RCM cabinet 'EGMW' located on the access road to the Hospital. Provides copper cable customer services from optical fibre transmission

Plate4:
Cable entry to Mobile Telephone Tower Hut showing two optical fibre cables into the Hut the larger diameter cable is F ENGA 3005 and the smaller diameter cable is the more vulnerable cable F ENGA 3001.

As shown in Appendix B the two cables are only exposed to around 50m of mining extraction at the northern commencing end of LW303 and approximately 350m within the Study Area. Since the cables are located at the northern location, full ground subsidence and ground strain development is not anticipated to develop. Accordingly the Risk Factor is considered to be **Moderate** an Unlikely event with Moderate consequences.

2.3.1) d) Copper Cable Network supplying customer services throughout Garrawarra Hospital and residential area.
Risk Factor is considered to be **Moderate** an Unlikely event with Moderate consequences.

i) Buried copper cable
ii) Aerial copper cable

Theses copper cable services are located within the Study Area and consist of 200 Branch pair cables from the RCM to the termination in the General Services Building. Then from this building the local services radiate out to the various Hospital buildings and residences located in and around the Hospital grounds. The mix of distribution of these local cables is approximately 50:50 between buried cable and aerial cable. As the majority of the network is north of LW302 and LW303 it is not considered to be particularly vulnerable to the likely ground movements. However the aerial cable from past mine related ground movement can be more susceptible to pole tilts and damage to the cable at the pole or building terminations. It is considered specially since there is very good mobile coverage in this area due to the presence of the mobile telephone towers that the Risk Factor for the fixed line copper network is **Moderate** an unlikely event with moderate consequences.

2.3.1) e) Mobile Telephone Tower and associated Infrastructure.
Risk Factor is considered to be **Moderate** an Unlikely event with Moderate consequences
The Mobile Telephone Tower as with the optical fibre cables which feed to the Tower is located at the northern end of LW303 approximately 50m from the north goaf edge. Accordingly the risk is that the Tower structure and hut will be subject to tilt which is predicted to be a maximum of 1.5mm/m with 150mm of subsidence.

Plate 5:
View of Tower base structure showing base ring of 24 x 24mm dia bolt cage to secure the base of the 25m steel monopole.

Plate 6:
View from western side of 25m steel monopole showing transmission array on north and eastern faces projecting signal towards M1

This particular tower does not use microwave dishes for any support functions such as back-up systems signalling and as such is not particularly sensitive to tilt occurring. The accepted standard for Telstra towers at Douglas Park and Tahmoor, subject to mining is a tilt level of less than 1 degree. Hence for the 25m tower this would be a tilt at the top of around 45mm. At a predicted maximum ground tilt of 1.5mm/m this would provide a tilt of around 37mm within the accepted limit. The details for this particular tower will be requested from Telstra to verify that this level of ground movement is acceptable.
Two types of footings are used for these towers either a bored 1.0m diameter pier or a mass concrete base of a 5m cube. Details will be requested from Telstra to verify the footing type and to then recommend the installation of tilt meters with real-time data provision as well as backup survey data for subsidence and tilt monitoring verification.

The Hut at the base of the tower carrying the transmission equipment is a 2000 line transportable exchange building also used for housing rural exchanges. Since the building is transportable it has a torsionally rigid base frame suitable for lifting onto trucks and then placing on blocks on site. Therefore the building is able to accept a reasonable degree of movement. However it does sit on a concrete base slab with penetrations around the building for cable entries, earthing cables and waveguides to the tower transmission aerials. Therefore these penetrations into the building should be monitored along with any obvious movement of the slab and supporting blocks to ensure the building is adequately supported at all times.

The Risk Factor for the Tower and Infrastructure is considered as Moderate an unlikely event with moderate consequences.

Plate 7:
View of Hut at Tower base housing all the transmission equipment for the support of the Mobile Telephone Tower. There is a very heavy battery array at the north end and a check should be maintained that the building is adequately supported at all times

2.3.1) f) Associated manholes pits and conduits supporting the above optical fibre and copper cable network.
(Likelihood – Moderate, Consequence- Major, Risk Assessment **- High)**

As discussed above, the Sydney Melbourne optical fibre cable is installed in 100mm PVC conduit and then in 32mm polyethylene sub-duct which passes through reinforced concrete joint housing pits within the eastern goaf area of LW301. As shown in Appendix A there are three manholes present in the study area, one within LW301, one within 70m of the eastern goaf edge and the third approximately 250m south of the finishing ends of the longwalls. The manhole outside the goaf area contains an optical fibre cable joint FAP 'CF' and the one south another joint at 'CE'. The cable joint section then extends approximately 1500m from the south side of the cable crossing of the Princes Highway to the north through to the joint on the eastern side of LW301

This section of conduit supporting the Major Sydney-Melbourne optical fibre cable will be fully impacted by the predicted ground strains along and across LW301. Although there is a reasonable degree of protection should significant ground movement cause movement of the 1.5 tonne manholes then serious damage could result on the cable. Hence due to the importance of this interstate cable and the critical transmission systems it carries the Risk Assessment for this part of the network is **High** with a Likelihood of Moderate combined with a Major consequence.

The conduit and pit network supporting the CAN optical fibre and copper cables through the Hospital grounds to the north of the longwalls is considered to be at a significantly reduced risk of damage. This is primarily due to the fact that this network only crosses into the goaf area by around 50m and is only within the Study Area for an additional 350m to the north where ground strains are significantly reduced.
There are two sections of the cable route shown in Appendix A which could not be located. See Appendix A. It is assumed the southern and western sections of these cables have been abandoned as

there are no existing structures in use in these areas where the cables terminate. Therefore the Risk Factor for this section of the network is considered as being **Low**, unlikely event with a minor consequence.

2.3.1) g) Proposed Subsidence Monitoring

MCPL is to establish new survey monitoring lines for Optical Fibre / Water, Garrawarra Lines and Tower Monitoring as indicated in Risk Analysis meeting with Telstra. The new lines are to be set prior to mining commencing and are to provide survey data on subsidence, strain and tilt, cumulative and incremental changes along the survey lines for the lines identified above. See Appendix C for layout of proposed monitoring lines.
It is also proposed that MCPL establish real-time data collection for two tiltmeters to be installed at the base of the Telstra Tower plus establish survey lines for subsidence, tilt and ground strain around the tower base prior to subsidence impact occurring.

3.0) Control Procedure

As identified in Item 2.3.1) a) to 2.3.1) f) above it is considered there is a **High** risk associated with mine subsidence impacts on some elements of the Telstra network. This is accepting that the systematic subsidence impacts predicted are relatively low yet there is still potential for anomalous ground movement which can account for much higher strain levels and the possibility of localised differential movement around this major telecommunications network.

See the following table, Table 2, which presents a Summary of the Telecommunications Plant, Risk Factor, Monitoring and Actions required for items of plant which may be impacted by mine subsidence. Note that in the Table items of plant have been grouped according to the monitoring technique proposed and the items as identified in 2.3.1 a) to 2.3.1) g) above.

Table 2 - Summary of Monitoring Procedures and Actions Proposed For Telstra Network

ITEM OF PLANT	Risk Factor	Monitoring & proposed Action				Actions & Responsibilities
		Method	Detail	Frequency	Trigger Levels	
a) Major Interstate Trunk Optical Fibre Cable F KNST 2005 ENGA-HBGH 80f, CAN Optical Fibre Cables b) F ENGA 3001 & c) F ENGA 3005	High Moderate	a)Continuous RFMS both cables b) Physically monitor cable line during LW301 to LW303 impacts c) MCPL to Survey. See g) below	a)Consult with Telstra Technical Specialist to set up RFMS if spare fibre avail. on F KNST 2005. CNS P/L Complete initial OTDR testing at 1625nm on spare fibres from ENGA Exchange b) CNS P/L Complete initial OTDR testing at 1625nm on F ENGA 3001 & 3005 on spare fibres from ENGA Exchange c) Physically check cable movement during critical periods for LW301 to 303 impacts.	a)Continuous monitor, Telstra Alarm, set @ 1.0dB initial loss level for F KNST 2005. Separate OTDR testing by CNS P/L for 3 cables from ENGA Exchange b) Physical monitoring in field during mining for a period covering 100m prior to crossing the cable and 400m past the cable line	a) Inspection during mining @ critical locations on longwalls. b) CNS determine loss present. Levels 0.3dB inspection & Uncover Cable, 1dB replace cable c) Ground movement detected check transmission monitoring	Telstra & CNS P/L to discuss with MCPL access requirements for F KNST 2005 through catchment area. C Dove physical inspection & advise any field impacts likely to adversely impact performance of cables. Telstra to maintain remote OTDR test F KNST 2005@1dB trigger, CNS monitor F DGPK 102 @ 0.3dB trigger. NIS, Team Leader, NSW (Mark Schneider) to activate mitigation strategy dependant on loss levels on test fibres. Telstra to advise of alarm condition or advise of damage reports to GOC. Mark Schneider to advise Plan Review Meeting. of proposed action on any of the three OF cables, i.e. uncover cable, emergency cutover or replace full length joint to joint
CAN Local Cables **d)** Copper Cable Network supplying customer services throughout Garrawarra Hospital and residential area. Includes cable in conduit and aerial distribution	Moderate	a) Physical cable inspection b) MCPL to Survey. See g) below	Physical Inspection of cable line, aerial cables & conduit and pit network to be carried out at critical subsidence times for each longwall as it impacts along the cable	The physical inspections regime for each longwall to be agreed between members of the Plan Review Meeting	Indication of damage identified along cable line then test cable and repair	MCPL to advise Mark Schneider & Colin Dove two weeks prior to each longwall crossing Telstra cable. Telstra consultant to monitor survey results provided from MCPL survey data. Physical Inspection of cable line during critical subsidence periods, details reported by Telstra consultant to Plan Review Meeting & proposed action to be agreed if impacts occur.

e) Mobile Telephone Tower and associated Infrastructure.	Moderate	a) MCPL establish survey lines around base b) MCPL install and maintain two tiltmetres at base of tower c) OTDR monitoring of cable line & physically monitor tower during LW302 & 303 impacts	a) Telstra specified tilt of 1 degree as trigger level. Survey regime & tiltmeters established @ base and on tower structure. Monitor data b) OTDR monitoring of cable line during LW302 303 impacts. Physically check cable and tower structure during LW302 & 303 passing tower	During commencing 400m of extraction from LW302 and LW303	Tilt of 1 degree and OTDR loss on cable 0.3dB	C Dove to liaise with Telstra specialist consultants and advise of progress of longwalls and impacts from survey data and tiltmetres. C Dove to advise Mark Schneider of any impacts for discussion & resolution at Plan Review Meetings
f) Conduit and pit network supporting cable	High to Low dependant on cable supported	As above for a) to e)	As above a) to e)	As above a) to e)	As above a) to e)	As above a) to e)
g) Subsidence Survey	N/A	Ground Survey of subsidence marks agreed with Telstra	MCPL to survey Telstra cable lines prior to, during and following each subsidence event. Survey lines to be established Optical Fibre/Water, Garrawarra Line & Tower Monitoring	As agreed during critical periods impacting each section of the network as mining progresses	As Above	MCPL to report survey results to Telstra within 48hrs following each individual survey, provide data on subsidence , ground strain and tilt to establish if there is any anomalous ground movement indicated

4.0) Geological fault:

Refer to the discussion in Section 1.2) above identifying the fault lines present to the north and south of the Study Area which both cross the Southern Freeway There is an area immediately south of the longwalls where fault lines are present in the vicinity of the cable line F KNST 2005 near the Princes Highway underpass which have the potential to intersect with the cable line and may cause differential movement at the structures along the cable line. Should any detailed evidence of anomalous surface movement be detected during survey monitoring in this area, this information should be reported to Telstra immediately to consider the implications for the Telstra network in the area.

5.0) Resources

Resources required to carry out the monitoring as identified in Section 3) above are to be provided by Telstra. The costs associated with the monitoring work required for the protection of the Telstra network are to be accepted by MCPL. As well MCPL will provide the survey resources required for the line and tower surveys to determine incremental subsidence, strain and tilt during the operation of the management plan, at agreed intervals, as each longwall approaches the cable line. Should survey results show any anomalous ground movement in the area of the cables then Telstra is to be advised, to complete immediate inspections and to be able to review current survey information and amend the monitoring regime on the network as required.

In the event of unforeseen impacts on the Telstra network, prior to commencing any proposed repair work, Telstra Network Integrity representatives will detail the extent of the proposed work and the associated costs to MCPL. A meeting should be called with representatives of Telstra Network Integrity, MCPL, and the Mine Subsidence Board to discuss the responsibility for the costs of the proposed work. In the event of a dispute as to responsibility for the costs, involving work to secure Telstra's network, where loss of service to customers or line system outage is involved, the work will be carried out by Telstra immediately to protect their customer network, while the discussion and resolution of the dispute regarding costs will continue.

6.0) Functions

The physical cable monitoring of the telecommunications network required by this management plan is to be carried out by a suitably qualified consultant experienced with both mine subsidence issues and the behaviour of optical fibre and copper cables during mine subsidence impacts. The cost for this work is the responsibility of MCPL. Regular discussions are to take place between Telstra, their consultants and MCPL who are to provide regular updates of the mine progress, present relevant survey information and to resolve any issues raised during the mine subsidence events relating to mining in LW301 to LW303. The current understanding of the status of the subsidence relative to the predictions and any change in potential risk to the Telstra network is to be used to determine the frequency of contact on mining related issues.

The representatives of the authorities involved in discussions involving potential impacts on the Telstra network are:-

Jon Degotardi, Technical Services Manager, Metropolitan Colliery.
Mark Schneider, Team Manager, Telstra Network Integrity.
Matthew Montgomery, District Manager, Mine Subsidence Board
Peter DeBono, Project Manager, Mine Subsidence Engineering Consultants
Colin Dove, Consultant Telecommunications Engineer.

Should significant risk be identified to the Telstra network then either party involved may call for a meeting of the interested parties, with one day's notice, to discuss proposed action and to keep other parties informed of developments in the monitoring and or protection of the Telstra network.

7.0) Audit and Review

It is anticipated that this plan will be in place for approximately 2 years from the commencement of LW301 operations or for a minimum period of three months following final ground settlement after completion of mining in LW303.

Should an audit of the management plan be required during its period of operation then a representative is to be appointed by Telstra, MCPL and the Mine Subsidence Board to review the operation of the plan and report to a meeting of the interested parties.

Other factors which may require the management plan to be reviewed are:-

- Poor performance of the Telstra plant in regard to mine subsidence, such as cable damage.
- Favourable performance of the Telstra plant in regard to mine subsidence, no observed or recorded impacts.
- Significant variations from predicted subsidence tilt or strain occurring.
- Significant movement identified at the geological fault lines

8.0) Associated Documents

8.1) References:

Reference No 1.- Mine Subsidence Engineering Consultants (MSEC) Report
" Metropolitan Colliery – Proposed Longwalls 301 to 303,
– Subsidence Predictions and Impact Assessments
for the Telstra Infrastructure" dated 12th July 2016.

8.2) Appendices

Appendix A.-
Telstra & Nextgen Cable Route,
Showing Metropolitan Coal Longwalls LW301 to LW303
(Google Earth 2016) Sheet 1 of 1

Appendix B -
"Metropolitan Coal Pty Ltd, Metropolitan Colliery
Longwalls 301 to 303, Telstra Infrastructure"
MSEC Dwg – MSEC844-04 rev D Sheet 1 of 1

Appendix C -
"Metropolitan Coal Pty Ltd, Metropolitan Colliery
Proposed Monitoring Lines LW301 to LW303"
MSEC Drawing Sheet 1 of 1

9.0) Contact List.

Metropolitan Colliery
Jon Degotardi,
Technical Services Manager,
PO Box 402, Helensburgh, NSW, 2508
Telephone: 4294 7233, Mobile 0407 241 761
Email : jdegotardi@peabodyenergy.com

Telstra
Mark Schneider,
Team Manager,
Telstra Network Integrity,
Locked Bag 5035, Parramatta, 2124, NSW,
Telephone: 8851 2297, Mobile 0419 242 044,
Email :Mark.P.Schneider@team.telstra.com

Mine Subsidence Board
Matthew Montgomery,
District Manager,
Southern Coalfields
Telephone: 4677 1967,
Mobile: 0425 275 564.
Email: m.montgomery@minesub.nsw.gov.au

Peter DeBono,
Project Manager,
Mine Subsidence Engineering Consultants,
PO Box 302 Chatswood NSW 2057
Telephone: 9413 3777, Fax: 8412 0222,
Email : peter@minesubsidence.com
Mobile: 0412 039 071.

Colin Dove,
Telecommunications Consultant, External Plant,
Mobile 0428 970 826,
Email cdove@bigpond.com.au,

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Appendices

Appendix A.-

Telstra & Nextgen Cable Route,
Showing Metropolitan Coal's
Longwalls LW301 to LW303
(Google Earth 2016) Sheet 1 of 1

Appendix B -

"Metropolitan Coal Pty Ltd, Metropolitan Colliery
Longwalls 301 to 303, Telstra Infrastructure"
MSEC Dwg – MSEC844-04 rev D Sheet 1 of 1

Appendix C -

"Metropolitan Coal Pty Ltd, Metropolitan Colliery
Proposed Monitoring Lines LW301 to LW303"
MSEC Drawing Sheet 1 of 1

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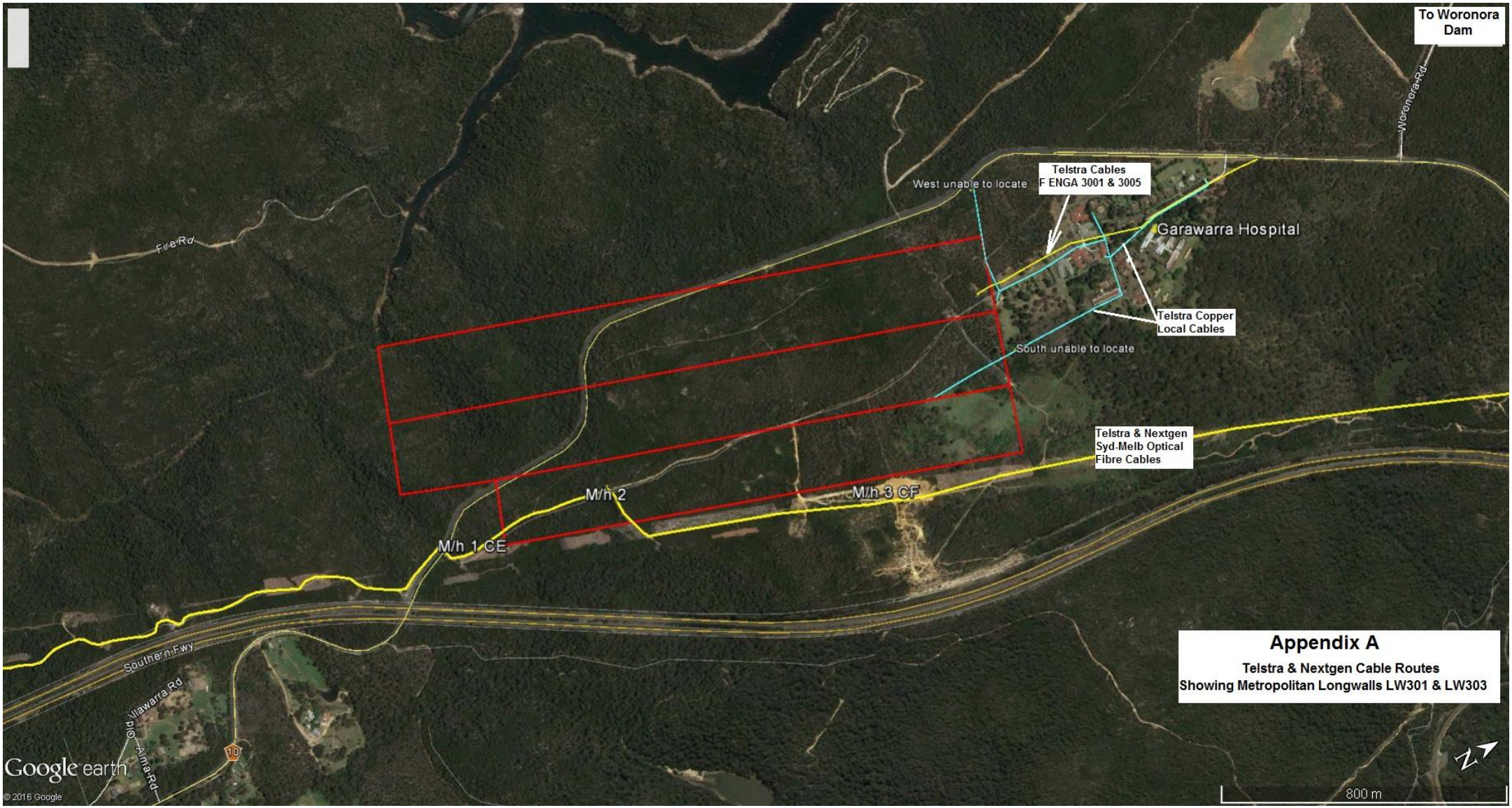
To Woronora Dam
Woronora Rd
Telstra Cables
F ENGA 3001 & 3005
West unable to locate
Garawarra Hospital
Telstra Copper
Local Cables
South unable to locate
Telstra & Nextgen
Syd-Melb Optical
Fibre Cables
M/h 2
M/h 3 CF
M/h 1 CE
Fire Rd
Southern Fwy
Illawarra Rd
Old Illawarra Rd
Google earth
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Appendix A
Telstra & Nextgen Cable Routes
Showing Metropolitan Longwalls LW301 & LW303

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
TELSTRA INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
26 Aug 2016	1:12500	MSEC844-04	D

Grid to MGA co-ordinates

6 218 000
312 000
314 000
6 216 000

LEGEND
OPTICAL FIBRE
LOCAL CABLE

STUDY AREA
PREDICTED 20mm SUBSIDENCE CONTOUR
20
20
LW303
LW302
LW301
TELSTRA OPTICAL FIBRE CABLE 2
TELSTRA OPTICAL FIBRE CABLE 1
TELSTRA TELECOMMUNICATIONS TOWER
METROPOLITAN FAULT
MAIN WEST FAULT
POWELL FAULT
FAULT
CAWLEY ROAD OVERPASS
CAWLEYS CK
M1 PRINCES MOTORWAY
WORONORA RESERVOIR
OLD PRINCES HWY
NEXTGEN
OPTUS
OPTUS
WILSONS CK
PRINCES HIGHWAY UNDERPASS 2

APPENDIX B

GEOLOGICAL STRUCTURES
FAULTS
DYKES

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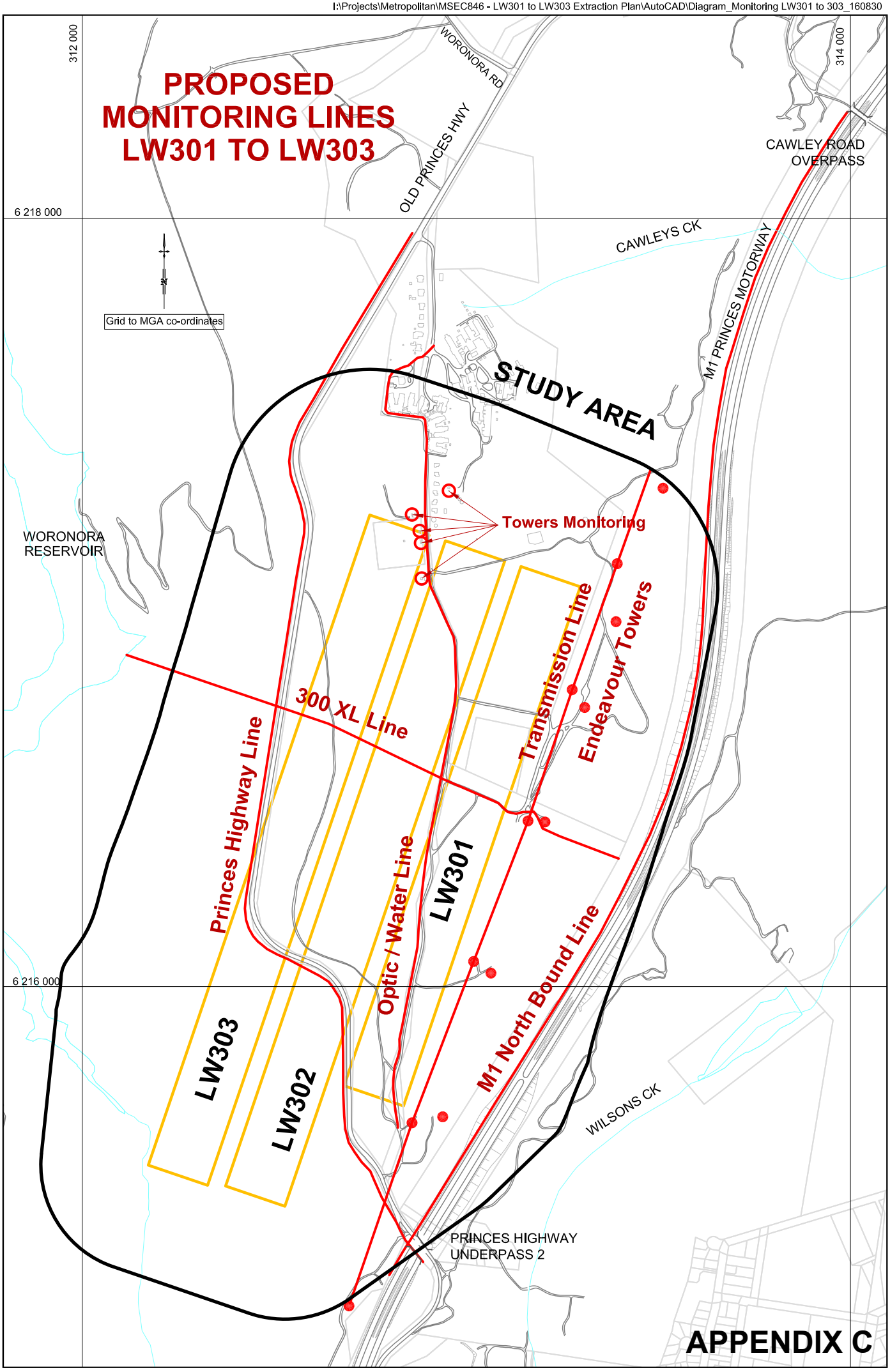
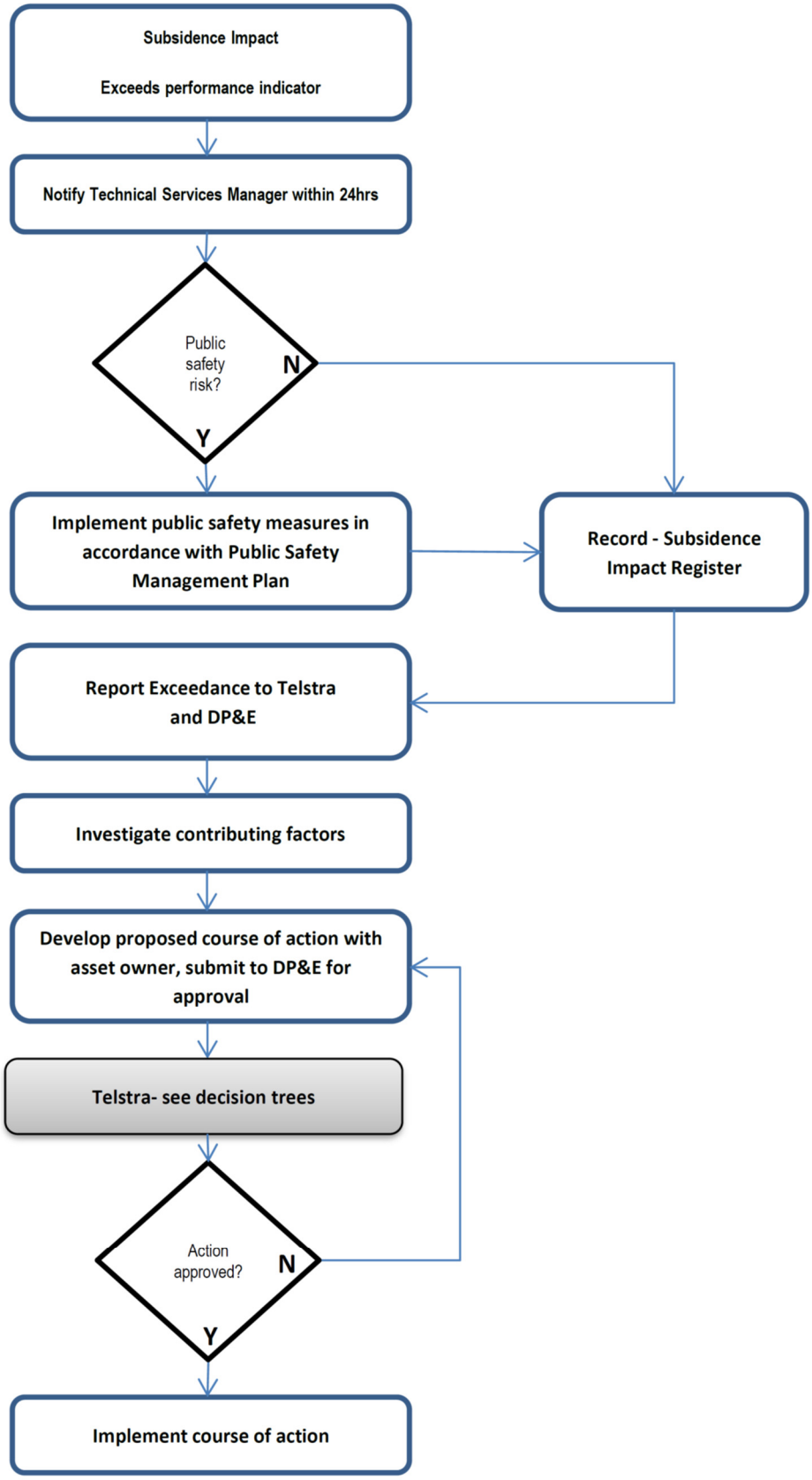
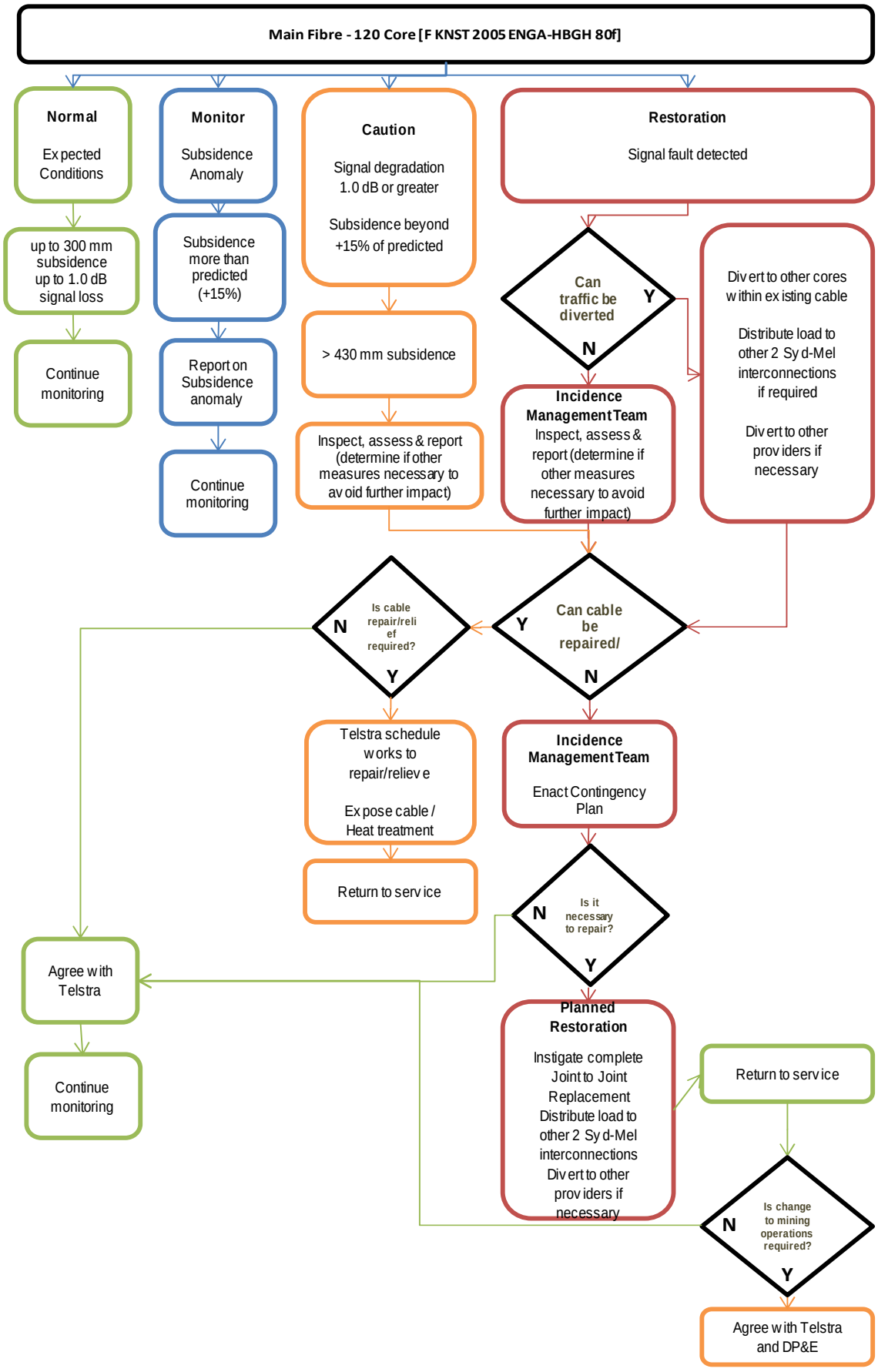
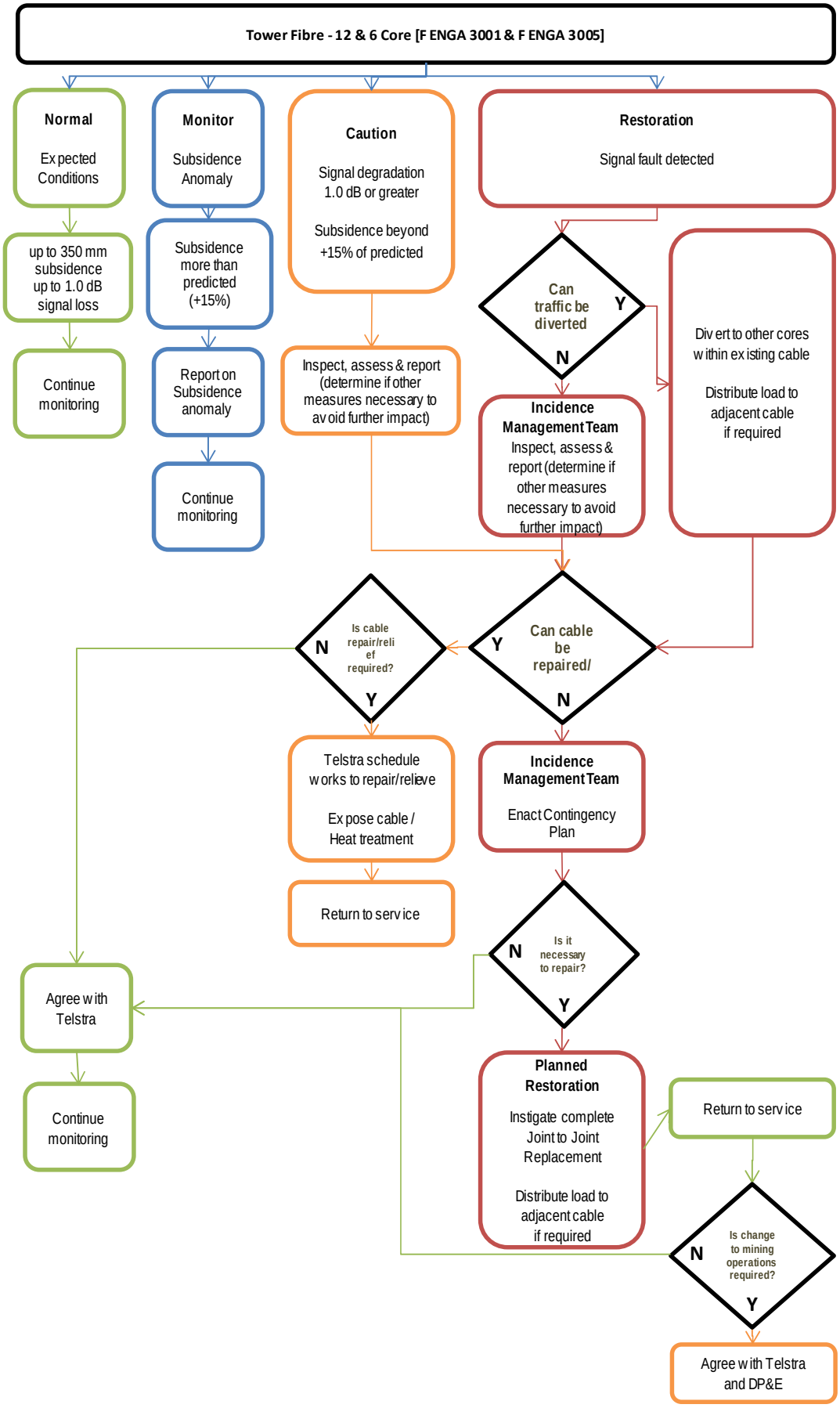


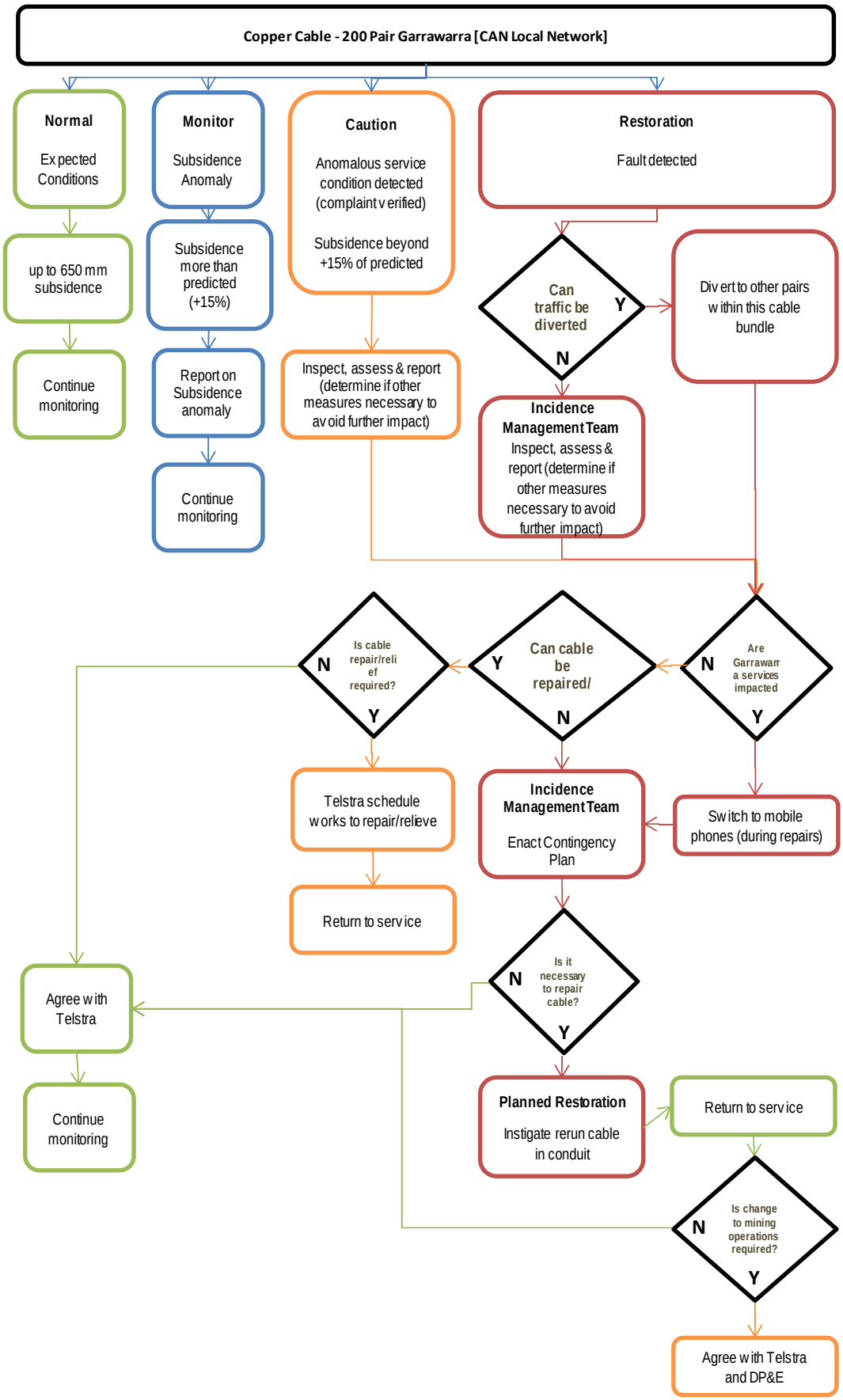
APPENDIX 5

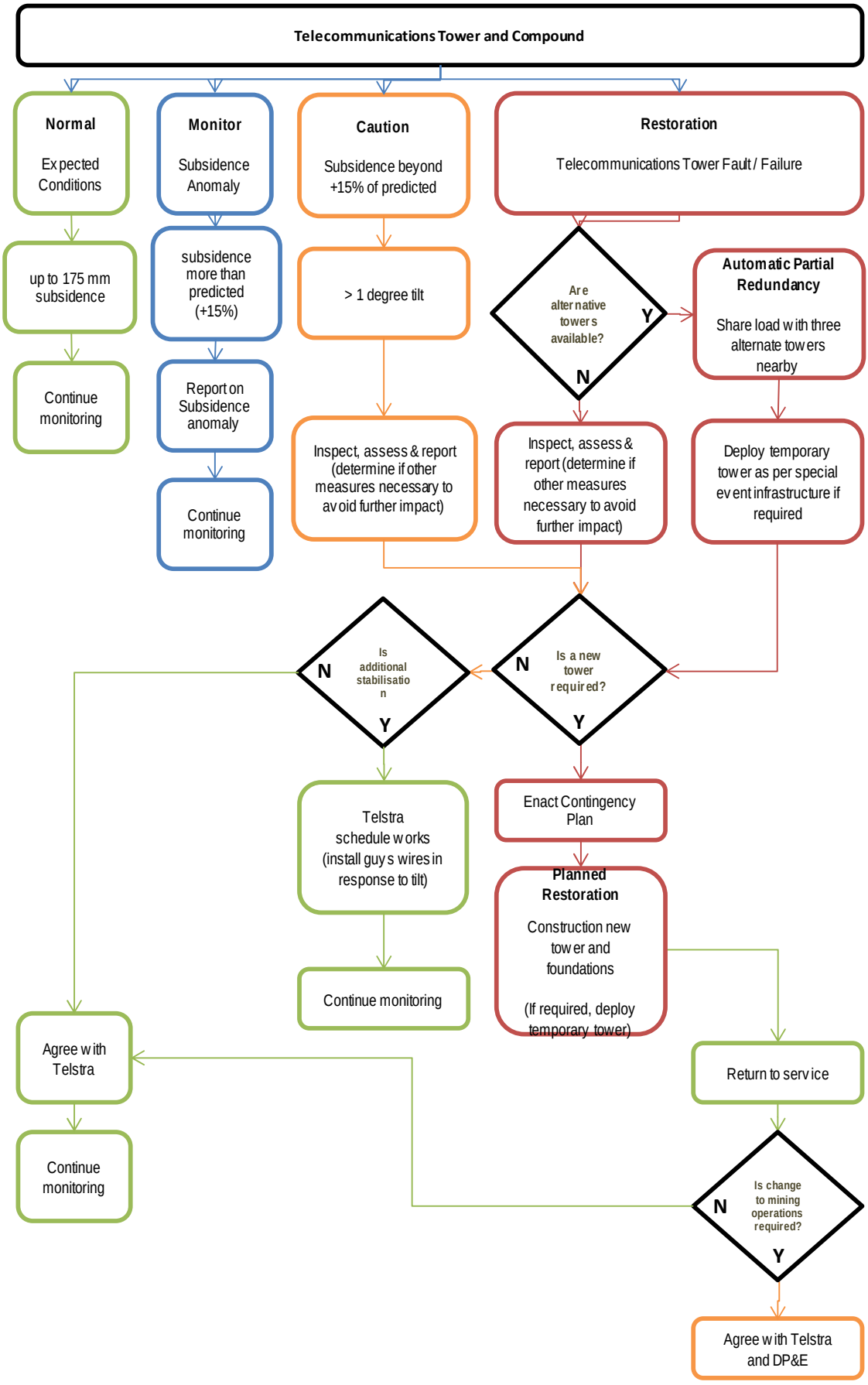
CONTINGENCY PLAN PROCEDURE AND DECISION TREES


Subsidence Impact
Exceeds performance indicator
Notify Technical Services Manager within 24hrs
Public safety risk?
N
Y
Implement public safety measures in accordance with Public Safety Management Plan
Record - Subsidence Impact Register
Report Exceedance to Telstra and DP&E
Investigate contributing factors
Develop proposed course of action with asset owner, submit to DP&E for approval
Telstra- see decision trees
Action approved?
N
Y
Implement course of action


Main Fibre - 120 Core [F KNST 2005 ENGA-HBGH 80f]
Normal
Expected Conditions
up to 300 mm subsidence up to 1.0 dB signal loss
Continue monitoring
Monitor
Subsidence Anomaly
Subsidence more than predicted (+15%)
Report on Subsidence anomaly
Continue monitoring
Caution
Signal degradation 1.0 dB or greater
Subsidence beyond +15% of predicted
> 430 mm subsidence
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration
Signal fault detected
Can traffic be diverted
Y
N
Incidence Management Team
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Divert to other cores within existing cable
Distribute load to other 2 Syd-Mel interconnections if required
Divert to other providers if necessary
Can cable be repaired/
Y
N
Is cable repair/relief required?
N
Y
Telstra schedule works to repair/relieve
Expose cable / Heat treatment
Return to service
Incidence Management Team
Enact Contingency Plan
Is it necessary to repair?
N
Y
Agree with Telstra
Continue monitoring
Planned Restoration
Instigate complete Joint to Joint Replacement
Distribute load to other 2 Syd-Mel interconnections
Divert to other providers if necessary
Return to service
Is change to mining operations required?
N
Y
Agree with Telstra and DP&E


Tower Fibre - 12 & 6 Core [F ENGA 3001 & F ENGA 3005]
Normal
Expected Conditions
up to 350 mm subsidence up to 1.0 dB signal loss
Continue monitoring
Monitor
Subsidence Anomaly
Subsidence more than predicted (+15%)
Report on Subsidence anomaly
Continue monitoring
Caution
Signal degradation 1.0 dB or greater
Subsidence beyond +15% of predicted
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration
Signal fault detected
Can traffic be diverted
Y
N
Incidence Management Team
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Divert to other cores within existing cable
Distribute load to adjacent cable if required
Can cable be repaired/
Y
N
Is cable repair/relief required?
N
Y
Telstra schedule works to repair/relieve
Expose cable / Heat treatment
Return to service
Incidence Management Team
Enact Contingency Plan
Is it necessary to repair?
N
Y
Agree with Telstra
Continue monitoring
Planned Restoration
Instigate complete Joint to Joint Replacement
Distribute load to adjacent cable if required
Return to service
Is change to mining operations required?
N
Y
Agree with Telstra and DP&E


Copper Cable - 200 Pair Garrawarra [CAN Local Network]
Normal
Expected Conditions
up to 650 mm subsidence
Continue monitoring
Monitor
Subsidence Anomaly
Subsidence more than predicted (+15%)
Report on Subsidence anomaly
Continue monitoring
Caution
Anomalous service condition detected (complaint verified)
Subsidence beyond +15% of predicted
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration
Fault detected
Can traffic be diverted
Y
N
Divert to other pairs within this cable bundle
Incidence Management Team
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Are Garrawarra services impacted
N
Y
Can cable be repaired/
Y
N
Is cable repair/relief required?
N
Y
Switch to mobile phones (during repairs)
Incidence Management Team
Enact Contingency Plan
Telstra schedule works to repair/relieve
Return to service
Is it necessary to repair cable?
N
Y
Agree with Telstra
Continue monitoring
Planned Restoration
Instigate rerun cable in conduit
Return to service
Is change to mining operations required?
N
Y
Agree with Telstra and DP&E


Telecommunications Tower and Compound
Normal
Expected Conditions
Monitor
Subsidence Anomaly
Caution
Subsidence beyond +15% of predicted
Restoration
Telecommunications Tower Fault / Failure
up to 175 mm subsidence
subsidence more than predicted (+15%)
> 1 degree tilt
Are alternative towers available?
Y
N
Automatic Partial Redundancy
Share load with three alternate towers nearby
Continue monitoring
Report on Subsidence anomaly
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Deploy temporary tower as per special event infrastructure if required
Continue monitoring
Is additional stabilisation
N
Y
Is a new tower required?
N
Y
Telstra schedule works (install guys wires in response to tilt)
Enact Contingency Plan
Planned Restoration
Construction new tower and foundations
(If required, deploy temporary tower)
Continue monitoring
Agree with Telstra
Return to service
Continue monitoring
Is change to mining operations required?
N
Y
Agree with Telstra and DP&E

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BUILT FEATURES MANAGEMENT PLAN
AXICOM

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&E Approval Date
All	LW301-303 BFMP_AXICOM-R01-A	Original – Draft for Consultation	Axicom, DRG and DP&E	-
Sections 4.2.1 & 9.1, Tables 3 & 5 and Figure 4	LW301-303 BFMP_AXICOM-R01-B	Revised – Incorporating updates	Axicom, DRG and DP&E	11 May 2017*
Sections 4.2.2 & 7.2.2, Tables 2, 3, 5 & 7 and Appendix 3	LW301-303 BFMP_AXICOM-R01-C	Revised – Addressing DP&E and DRG requirements	Axicom, DRG and DP&E	-
Table 7 & 5	LW301-303 BFMP_AXICOM-R01-D	Revised TARP to include tower leg monitoring	Axicom and DRG	-
All	LW301-303 BFMP_AXICOM-R01-E	Revised TARP - Revised for LW303	Axicom and DRG	8 November 2018#
All	BFMP_AXICOM-R01-F	Inclusion of Longwall 304 into BFMP	Axicom	-

* The approval allows for the extraction of Longwalls 301 and 302 only.

Approval for the extraction of Longwall 303.

April 2019

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Appendix 3 Built Features Management Plan – Subsidence Impact Register

Appendix 4 Contingency Plan Procedure and Decision Tree

1 INTRODUCTION

Metropolitan Coal is a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under section 75J of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com).

The Project comprises the continuation, upgrade and extension of underground coal mining operations (Longwalls 20-27 and Longwalls 301-317) and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1. Following the completion of Longwall 27 in 2017, Longwalls 301, 302, 303 and 304 define the next mining sub-domains within the Project underground mining area (Figures 1 to 3).

1.1 PURPOSE AND SCOPE

In accordance with Condition 6(f), Schedule 3 of the Project Approval, this Built Features Management Plan – Axicom (BFMP-AXICOM) has been developed to manage the potential consequences of longwall extraction on the Axicom assets.

The relationship of this BFMP-AXICOM to the Metropolitan Coal Environmental Management Structure is shown on Figure 4.

In accordance with Condition 6, Schedule 3 of the Project Approval, the suitably qualified and experienced experts that have prepared this BFMP-AXICOM, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and Metropolitan Coal were endorsed by the Director-General (now Secretary) of the Department of Planning and Environment (DP&E). This BFMP-AXICOM has been prepared in consultation with Axicom.

1.2 STRUCTURE OF THE BFMP-AXICOM

The remainder of the BFMP-AXICOM is structured as follows:

Section 2: Describes the review and update of the BFMP-AXICOM.

Section 3: Outlines the statutory requirements applicable to the BFMP-AXICOM.

Section 4: Provides a revised assessment of the potential subsidence impacts and environmental consequences for Longwalls 301-304.

Section 5: Details the performance measures and indicators that will be used to assess the Project.

Section 6: Provides the detailed baseline data.

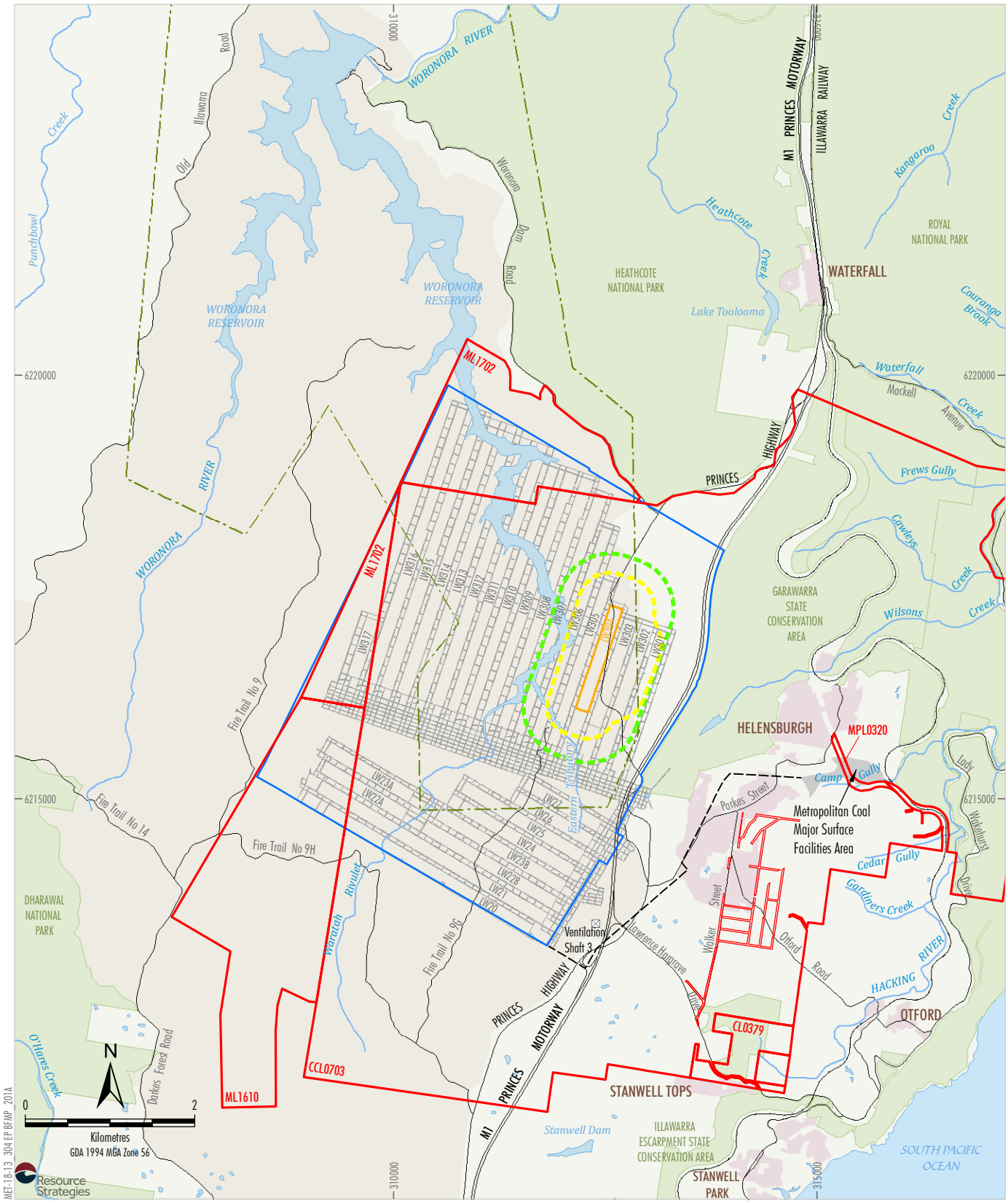
Section 7: Describes the monitoring program.

Section 8: Describes the management measures that will be implemented.

Section 9: Provides a contingency plan to manage any unpredicted impacts and their consequences.

Section 10: Describes the Trigger Action Response Plan (TARP) management tool.

Section 11: Describes the program to collect sufficient baseline data for future Extraction Plans.



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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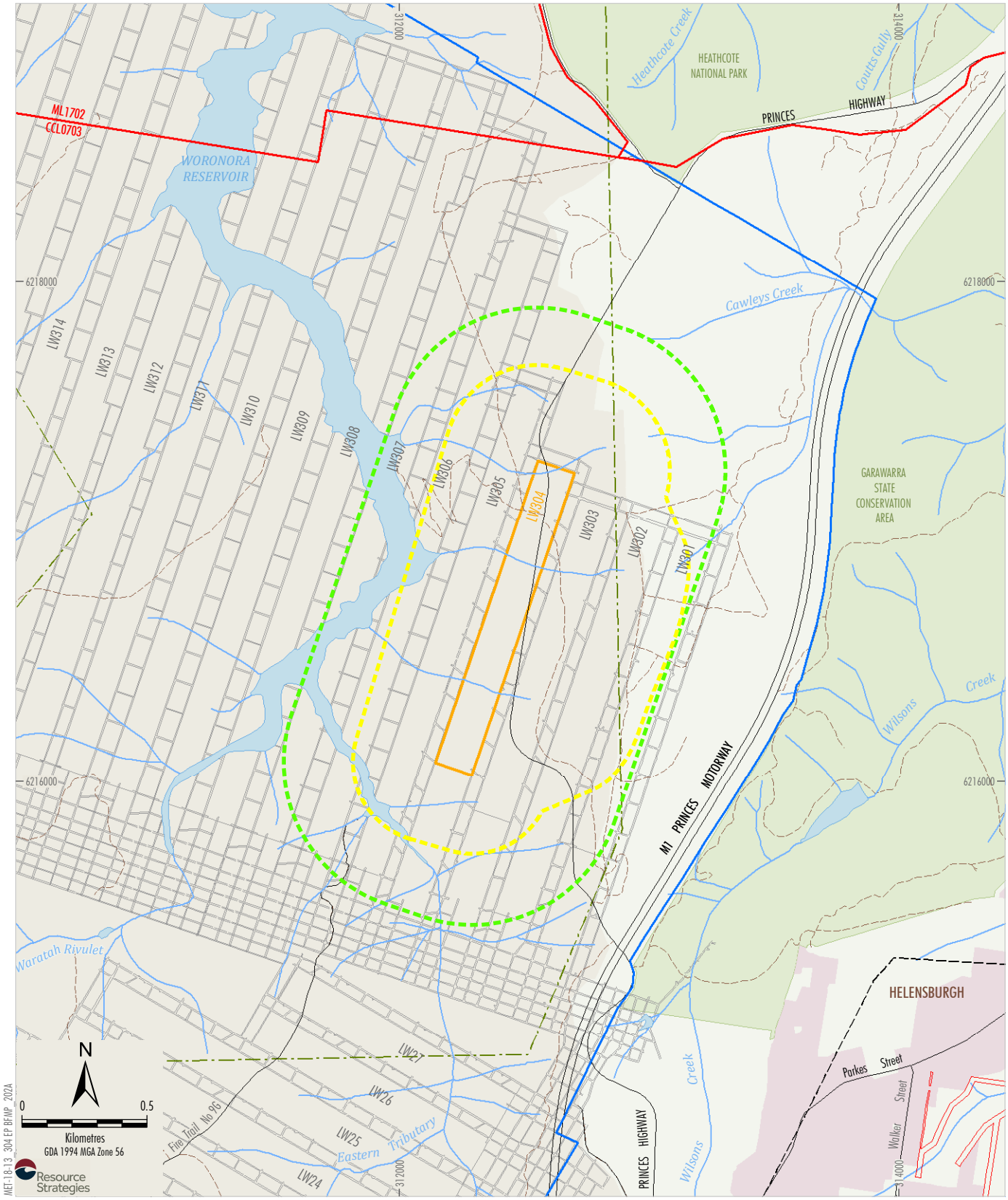
Longwalls 20-27 and Longwalls 301-317 Layout

Figure 1



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)
- Vehicular Track

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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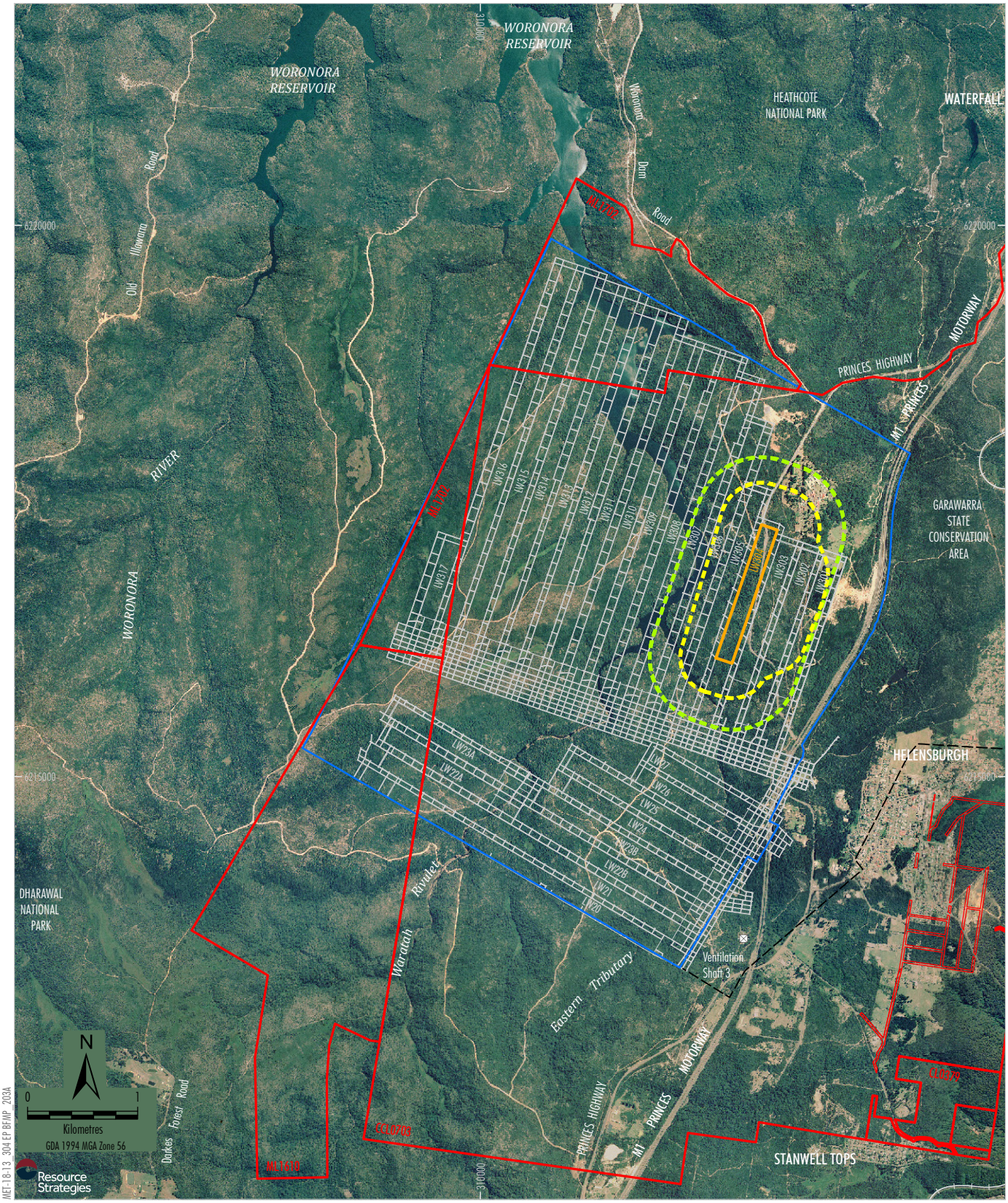
Longwalls 301-304 Layout

Figure 2



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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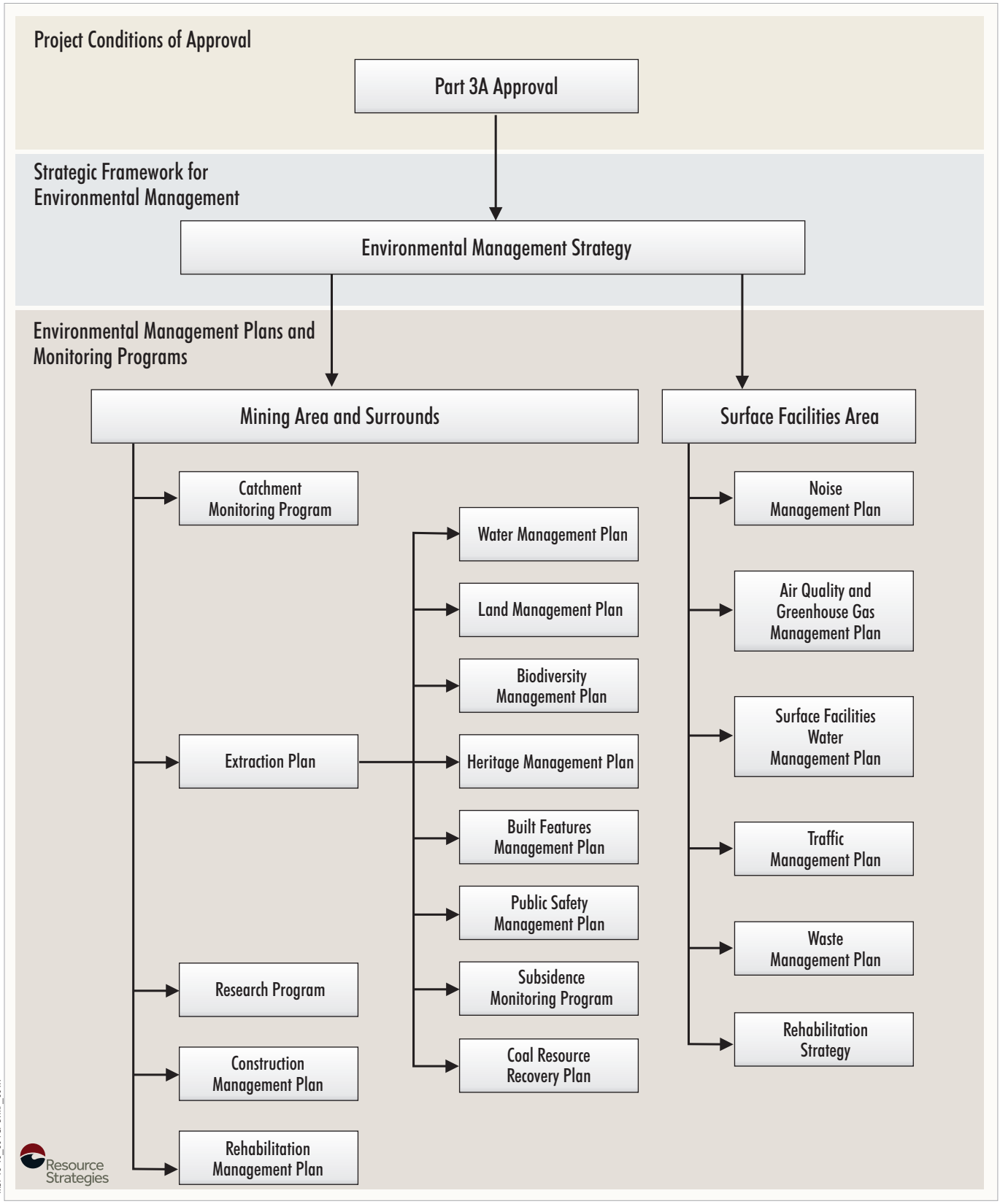
Longwalls 20-27 and Longwalls 301-317 Layout - Aerial Photograph

Figure 3



MET-18-13_304 EP BHMP_001A

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Environmental Management Structure

Figure 4

Section 12: Describes the annual review and improvement of environmental performance.

Section 13: Outlines the management and reporting of incidents.

Section 14: Outlines the management and reporting of complaints.

Section 15: Outlines the management and reporting of non-compliances with statutory requirements.

Section 16: Lists the references cited in this BFMP-AXICOM.

2 BFMP-AXICOM REVIEW AND UPDATE

In accordance with Condition 4, Schedule 7 of the Project Approval, this BFMP-AXICOM will be reviewed within three months of the submission of:

- an audit under Condition 8 of Schedule 7;
- an incident report under Condition 6 of Schedule 7;
- an annual review under Condition 3 of Schedule 7; and

if necessary, revised to the satisfaction of the Director-General (now Secretary) of DP&E, to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

This BFMP-AXICOM will also be reviewed within three months of approval of any Project modification and if necessary, revised to the satisfaction of the DP&E.

The revision status of this plan is indicated on the title page of each copy of the BFMP-AXICOM. The distribution register for controlled copies of the BFMP-AXICOM is described in Section 2.1.

Revisions to any documents listed within this BFMP-AXICOM will not necessarily constitute a revision of this document.

2.1 DISTRIBUTION REGISTER

In accordance with Condition 10, Schedule 7 ‘Access to Information’, Metropolitan Coal will make the BFMP-AXICOM publicly available on the Peabody website. A hard copy of the BFMP-AXICOM will also be maintained at the Metropolitan Coal site.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format. An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom the Metropolitan Coal plans and programs, such as the BFMP-AXICOM, will be distributed;
- the format (i.e. electronic or hard copy) of distribution; and
- the format of revision notification.

Metropolitan Coal will make the Distribution Register publicly available on the Peabody website.

Metropolitan Coal will be responsible for maintaining the Distribution Register and for ensuring that the notification of revisions is sent by email or post as appropriate.

In addition, Metropolitan Coal employees with local computer network access will be able to view the controlled electronic version of this BFMP-AXICOM on the Metropolitan Coal local area network. Metropolitan Coal will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on the Metropolitan Coal computer system and Peabody website.

3 STATUTORY REQUIREMENTS

Metropolitan Coal's statutory obligations are contained in:

(i) the conditions of the Project Approval;

(ii) relevant licences and permits, including conditions attached to mining leases; and

(iii) other relevant legislation.

These are described below.

3.1 EP&A ACT APPROVAL

Condition 6(f), Schedule 3 of the Project Approval requires the preparation of a BFMP as a component of Extraction Plan(s) for second workings. Project Approval Condition 6(f), Schedule 3 states:

> ***SECOND WORKINGS***
>
> ***Extraction Plan***
>
> *6. The Proponent shall prepare and implement an Extraction Plan for all second workings in the mining area to the satisfaction of the Director-General. This plan must:*
>
> *…*
>
> *(f) include a:*
>
> *…*
>
> - *Built Features Management Plan, which has been prepared in consultation with the owner of the relevant feature, to manage the potential environmental consequences of the Extraction Plan on any built features;*
>
> *…*

In addition, Condition 2, Schedule 7 and Condition 7, Schedule 3 of the Project Approval outline management plan requirements that are applicable to the preparation of the BFMP-AXICOM. Table 1 indicates where each component of the conditions is addressed within this BFMP-AXICOM.

Table 1
Management Plan Requirements

Project Approval Condition	BFMP-AXICOM Section
Condition 2 of Schedule 7	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Section 6
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 3
• any relevant limits or performance measures/criteria;	Section 5
• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 5
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Sections 7, 8, 9 and 10
d) a program to monitor and report on the:	Sections 7, 8 and 12
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 9 and Appendix 4
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Sections 7 and 12
g) a protocol for managing and reporting any;	
• incidents;	Section 13
• complaints;	Section 14
• non-compliances with statutory requirements; and	Section 15
• exceedances of the impact assessment criteria and/or performance criteria; and	Section 9 and Appendix 4
h) a protocol for periodic review of the plan.	Section 2
Condition 7 of Schedule 3	
7. In addition to the standard requirements for management plans (see condition 2 of schedule 7), the Proponent shall ensure that the management plans required under condition 6(f) above include:	
a) a program to collect sufficient baseline data for future Extraction Plans;	Section 11
b) a revised assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval;	Section 4
c) a detailed description of the measures that would be implemented to remediate predicted impacts; and	Section 8
d) a contingency plan that expressly provides for adaptive management.	Section 9 and Appendix 4

3.2 LICENCES, PERMITS AND LEASES

In addition to the Project Approval, all activities at or in association with the Metropolitan Coal Mine will be undertaken in accordance with the following licences, permits and leases which have been issued or are pending issue:

- The conditions of mining leases issued by the NSW Division of Resources and Geoscience (DRG), under the NSW *Mining Act, 1992* (e.g. Consolidated Coal Lease [CCL] 703, Mining Lease [ML] 1610, ML 1702, Coal Lease [CL] 379 and Mining Purpose Lease [MPL] 320).
- The Metropolitan Coal Mining Operations Plan 1 October 2012 to 30 September 2019 approved by the DRG.
- The conditions of Environment Protection Licence (EPL) No. 767 issued by the NSW Environment Protection Authority (EPA) under the NSW *Protection of the Environment Operations Act, 1997*. Revision of the EPL will be required prior to the commencement of Metropolitan Coal activities that differ from those currently licensed.
- The prescribed conditions of specific surface access leases within CCL 703 for the installation of surface facilities as required.
- Water Access Licences (WALs) issued by the NSW Department of Primary Industries – Water (now the Department of Industry – Water) under the NSW *Water Management Act, 2000*, including WAL 36475 under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* and WAL 25410 under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*.
- Mining and workplace health and safety related approvals granted by the NSW Resources Regulator and WorkCover NSW.
- Supplementary approvals obtained from WaterNSW for surface activities within the Woronora Special Area (e.g. fire road maintenance activities).

3.3 OTHER LEGISLATION

Metropolitan Coal will conduct the Project consistent with the Project Approval and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to the conduct of the Project (Helensburgh Coal Pty Ltd [HCPL], 2008)[1]:

- *Biodiversity Conservation Act, 2016;*
- *Biosecurity Act, 2015;*
- *Contaminated Land Management Act, 1997;*
- *Crown Land Management Act, 2016;*
- *Dams Safety Act, 2015;*
- *Dangerous Goods (Road and Rail Transport) Act, 2008;*
- *Energy and Utilities Administration Act, 1987;*
- *Fisheries Management Act, 1994;*

[1] The list of potentially applicable Acts has been updated to reflect changes to the Acts that were in force at the time of submission of the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008).

- *Mining Act, 1992;*
- *Protection of the Environment Operations Act, 1997;*
- *Rail Safety (Adoption of National Law) Act, 2012;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Water NSW Act, 2014;*
- *Work Health and Safety Act, 2011; and*
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

Relevant licences or approvals required under these Acts will be obtained as required.

4 REVISED ASSESSMENT OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

4.1 EXTRACTION LAYOUT

Longwalls 301-304 and the area of land within 600 metres (m) of Longwall 304 secondary extraction are shown on Figures 2 and 3. Longwall extraction occurs from north to south. The longwall layouts include 163 m panel widths (void) with 45 m pillars (solid).

The provisional extraction schedule for Longwalls 301-304 is provided in Table 2.

Table 2
Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
301	June 2017	6 months	February 2018
302	March 2018	7 months	October 2018
303	November 2018	7 months	May 2019
304	July 2019	6 months	December 2019

The future Extraction Plans will consider the cumulative subsidence effects, subsidence impacts and/or environmental consequences. Note that the total cumulative predicted subsidence effects, subsidence impacts and/or environmental consequences at the completion of the Project are considered in the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008) and the Preferred Project Report (HCPL, 2009).

4.1.1 Axicom Assets

Figure 5 illustrates the Axicom assets in relation to Longwalls 301-304 extraction. The assets include two telecommunications towers within separate compounds.

4.2 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

4.2.1 Revised Subsidence Predictions

Subsidence predictions for Longwalls 20-44 in relation to the Axicom assets was conducted by MSEC (2008) as part of the Metropolitan Coal Project EA. MSEC (2008) includes a table summarising the incremental systematic subsidence parameters for the extraction of each longwall from Longwalls 20-44. These include:

- maximum predicted incremental subsidence (vertical movement);
- maximum predicted incremental tilt along alignment;
- maximum predicted incremental tilt across alignment;
- maximum predicted incremental tensile strain; and
- maximum predicted incremental compressive strain.

Revised subsidence and impact predictions for the extraction of Longwalls 301-303 and Longwall 304 on Axicom assets were conducted by MSEC and reported in MSEC (2016) and MSEC (2019) (Appendices 1 and 2), respectively.

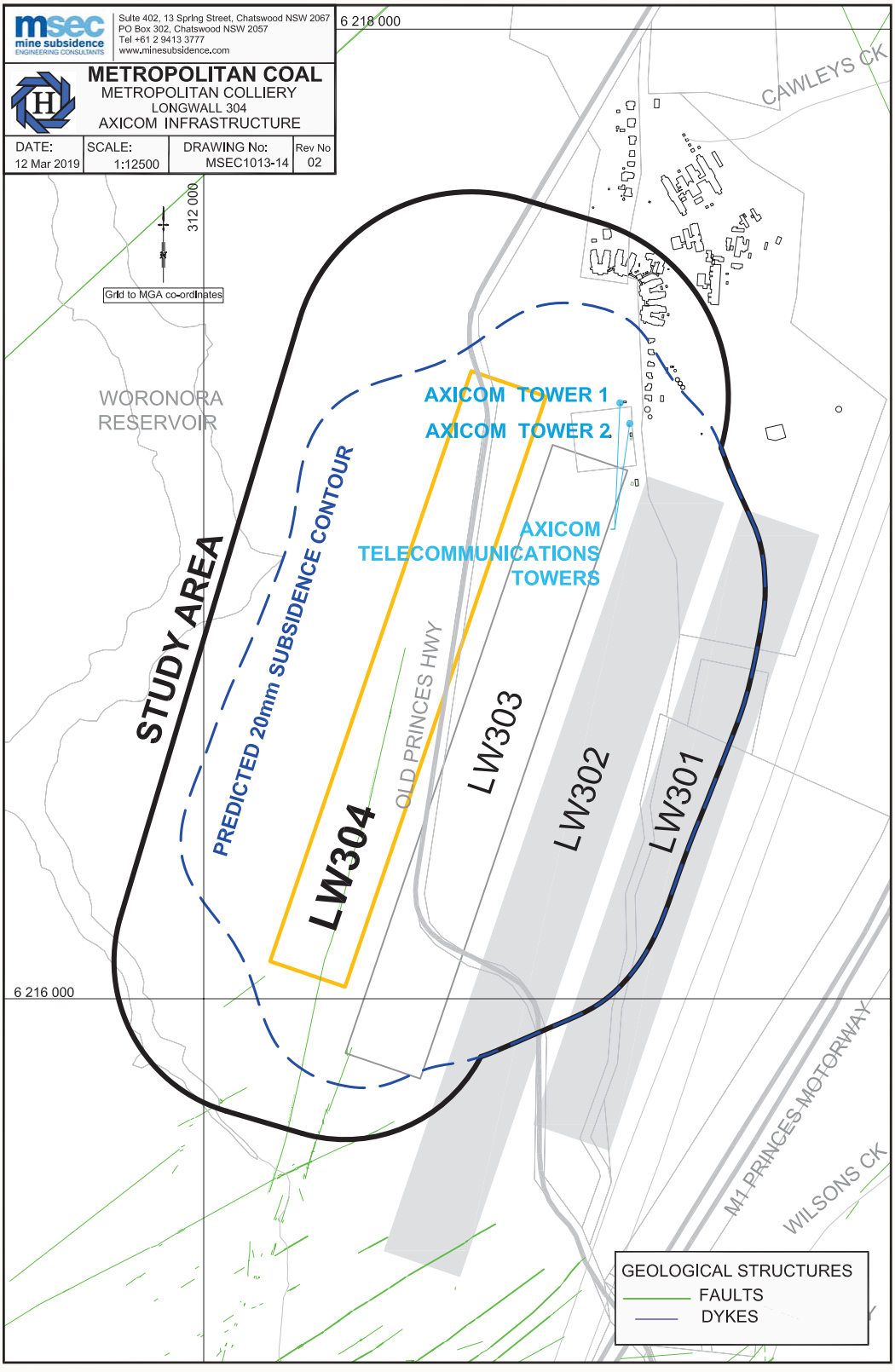
In relation to subsidence predictions due to the extraction of Longwalls 301-303, MSEC (2016) make the following conclusions (Appendix 1):

- The magnitude of tilt predicted at the telecommunications towers (and compounds) is very small (less than 1% or an equivalent angle of 0.09 degrees) and is unlikely to be adversely impacted.
- The building enclosures are all elevated above the natural ground on short concrete piers, a concrete ground slab or concrete pads, and therefore are unlikely to experience adverse impacts.
- It is expected that the building enclosures would remain in safe and serviceable conditions during and after mining.

It is important to note that the above predictions are for total subsidence after extraction of the three Longwalls 301, 302 and 303.

In relation to subsidence predictions due to the extraction of Longwall 304, MSEC (2019) make the following conclusions (Appendix 2):

- The magnitude of tilt is very small (i.e. less than 1%, predicted maxima is 0.15%) and therefore is unlikely to adversely impact on the tower or compound.
- The maximum predicted conventional curvatures are 0.02 km-1 hogging and less than 0.01 km-1 sagging, which equate to minimum radii of curvature of greater than 50 kilometres and 100 kilometres, respectively.
- The predicted strains are 0.5 mm/m tensile and 0.4 mm/m compressive based on the 95% confidence level and 0.8 mm/m tensile and 0.7 mm/m compressive based on the 99% confidence level.
- It is expected that the potential impacts on the Axicom infrastructure can be managed with the implementation of the appropriate monitoring and management strategies.



MET-18-13_304 EP BHMP_013A

Source: MSEC (2019)

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Axicom Assets

Figure 5

4.2.2 Risk Assessment Meeting

In accordance with the *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) a risk assessment meeting for Longwalls 301-303 was held on 26 August 2016. Attendees at the risk assessment meeting included representatives from Metropolitan Coal, Axicom, MSEC and Resource Strategies. The investigation and analysis methods used during the risk assessment included:

- preliminary identification of Axicom assets;
- review of the revised subsidence predictions and potential impacts on Axicom assets (including consideration of past experience in the Southern Coalfield); and
- development of a preliminary monitoring plan.

A number of risk control measures and procedures were identified during the risk assessment which considered the extraction of coal beneath the Axicom assets, and are summarised as follows:

Baseline Data / Validation

1. Obtain information from Axicom Engineering Group on the effect of mining under the mobile towers may have based on the revised subsidence predictions and have Axicom confirm that it is within the limitation of the current towers.
2. Obtain from Axicom the mobile towers footing details to assist with a review of the potential for horizontal sheer that mining would have on the tower footings.
3. Conduct a review of the horizontal sheer impact on the structural integrity / footings of the towers due to mining of Longwalls 301 to 303 and provide this information to Axicom.
4. Obtain from Axicom if there is any impact on the proposed tilt of the towers after the mining of Longwalls 301 to 303 has completed to confirm if there is any impact on services supplied by the towers.
5. Obtain from Axicom an audit to confirm that all services (including any vulnerabilities due to age, installation process, etc.) and cables entering the tower hut that may be affected by mining of Longwalls 301 to 303 have been identified and documented in the BFMP.

Management / Monitoring / Response Measures

6. Include a pre and post inspection in the BFMP of the Axicom compounds (including the hut, fencing, etc.) to document if there has been any damage to the Axicom infrastructure as a result from the mining of Longwalls 301 to 303.

Contingency Planning

7. Include in the BFMP contact information from Axicom to mobilise auxiliary mobile towers if the existing Axicom mobile tower(s) was to become unserviceable.
8. Obtain an understanding from Axicom of the time involved that it would take to mobilise an auxiliary mobile tower.

Metropolitan Coal considers all risk control measures and procedures to be feasible to manage all identified risks.

The proposed risk control measures and procedures have been incorporated where relevant in this BFMP and the program for implementation is summarised in Table 3.

Table 3
Program for Implementation of Proposed Risk Control Measures and Procedures

	Risk Control Measure / Procedure	BFMP Section	Timing
Baseline Data / Validation			
1	Obtain tower details from Axicom	Section 6	Complete
2	Obtain tower footings details from Axicom	Section 6	Complete
3	Provide horizontal sheer impact information to Axicom	Section 6	Complete
4	Obtain tower tilt details from Axicom to confirm if any impact on services supplied by the towers	Section 6	Complete
5	Obtain from Axicom an audit to confirm that all services (including any vulnerabilities due to age, installation process, etc.) and cables entering the tower hut have been identified and documented in the BFMP	Section 6	Complete
Management / Monitoring / Response Measures (Continued)			
6	Include a pre and post inspection of the Axicom huts and fencing at the compounds	Sections 6 and 7.2.3	Complete
Contingency Planning			
7	Include contact information from Axicom in the BFMP to mobilise auxiliary mobile towers	Sections 6.1 and 9.1	Complete
8	Obtain timing estimate from Axicom to mobilise auxiliary towers	Section 9.1	If required

The risk control measures and procedures identified during the risk assessment for Longwalls 301-303 will be implemented for the extraction of Longwall 304.

5 PERFORMANCE MEASURES AND INDICATORS

The Project Approval requires Metropolitan Coal not to exceed the subsidence impact performance measures outlined in Table 1 of Condition 1, Schedule 3. The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

> *Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.*

The performance indicators proposed to ensure that the above performance measure is achieved include:

- structural integrity of the telecommunications towers and compounds has been maintained; and
- serviceability of the access roads/tracks has been maintained.

Section 7 of this BFMP-AXICOM describes the monitoring that will be conducted to assess the Project against the above performance measure. Section 9 of this BFMP-AXICOM provides a Contingency Plan in the event the performance measure is exceeded.

6 BASELINE DATA

Photographs of the Axicom telecommunication towers and compounds are shown in Plates 1 to 4.

Plates 1 & 2 – Telecommunications Tower 1 and Compound (Source: MSEC, 2016)

Plates 3 & 4 – Telecommunications Tower 2 and Compound (Source: MSEC, 2016)

An audit and site inspection of the Axicom assets including inspection of entries and cable lines to the hut and condition of the cable was conducted prior to extraction of Longwall 302.

6.1 KEY CONTACTS LIST

The list of key contacts for Peabody and Axicom during the development and implementation of this BFMP are provided in Table 4.

Table 4
List of Key Contacts

Company	Position	Contact
Peabody (Metropolitan Coal)	Jon Degotardi Manager – Technical Services	Metropolitan Coal 24 hr control room 02 4294 7333
Axicom	Nathan Ward Sales - Account Manager	Axicom General 9495 9000 Operational Issues 1800 006 667 accesstosite@axicom.com.au

7 MONITORING

A monitoring program will be implemented to monitor the impacts of the Project on the Axicom assets. Table 5 summarises the BFMP-AXICOM monitoring components.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts for comparison with baseline photographic records.

Axicom or their delegates will conduct the various visual inspections. Metropolitan Coal will be notified of the timing of inspections and accompany Axicom or delegates if considered necessary. All personnel will complete necessary inductions or orientation relevant to the tasks required.

Table 5
BFMP-AXICOM Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Baseline	Telecommunications Towers (and compounds)	Survey	Adjacent optic / water subsidence line points at approximately 20 m spacing	Establish base conditions – to track general land movement*	Prior to Longwall 301 extraction	Completed
			Survey marks at Towers	Establish base conditions – to track 3D movement.	Prior to Longwall 302 extraction	Completed
		Visual Inspection (including photographs of infrastructure, services and cables)		Establish base condition	Prior to Longwall 302 extraction	Completed
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Establish base condition	Prior to Longwall 302 extraction	Completed
During Mining	Telecommunications Towers (and compounds)	Survey (subsidence, tilt, strain)	Adjacent optic / water subsidence line points at approximately 20 m spacing	Monitor subsidence effects during mining*	On commencement of LW302, LW303 and LW304	Weekly until effects of subsidence no longer detectable
		Survey	Survey Ground monitoring Points Survey Tower leg mounted prisms	Monitor any structural movements as per Tower TARP	On commencement of LW302, LW303 and LW304	Weekly until effects of subsidence no longer detectable
		Visual inspection (for evidence of subsidence effects on compounds – movement of building/cables entering compounds)		Monitor structural integrity of compounds	On commencement of LW302, LW303 and LW304	Weekly until effects of subsidence no longer detectable
	Access roads / tracks	Visual inspection (including notes on general condition of access roads/tracks)		Monitor for surface cracks, buckling and general safety	On commencement of LW302, LW303 and LW304	Weekly until effects of subsidence no longer detectable
					As per Longwall 304 LMP	

Table 5 (Continued)
BFMP-AXICOM Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Post Mining	Telecommunications Towers (and compounds)	Visual Inspection (including photographs of infrastructure, services and cables)		Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 302, 303 and 304	Once per longwall
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Determine level of impact of mining (if any)	Within 3 months of the completion Longwalls 302, 303 and 304	Once per longwall

* Subsidence effects predicted for the telecommunications towers (and compounds) during mining of Longwall 301 alone are minimal to nil as the total subsidence profile does not develop until after commencement of Longwall 302.

The frequency of monitoring will be reviewed either:

- in accordance with the Annual Review outlined in Section 12; or
- if triggered as a component of the Contingency Plan as outlined in Section 9 of this BFMP-AXICOM.

7.1 SUBSIDENCE PARAMETERS

Subsidence parameters (i.e. subsidence, tilt, tensile strain, compressive strain, absolute horizontal translation, and differential leg movement) associated with mining will be measured in accordance with the Longwall 304 Subsidence Monitoring Program (Figure 6).

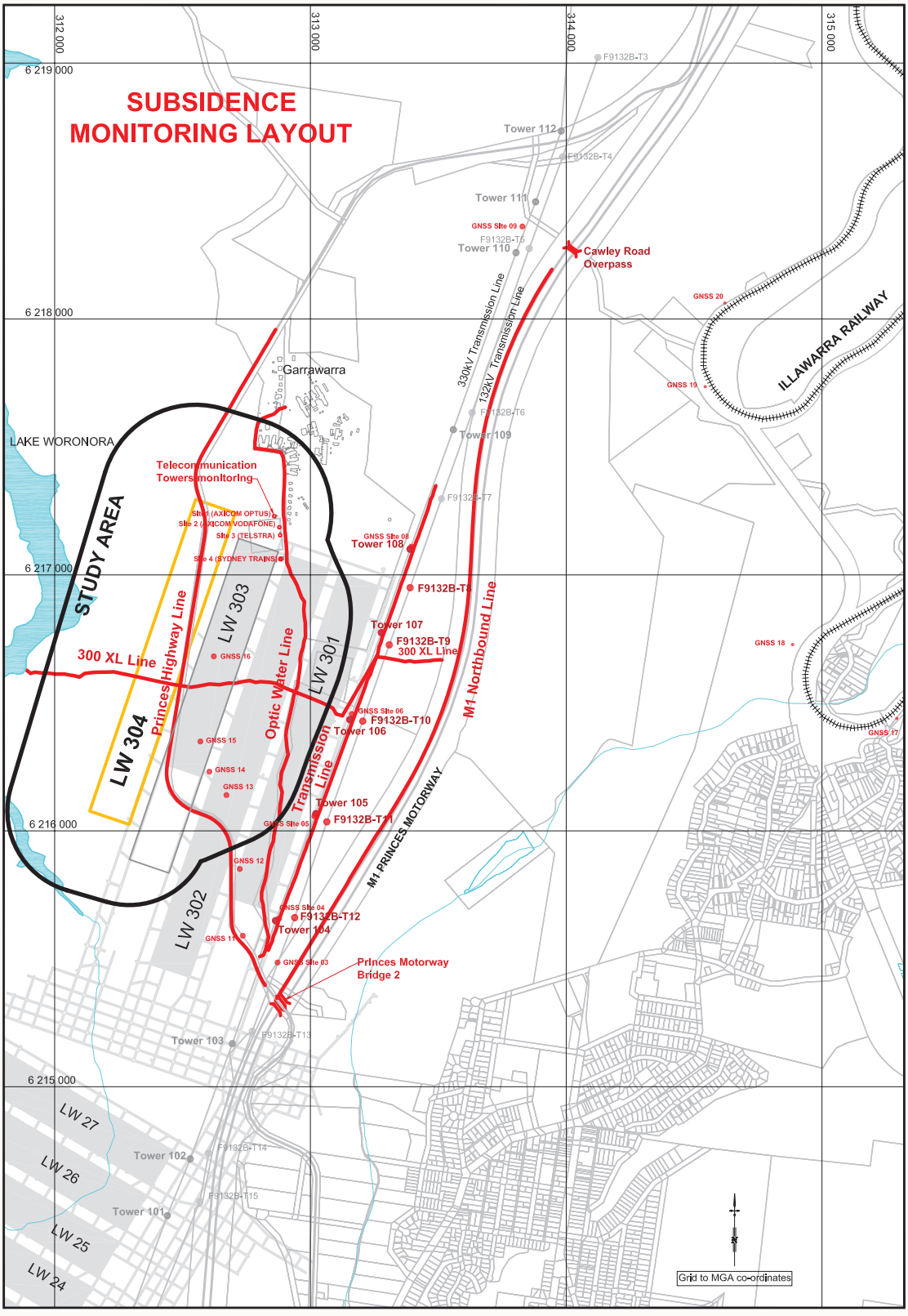
In summary, surveys will be conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence movements (i.e. subsidence, tilt, tensile strain and compressive strain) will be measured along subsidence lines that have been positioned across the general landscape.

Monitoring of subsidence parameters specific to the Axicom assets will be measured by a survey line along the adjacent Optic / Water Line, and by survey of each transmission tower. These surveys will monitor the general movement about the longwalls and the data will allow evaluation of the likely ground movements about the telecommunications towers and compounds (by comparison between measured and predicted movements).

7.2 SUBSIDENCE IMPACTS

7.2.1 Telecommunications Towers and Compounds

A pre and post-mining inspection of the Axicom towers and huts (including fencing) at the compound will be undertaken. Visual inspections will be conducted of the telecommunications towers and compounds.



MET-18-13_304 EP BFMP_017A

Source: MSEC (2019)

Peabody

METROPOLITAN COAL

Subsidence Monitoring Layout

Figure 6

Specific details that will be noted and/or photographed include:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- assessment against the performance indicators and performance measure;
- whether any actions are required (e.g. initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The information will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 3) and reported in accordance with the Project Approval conditions.

7.2.2 Access Roads/Tracks

Visual inspection of the access roads/tracks to the Axicom assets will occur prior to the commencement of Longwall 302 (or otherwise agreed with Axicom), and following extraction of each longwall panel.

Visual observations of access roads/tracks would also occur as part of routine works and inspections within 600 m of Longwalls 301-304 secondary extraction as described in the Metropolitan Coal Longwall 304 Land Management Plan (Longwall 304 LMP).

Specific details that will be noted and/or photographed that are relevant to the access roads/tracks to the Axicom assets include:

- the location, approximate dimensions (length, width and depth), and orientation of surface tension cracks;
- the location of the surface tension crack in relation to access road/track to the Axicom asset;
- whether any actions are required (e.g. implementation of management measures as outlined in the Longwall 304 LMP, initiation of the Contingency Plan as outlined in the Longwall 304 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The date of the observation, details of the observer and the location of longwall extraction will also be documented.

The information obtained will be recorded in the Longwall 304 LMP - Subsidence Impact Register and reported in accordance with the Project Approval conditions.

The information obtained will be used to assess the potential environmental consequences of the subsidence impact (described in the Longwall 304 LMP) and to identify required management measures. Management measures are discussed in the Longwall 304 LMP.

In the event the subsidence impacts are deemed to present a safety hazard (i.e. regardless of the nature or extent of the subsidence impact), actions will be implemented in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan.

7.3 ENVIRONMENTAL CONSEQUENCES

Metropolitan Coal and Axicom will compare the results of the subsidence impact monitoring against the built features performance measure and indicators. In the event the observed subsidence impacts exceed the performance measure or indicators, Metropolitan Coal and Axicom will assess the consequences of the exceedance in accordance with the Contingency Plan described in Section 9.

8 MANAGEMENT MEASURES

A number of potential management measures in relation to telecommunications towers and compounds are considered to be applicable and further measures are summarised in the Contingency Plan (Section 9.1). In relation to access roads/tracks, if, for example, minor surface cracks eventuate, and can be identified, they can be readily repaired by infilling with soil or other suitable materials.

Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.

Management measures will be reported in the Annual Review (Section 12).

9 CONTINGENCY PLAN

In the event the subsidence impacts observed exceed the performance measure or indicators detailed in Section 5 of this BFMP-AXICOM, Metropolitan Coal will implement the following Contingency Plan (Appendix 4):

- The observation will be reported to the Manager - Technical Services within 24 hours.
- With the exception of access roads/tracks, the observation will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 3) consistent with the monitoring program described in Section 7 of this BFMP-AXICOM.
- If relating to an access road/track, the observation will be recorded in the Metropolitan Coal LW304 Land Management Plan – Subsidence Impact Register.
- Metropolitan Coal will report any exceedance of the performance measure or indicators to the DP&E and Axicom as soon as practicable after Metropolitan Coal becomes aware of the exceedance.
- Metropolitan Coal will assess public safety and where appropriate implement safety measures in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan;
- Metropolitan Coal will conduct an investigation to evaluate the potential contributing factors. The investigation will:
  - include the re-survey of relevant subsidence monitoring lines;
  - compare and critically analyse measured versus predicted subsidence parameters;
  - review measured subsidence parameters against the observed impact; and
  - review the subsidence monitoring program and update the program where appropriate.

- The course of action with respect to the identified impact(s), in consultation with specialists and relevant agencies, will include:
  - a program to review the effectiveness of the contingency measures; and
  - consideration of adaptive management.

  Contingency measures are provided in Section 9.1.
- Metropolitan Coal will submit the proposed course of action to the DP&E for approval.
- Metropolitan Coal will implement the approved course of action to the satisfaction of the DP&E.

In accordance with Condition 6, Schedule 6 of the Project Approval, Metropolitan Coal will provide a suitable offset to compensate for the impact to the satisfaction of the Director-General (now Secretary) of DP&E if either the contingency measures implemented by Metropolitan Coal have failed to remediate the impact or the Director-General (now Secretary) determines that it is not reasonable or feasible to remediate the impact.

Metropolitan Coal will comply with the NSW *Coal Mine Subsidence Compensation Act, 2017* in the event that property damages occur as a result of mining Longwalls 301-304.

9.1 CONTINGENCY MEASURES

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of environmental consequences).

Contingency measures are summarised in Table 6. The decision tree for the contingency measures is shown in Appendix 4.

Table 6
Contingency Measures

Asset	Contingency Measures / Description	
Phone Tower	Stabilisation	• Installation of tower supports such as guy wires in response to tilt.
	Rebuilding	• Construction of new tower and foundations.
	Contingency	• Deployment of temporary broadcast/receiving tower as per special event infrastructure (temporary mobile tower systems available).
	Redundancy	• Alternate phone towers nearby.

It is understood that there may be opportunities to deploy temporary broadcast/receiving tower as per special event infrastructure that could be used as a contingency. If required, Metropolitan Coal would consult with Axicom to obtain contact details and timeframes for mobilisation.

10 TARP – MANAGEMENT TOOL

The framework for the various components of the BFMP-AXICOM are summarised in the BFMP-AXICOM TARP shown in Table 7. The BFMP-AXICOM TARP illustrates how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

The TARP comprises:

- baseline conditions;
- predicted subsidence impacts;
- trigger levels from monitoring to assess performance; and
- triggers that flag implementation of contingency measures.

The TARP system provides a simple and transparent snapshot of the monitoring of environmental performance and the implementation of management and/or contingency measures.

Table 7
BFMP-AXICOM Trigger Action Response Plan

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
Safe, serviceable and repairable	The structural integrity of the tower and compound is maintained. Subsidence parameters.	Visual inspection of the compound. Survey lines along the adjacent optic/water subsidence line. Ground Monitoring points at each tower Tower leg mounted prisms	Direct signs of subsidence effects on structures, i.e. new cracking evident in masonry Subsidence, Tilt Tensile Strain. Differential horizontal movement.	End of LW302. Weekly on commencement of LW303 and LW304 until subsidence becomes negligible.	Visual inspection. Evaluation of the subsidence movements about the site and comparison between measured and predicted movements.	Subsidence measurement accuracy.	Pre-mining audit conducted prior to commencement of LW 302. Pre-mining survey of subsidence monitoring points	Level 1	Negligible impact to towers or compound. At end of LW 302 Subsidence < 150 mm Tilt < 1.5 mm/m Tensile strain < 0.8 mm/m Differential horizontal movement < 2.5mm At end LW 303 Subsidence < 50 mm Tilt < 0.5 mm/m Tensile strain < 0.8 mm/m Differential horizontal movement < 2.5mm At end of LW 304 Subsidence < 150 mm Tilt < 1.5 mm/m Tensile strain < 0.8 mm/m Differential horizontal movement < 2.5mm (i.e. measured subsidence parameters generally in accordance with predicted).	Continue monitoring.
								Level 2	Negligible impact to towers or compound. Subsidence effects up to 15% greater than predicted. At end LW 302 Subsidence between 150 mm and 172 mm Tilt between 0.1 and 1 degree Strain between 0.8 and 1.0 mm/m. Differential horizontal movement between 2.5 and 2.9 mm At end LW 303 Subsidence effects up to 15% greater than predicted. Subsidence between 50 mm and 57 mm Tilt between 0.5 and 0.6 mm/m Strain between 0.8 and 1.0 mm/m. Differential horizontal movement between 2.5 and 2.9 mm At end LW 304 Subsidence effects up to 15% greater than predicted. Subsidence between 150 mm and 172 mm Tilt between 1.5 and 1.7 mm/m Strain between 0.8 and 1.0 mm/m. Differential horizontal movement between 2.5 and 2.9 mm	Implement actions in accordance with the Axicom Management Plan Agreement (Appendix 1). **MCPL** Report subsidence anomaly. Immediately resurvey subsidence line to confirm results. Engage subsidence expert to assess results. Confirm results are consistent with other subsidence lines. Compare and critically analyse measured versus predicted subsidence. Inform and provide report to Axicom of subsidence results. Collaboratively share information with Axicom to monitor situation. **Axicom** Assess information provided by Metropolitan Coal.

Table 7 (Continued)
BFMP-AXICOM Trigger Action Response Plan

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
								Level 3	Indication of impact to towers or compound. Subsidence effects greater than 15% more than predicted. At end LW 302 Subsidence > 172 mm Tilt > 1 degree Strain > 1.0 mm/m. Differential horizontal movement > 2.9 mm At end LW 303 Subsidence > 57 mm Tilt > 0.6 mm/m Strain > 1.0 mm/m. Differential horizontal movement > 2.9 mm At end LW 304 Subsidence > 172 mm Tilt > 1.7 mm/m Strain > 1.0 mm/m. Differential horizontal movement > 2.9 mm	**MCPL** Increase frequency of subsidence line (Optic / Water Line) surveys to weekly in affected area. In conjunction with Axicom identify impact location and work with Axicom to resolve. Review the subsidence monitoring program and update the program where appropriate. Provide report on issue to both Axicom and DP&E. **Axicom** In conjunction with Metropolitan Coal identify impact location; install guy wires in response to tilt. Make determination if other measures necessary to avoid further impact.
								Level 4	Impact occurs or Fault detected	Implement Contingency Plan as per BFMP Section 9. **MCPL** General Manager to be involved in all decision making processes. Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwall 304 Public Safety Management Plan. Report exceedance of the performance measure or indicators to the DP&E as soon as practicable. Update the 'Built Features Management Plan – Subsidence Impact Register'. **Axicom** Axicom to enact automatic partial redundancy and use alternate phone towers nearby to share load. Determine appropriate course of action for restoration of service (e.g. deploy temporary tower as per special event infrastructure) and rebuilding (e.g. construct new tower and foundations). Complete restoration/rebuilding works. Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.

Table 7 (Continued)
BFMP-AXICOM Trigger Action Response Plan

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
Safe, serviceable and repairable	The serviceability of the access roads and tracks are maintained.	Access roads and tracks in the vicinity of the Axicom assets.	Cracking about access road/tracks.	After LW 301, 302, and 303	Visual Inspection. Visual observations of access roads/tracks will also be conducted by Metropolitan Coal as part of routine works and inspections within 600 m of Longwalls 301-304 secondary extraction as described in the Metropolitan Coal Longwall 304 Land Management Plan.	Subsidence measurement accuracy.	Pre-mining audit conducted prior to commencement of LW 301.	Level 1	Minor cracking.	**Continue monitoring.** Consider whether any actions are required (e.g. implementation of management measures as outlined in the Longwall 304 LMP, initiation of the Contingency Plan as outlined in the Longwall 304 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.).
								Level 2	Moderate cracking (ie cracking that requires implementation of management measures).	Implement management measures as outlined in the Longwall 304 LMP.
								Level 3	Greater than moderate cracking.	Implement contingency measures as outlined in the Longwall 304 LMP.

11 FUTURE EXTRACTION PLANS

In accordance with Condition 7, Schedule 3 of the Project Approval, Metropolitan Coal will collect baseline data for the next Extraction Plan (i.e. Longwalls 305-310). The collection of baseline data will be consistent with the baseline data collected for Longwalls 301-304. Where possible, the baseline (and post-mining) data collected for Longwalls 301-304 will be used as baseline for Longwalls 305 onward as longwall mining progressively moves further away from the Axicom assets.

In addition to the baseline data collection, consideration of the environmental performance and management measures in accordance with the review(s) conducted as part of this BFMP-AXICOM will inform the appropriate type and frequency of monitoring of the assets relevant to the next Extraction Plan.

12 ANNUAL REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

In accordance with Condition 3, Schedule 7 of the Project Approval, Metropolitan Coal will conduct an Annual Review of the environmental performance of the Project by the end of March each year.

The Annual Review will:

- describe the works carried out in the past year, and the works proposed to be carried out over the next year;
- include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the EA, Preferred Project Report and Extraction Plan;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

As described in Section 2, this BFMP-AXICOM will be reviewed within three months of the submission of an Annual Review and revised where appropriate.

13 INCIDENTS

An incident is defined as a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval.

The reporting of incidents will be conducted in accordance with Condition 6, Schedule 7 of the Project Approval. Metropolitan Coal will notify the Director-General (now Secretary) of DP&E and any other relevant agencies of any incident associated with the Project as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of DP&E and any relevant agencies with a detailed report on the incident.

Axicom will be notified within 24 hours of any access limitations or restrictions.

14 COMPLAINTS

A protocol for the managing and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

The Environment & Community Superintendent is responsible for maintaining a system for recording complaints.

Metropolitan Coal will maintain public signage advertising the telephone number on which environmental complaints can be made. The Environment & Community Superintendent is responsible for ensuring that the currency and effectiveness of the service is maintained. Notifications of complaints received are to be provided as quickly as practicable to the Environment & Community Superintendent.

Complaints and enquiries do not have to be received via the telephone line and may be received in any other form. Any complaint or enquiry relating to environmental management or performance is to be relayed to the Environment & Community Superintendent as soon as practicable. All employees are responsible for ensuring the prompt relaying of complaints. All complaints will be recorded in a complaints register.

For each complaint, the following information will be recorded in the complaints register:

- date and time of complaint;
- method by which the complaint was made;
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- nature of the complaint;
- the action(s) taken by Metropolitan Coal in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken by Metropolitan Coal, the reason why no action was taken.

The Environment & Community Superintendent is responsible for ensuring that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary.

In accordance with Condition 10, Schedule 7 of the Project Approval, the complaints register will be made publicly available on the website and updated on a monthly basis. A summary of complaints received and actions taken will be presented to the Community Consultative Committee as part of the operational performance review.

15 NON-COMPLIANCES WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with Metropolitan Coal, and will be developed through promotion of Metropolitan Coal ownership under the direction of the General Manager.

The Manager - Technical Services and/or Environment & Community Superintendent will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 13, Metropolitan Coal will notify the Director-General (now Secretary) of the DP&E and any other relevant agencies of any incident associated with Metropolitan Coal as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of the DP&E and any relevant agencies with a detailed report on the incident.

A review of Metropolitan Coal's compliance with all conditions of the Project Approval, mining leases and all other approvals and licenses will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the Peabody website.

Additionally, in accordance with Condition 8, Schedule 7 of the Project Approval, an independent environmental audit was undertaken by the end of December 2011, and is undertaken a minimum of once every three years thereafter. A copy of the audit report will be submitted to the Director-General (now Secretary) of the DP&E and made publicly available on the Peabody website. The independent audit will be undertaken by an appropriately qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General (now Secretary) of the DP&E.

16 REFERENCES

Department of Planning & Environment and Division of Resources and Energy (2015) *Guidelines for the Preparation of Extraction Plans*.

Helensburgh Coal Pty Ltd [HCPL] (2008) *Metropolitan Coal Project Environmental Assessment*.

Helensburgh Coal Pty Ltd [HCPL] (2009) *Metropolitan Coal Project Preferred Project Report*.

Mine Subsidence Engineering Consultants (2016) *Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Axicom Infrastructure, 25 August 2016.*

Mine Subsidence Engineering Consultants (2019) *Metropolitan Colliery – Proposed Longwall 304 – Subsidence Predictions and Impact Assessments for the Axicom Infrastructure.*

APPENDIX 1

MSEC (2016) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 301 TO 303 - SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE AXICOM INFRASTRUCTURE, DATED 25 AUGUST 2016

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

25th August 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-14

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Axicom Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Axicom infrastructure resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery.

The locations of the Axicom infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC844-14. Tower 1 is located 35 metres to the north of the commencing end of Longwall 303. Tower 2 is close to the commencing end of Longwall 303. Photographs of this installation are provided in Figure 1 and Figure 2.

Figure 1 Axicom Telecommunications Tower 1 and Compound

Figure 2 Axicom Telecommunications Tower 2 and Compound

The predictions and impact assessments for the Axicom infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the Axicom Infrastructure

The following provides summaries of the maximum predicted conventional movements for the Axicom infrastructure resulting from the extraction of Longwalls 301 to 303. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures. Discussions on the potential for non-conventional movements are provided in this letter report.

A summary of the maximum predicted values of total subsidence, tilt and curvature for this installation, resulting from the extraction of Longwalls 301 to 303, is provided in Table 1.

Table 1 Maximum Predicted Total Subsidence, Tilt and Curvature for the Axicom Telecommunications Towers and Compounds Resulting from the Extraction of Longwalls 301 to 303

Locaiton	Longwall	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})
Tower 1 and compound	After LW301	< 20	< 0.5	< 0.01	< 0.01
	After LW302	< 20	< 0.5	< 0.01	< 0.01
	After LW303	100	1.0	0.01	< 0.01
Tower 2 and compound	After LW301	< 20	< 0.5	< 0.01	< 0.01
	After LW302	30	< 0.5	< 0.01	< 0.01
	After LW303	150	1.5	0.02	< 0.01

The maximum predicted conventional tilt for the telecommunications towers and compounds is 1.5 mm/m (i.e. 0.15 %, or 1 in 667). The maximum predicted conventional curvatures are less than 0.02 km^{-1} hogging and 0.01 km^{-1} sagging, which equate to minimum radii of curvature of greater than 50 kilometres and 100 kilometres, respectively.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the Axicom infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The Axicom infrastructure is near the commencing end if Longwall 303. The database has been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located outside between zero and 100 metres of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

A histogram of the maximum observed tensile and compressive strains measured in survey bays located above solid coal, for monitoring lines in the Southern Coalfield, is provided in Figure 3. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

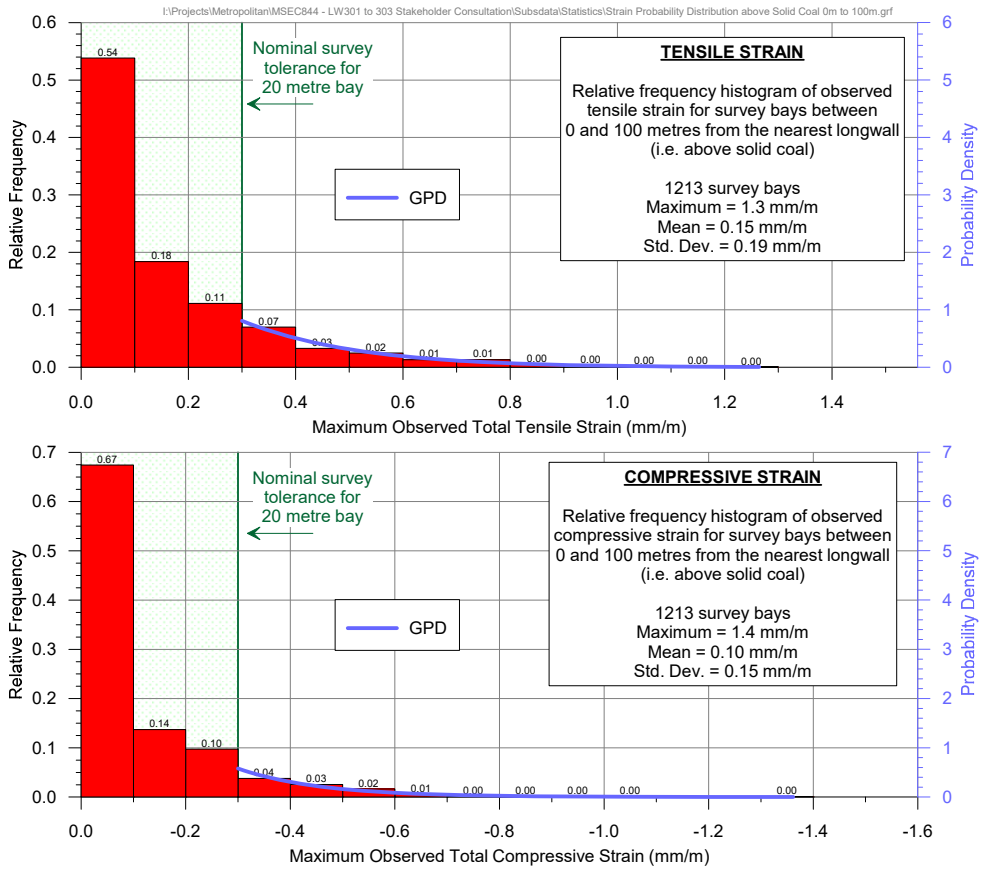


Figure 3 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Solid Coal (0 to 100 metres)

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above solid coal, based the fitted GPDs, is provided in Table 2.

Table 2 Probabilities of Exceedance for Strain for Survey Bays Located above Solid Coal

Strain (mm/m)		Probability of Exceedance
Compression	-1.5	1 in 3,100
	-1.0	1 in 630
	-0.5	1 in 40
	-0.3	1 in 10
Tension	+0.3	1 in 6
	+0.5	1 in 15
	+1.0	1 in 250
	+1.5	1 in 2,200

The 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.5 mm/m tensile and 0.4 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.8 mm/m tensile and 0.7 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures and the streams are shown in Drawing No. MSEC844-14.

There are no mapped faults or streams located in the vicinity of the Axicom infrastructure. It is possible that the infrastructure located near the longwalls could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). The range of strains provided in the previous section include those resulting from irregular anomalous movements.

Impact Assessments for the Axicom Infrastructure

The telecommunications towers and compounds are located near the commencing end of Longwall 303.

The maximum predicted tilt is 1.5 mm/m (i.e. 0.15 %, or 1 in 667) which equates to an angle of 0.09 degrees. The magnitude of tilt is very small (i.e. less than 1 %) and therefore is unlikely to adversely impact on the tower or compound. Tilt can potentially effect directional antennas (i.e. microwave dishes) and therefore it is recommended that the radio engineer reviews the predicted change in alignment. If adverse impacts were anticipated, the alignments of the directional antennas could be adjusted during active subsidence.

The maximum predicted conventional curvatures are less than 0.02 km^{-1} hogging and 0.01 km^{-1} sagging, which equate to minimum radii of curvature of greater than 50 kilometres and 100 kilometres, respectively. The predicted strains are 0.5 mm/m tensile and 0.4 mm/m compressive based on the 95 % confidence level and 0.8 mm/m tensile and 0.7 mm/m compressive based on the 99 % confidence level.

It is recommended that the structural engineer reviews the structural integrity of the tower structure based on the predicted conventional subsidence, tilt and curvatures and the predicted distributions of strain. If adverse impacts were anticipated, then preventive measures should be implemented that could include the installation of additional bracing members and/or strengthening members to the existing frame.

The building enclosures include brick structure adjacent to Tower 1 and a steel framed structure adjacent to Tower 2, both supported on short concrete piers. The steel framed structure is founded on a concrete ground slab. A small structure similar to a shipping container is also located adjacent to Tower 1 and is supported on small concrete pads. It is unlikely that these structures would experience adverse impacts due to the elevation above natural ground.

Summary

Two telecommunications towers and compounds are located above solid coal near the commencing end of Longwall 303. It is recommended that the predicted movements are reviewed by the telecommunications and structural engineers. Preventive measures for the towers should be installed if adverse impacts are anticipated. It is unlikely that adverse impacts would occur for the building enclosures.

It is expected that the potential impacts on the Axicom infrastructure can be managed with the implementation of the appropriate monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:

Drawing No. MSEC844-14 – Longwalls 301 to 303 – Axicom Infrastructure

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COAL

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
AXICOM INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
26 Aug 2016	1:12500	MSEC844-14	B

6 218 000
6 216 000
312 000
314 000

Grid to MGA co-ordinates

CAWLEY ROAD OVERPASS
CAWLEYS CK
STUDY AREA
METROPOLITAN FAULT
AXICOM TOWER 1
AXICOM TOWER 2
AXICOM TELECOMMUNICATIONS TOWERS
WORONORA RESERVOIR
PREDICTED 20mm SUBSIDENCE CONTOUR
20
OLD PRINCES HWY
LW303
LW302
LW301
M1 PRINCES MOTORWAY
OPTUS
WILSONS CK
PRINCES HIGHWAY UNDERPASS 2
FAULT
MAIN WEST FAULT
POWELL FAULT

GEOLOGICAL STRUCTURES
FAULTS
DYKES

APPENDIX 2

MSEC (2019) METROPOLITAN COLLIERY – PROPOSED LONGWALL 304 – SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE AXICOM INFRASTRUCTURE

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

14th March 2019

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC1013-14

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Axicom Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Axicom infrastructure resulting from the extraction of the proposed Longwall 304 at Metropolitan Colliery.

The locations of the Axicom infrastructure and the proposed Longwall 304 are shown in the attached Drawing No. MSEC1013-14. Tower 1 is located 150 m to the east of the commencing end of Longwall 304. Tower 2 is located 180 m to the east of the commencing end of Longwall 304. Photographs of the Axicom infrastructure are provided in Figure 1 and Figure 2.

Figure 1 Axicom Telecommunications Tower 1 and Compound

Figure 2 Axicom Telecommunications Tower 2 and Compound

The predictions and impact assessments for the Axicom infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the Axicom Infrastructure

The following provides summaries of the maximum predicted conventional movements for the Axicom infrastructure following the extraction of Longwall 303 and after extraction of Longwall 304. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures. Discussions on the potential for non-conventional movements are provided in this letter report.

A summary of the maximum predicted values of total subsidence, tilt and curvature for this installation, following the extraction of Longwall 303 and after extraction of Longwall 304, is provided in Table 1.

Table 1 Maximum Predicted Total Subsidence, Tilt and Curvature for the Axicom Telecommunications Towers and Compounds after the Extraction of Longwalls 303 and 304

Location	Longwall	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})
Tower 1 and compound	After LW303	50	< 0.5	< 0.01	< 0.01
	After LW304	125	1.0	0.01	< 0.01
Tower 2 and compound	After LW303	70	0.5	< 0.01	< 0.01
	After LW304	150	1.5	0.02	< 0.01

The maximum predicted conventional tilt for the telecommunications towers and compounds is 1.5 mm/m (i.e. 0.15 %, or 1 in 667). The maximum predicted conventional curvatures are 0.02 km^{-1} hogging and less than 0.01 km^{-1} sagging, which equate to minimum radii of curvature of greater than 50 kilometres and 100 kilometres, respectively.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the Axicom infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The Axicom infrastructure is situated east of the commencing end of Longwall 304 and 90 m to 120 m north of the commencing end of Longwall 303. The database has been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located outside between zero and 100 metres of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

A histogram of the maximum observed tensile and compressive strains measured in survey bays located above solid coal, for monitoring lines in the Southern Coalfield, is provided in Figure 3. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

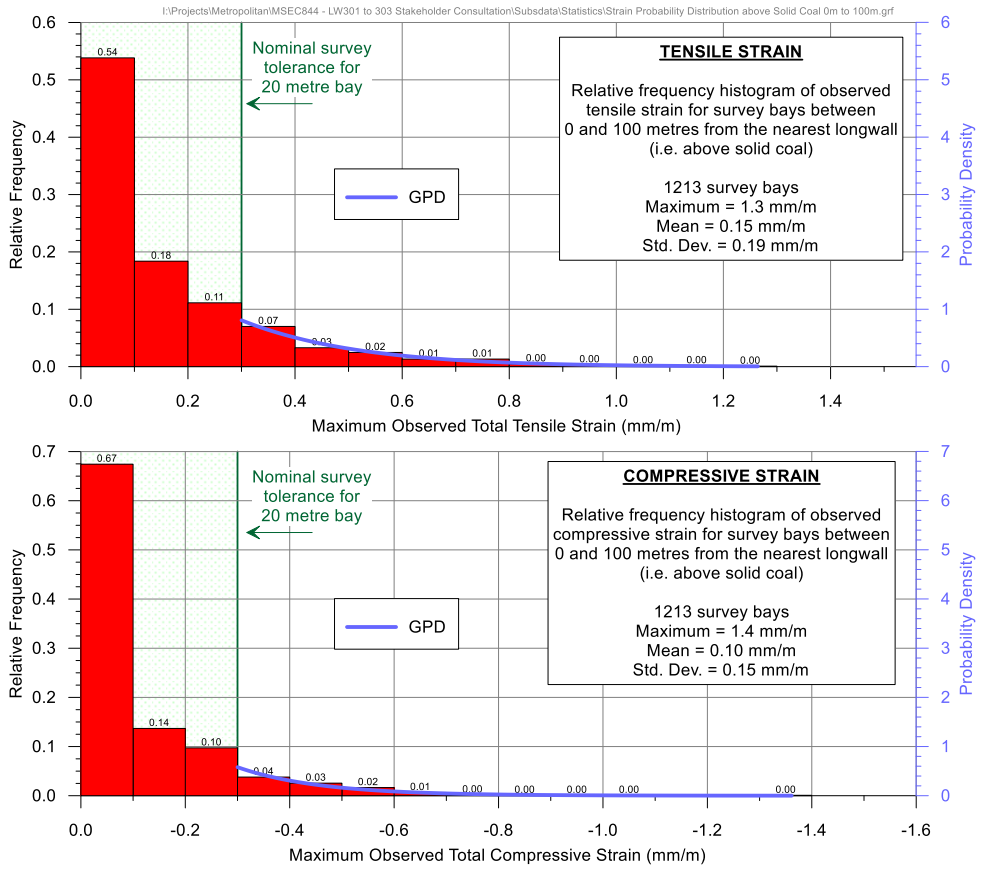


Figure 3 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Solid Coal (0 to 100 metres)

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above solid coal, based the fitted GPDs, is provided in Table 2.

Table 2 Probabilities of Exceedance for Strain for Survey Bays Located above Solid Coal

Strain (mm/m)		Probability of Exceedance
Compression	-1.5	1 in 3,100
	-1.0	1 in 630
	-0.5	1 in 40
	-0.3	1 in 10
Tension	+0.3	1 in 6
	+0.5	1 in 15
	+1.0	1 in 250
	+1.5	1 in 2,200

The 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.5 mm/m tensile and 0.4 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.8 mm/m tensile and 0.7 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures at seam level and the major streams are shown in Drawing No. MSEC1013-14. There are no mapped faults located within the Study Area that extend beneath the Axicom towers and compounds. It is possible that the towers compounds could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). Non-conventional or anomalous movements have not been identified during the extraction of Longwalls 301 and 302 and part extraction of Longwall 303. The range of strains provided in the previous section include those resulting from irregular anomalous movements.

Impact Assessments for the Axicom Infrastructure

The maximum predicted tilt is 1.5 mm/m (i.e. 0.15 %, or 1 in 667) which equates to an angle of 0.09 degrees. The magnitude of tilt is very small (i.e. less than 1 %) and therefore is unlikely to adversely impact on the tower or compound. Tilt can potentially effect directional antennas (i.e. microwave dishes) and therefore it is recommended that the radio engineer reviews the predicted change in alignment. If adverse impacts were anticipated, the alignments of the directional antennas could be adjusted during active subsidence.

The maximum predicted conventional curvatures are 0.02 km^{-1} hogging and less than 0.01 km^{-1} sagging, which equate to minimum radii of curvature of greater than 50 kilometres and 100 kilometres, respectively. The predicted strains are 0.5 mm/m tensile and 0.4 mm/m compressive based on the 95 % confidence level and 0.8 mm/m tensile and 0.7 mm/m compressive based on the 99 % confidence level.

The building enclosures include a brick structure adjacent to Tower 1 and a steel framed structure adjacent to Tower 2, both supported on short concrete piers. The steel framed structure is founded on a concrete ground slab. A small structure similar to a shipping container is also located adjacent to Tower 1 and is supported on small concrete pads. It is unlikely that these structures would experience adverse impacts due to the elevation above natural ground.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301 to 303 are updated and continued, in consultation with Axicom, to manage the towers for potential irregular ground movements. Structural assessments undertaken for the extraction of Longwalls 301 to 303 should also be reviewed for the extraction of Longwall 304.

Summary

Two telecommunications towers and compounds are located above solid coal near the commencing end of Longwall 304. It is recommended that the predicted movements are reviewed by the telecommunications and structural engineers. Preventive measures for the towers should be installed if adverse impacts are anticipated. It is unlikely that adverse impacts would occur for the building enclosures.

It is expected that the potential impacts on the Axicom infrastructure can be managed with the implementation of the appropriate monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:

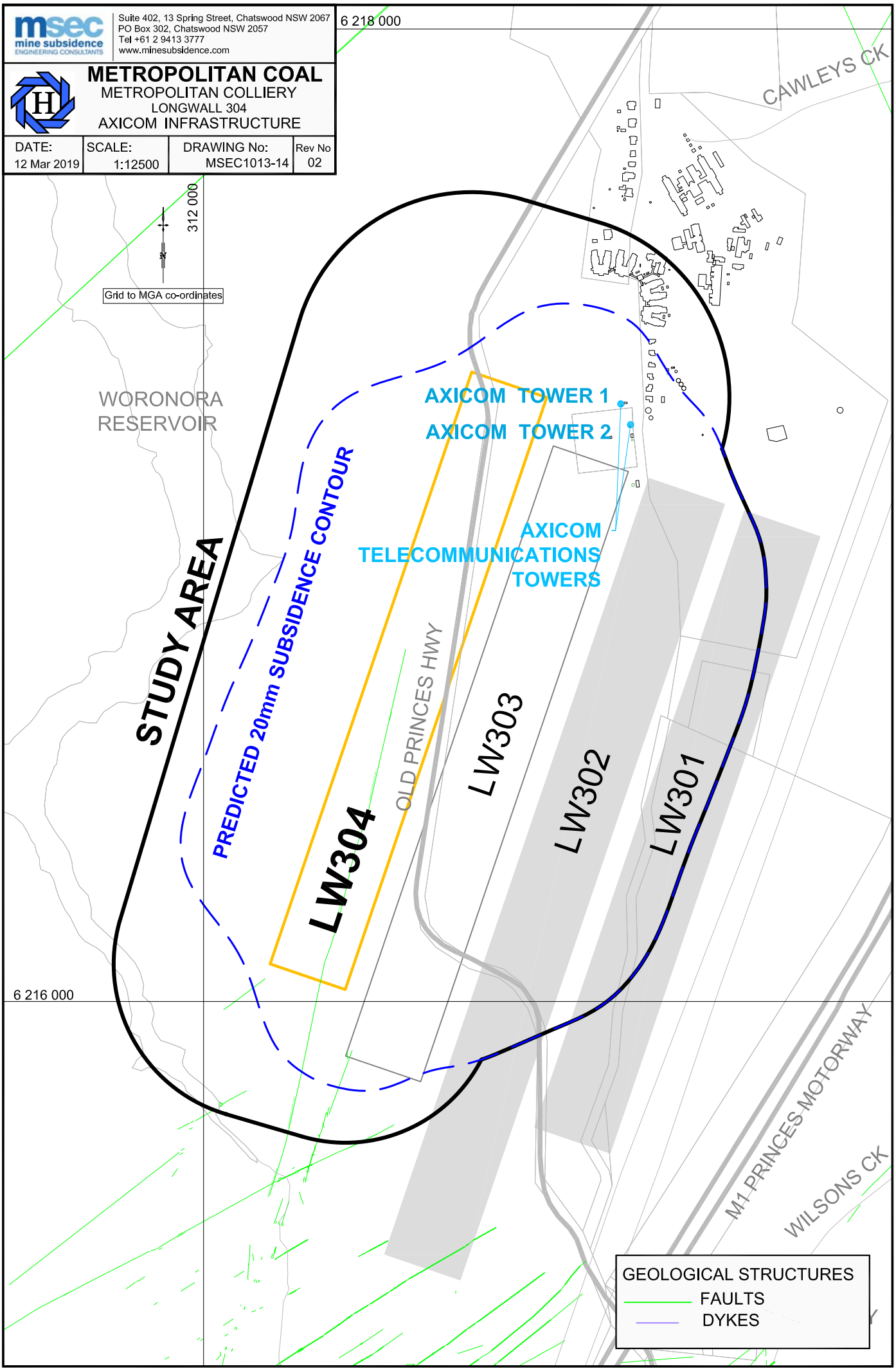
Drawing No. MSEC1013-14 – Longwall 304 – Axicom Infrastructure

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COAL

METROPOLITAN COLLIERY
LONGWALL 304
AXICOM INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	1:12500	MSEC1013-14	02



APPENDIX 3

BUILT FEATURES MANAGEMENT PLAN – SUBSIDENCE IMPACT REGISTER

Built Features Management Plan - Subsidence Impact Register

Impact Register Number[1]	Built Feature[2]	Impact Description	Does Impact Exceed the Built Feature Performance Measure/Indicators? (Yes/No)	Management Measures Implemented	Were Management Measures Effective? (Yes/No)

Notes:

1: Fill out all details in the Assessment Form and record the register number here.

2: Built feature (e.g. tower, etc.).

3: Impacts to access roads/tracks to be included in the Land Management Plan – Subsidence Impact Register.

Built Feature Management Plan – Subsidence Impact Register Assessment Form

Date:
Observer (Name and position):
Register Number (i.e. Number 1, 2, etc.):
Longwall Number and Chainage:

Location of Observed Impact:

(Examples: location of tower, include GPS co-ordinates and a sketch)

Description of Observed Impact:

(Examples: nature and extent of impact - cracks in road etc any relevant information, attach photographs)

Person Notified:	Manager - Technical Services	☐

Description of Photographs:

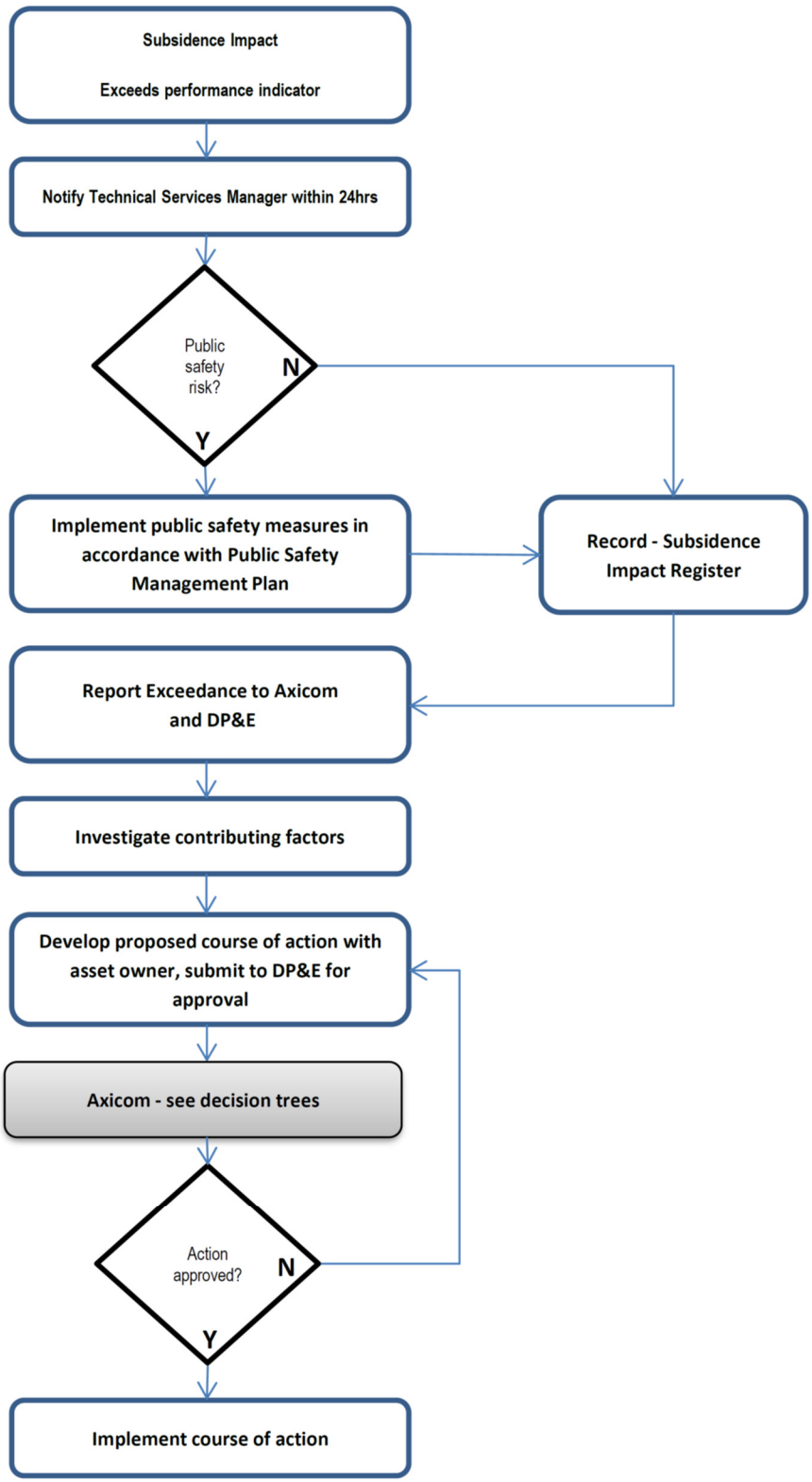
Actions Required:	Contingency Plan Initiated	☐
	Incident Notification	☐
	Safety Measures/Public Safety Management Plan Requirements	☐

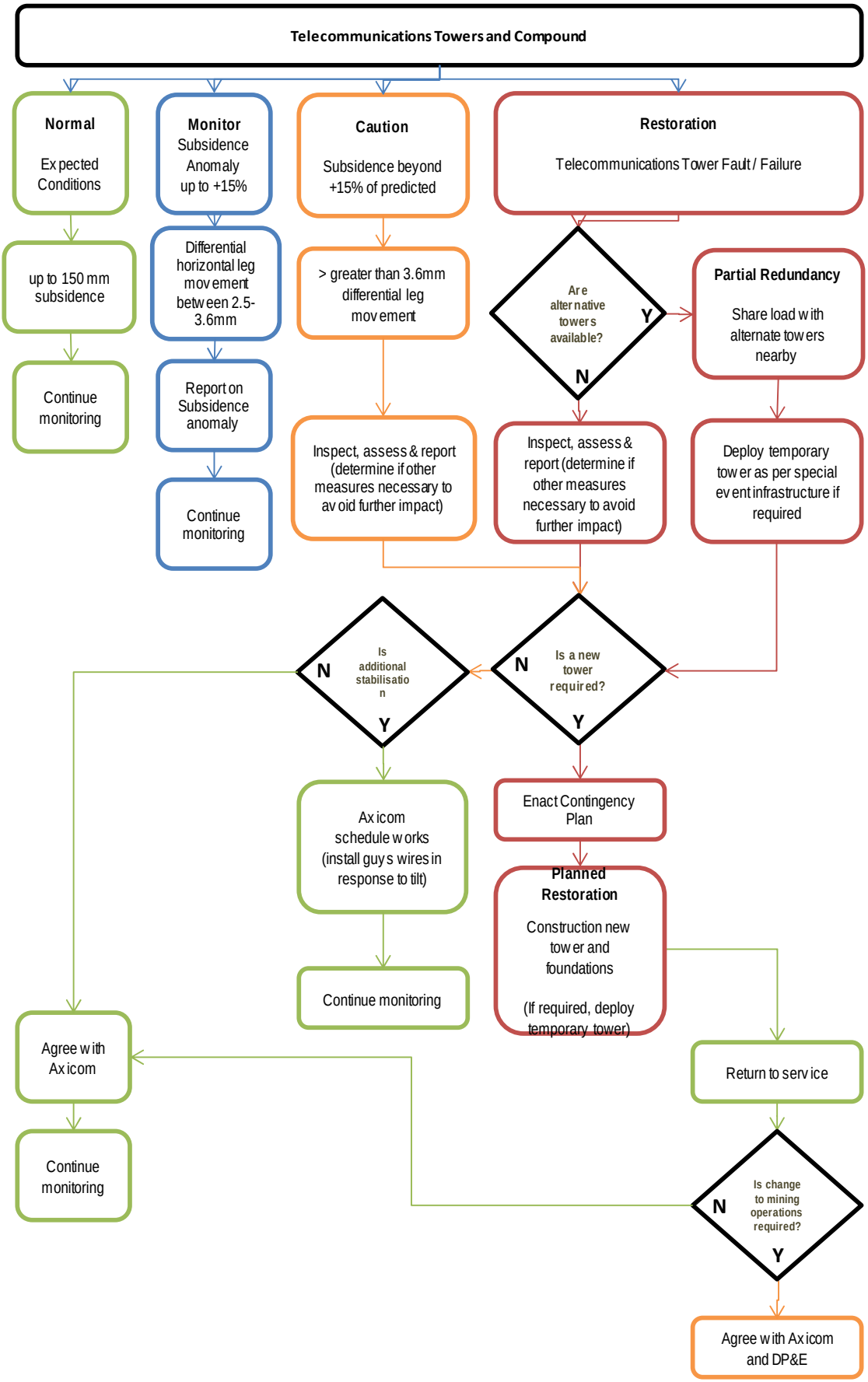
Management or Contingency Measures Implemented:

Effectiveness of Management or Contingency Measures:

APPENDIX 4

CONTINGENCY PLAN PROCEDURE AND DECISION TREE


Subsidence Impact
Exceeds performance indicator
Notify Technical Services Manager within 24hrs
Public safety risk?
N
Y
Implement public safety measures in accordance with Public Safety Management Plan
Record - Subsidence Impact Register
Report Exceedance to Axicom and DP&E
Investigate contributing factors
Develop proposed course of action with asset owner, submit to DP&E for approval
Axicom - see decision trees
Action approved?
N
Y
Implement course of action


Telecommunications Towers and Compound
Normal
Expected Conditions
up to 150 mm subsidence
Continue monitoring
Monitor
Subsidence Anomaly up to +15%
Differential horizontal leg movement between 2.5-3.6mm
Report on Subsidence anomaly
Continue monitoring
Caution
Subsidence beyond +15% of predicted
> greater than 3.6mm differential leg movement
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration
Telecommunications Tower Fault / Failure
Are alternative towers available?
Y
N
Partial Redundancy
Share load with alternate towers nearby
Deploy temporary tower as per special event infrastructure if required
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Is a new tower required?
N
Y
Is additional stabilisation
N
Y
Axicom schedule works (install guys wires in response to tilt)
Continue monitoring
Enact Contingency Plan
Planned Restoration
Construction new tower and foundations
(If required, deploy temporary tower)
Return to service
Is change to mining operations required?
N
Y
Agree with Axicom and DP&E
Agree with Axicom
Continue monitoring

METROPOLITAN COAL

BUILT FEATURES MANAGEMENT PLAN
SYDNEY TRAINS

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&E Approval Date
All	LW301-303 BFMP_SYDTRAINS-R01-A	Original – Draft for Consultation	Sydney Trains	-
Section 4.2.1, Tables 3 & 5 and Figure 4	LW301-303 BFMP_SYDTRAINS-R01-B	Revised – Incorporating updates	Sydney Trains and DP&E	11 May 2017*
Section 4.2.2, Tables 2, 5, 7 & 8 and Appendix 4	LW301-303 BFMP_SYDTRAINS-R01-C	Revised – Addressing DP&E and DRG requirements	Sydney Trains and DRG	-
Tables 2,3,5,6 & 8. Section 6, 8 and 16	LW301-303 BFMP_SYDTRAINS-R01-D	Incorporating findings of Cardno report into effects of ground movement on repeater tower and comments from Sydney Trains	Sydney Trains	-
Preface, Tables 2 and 5	LW301-303 BFMP_SYDTRAINS-R01-E	Revised TARP. Revised for LW303	Sydney Trains and DRG	-
Table 5 and 7, 7.2.1	LW301-303 BFMP_SYDTRAINS-R01-F	Monitoring of rail culverts and valley closure at railway added	Sydney Trains and DRG	8 November 2018#
All	BFMP_SYDTRAINS-R01-G	Inclusion of Longwall 304 into BFMP	Sydney Trains	-

* The approval allows for the extraction of Longwalls 301 and 302 only.

Approval for the extraction of Longwall 303.

April 2019

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Appendix 2 MSEC (2019) Metropolitan Colliery – Proposed Longwall 304 – Subsidence Predictions and Impact Assessment for the Sydney Trains Infrastructure

Appendix 3 Built Features Management Plan – Subsidence Impact Register

Appendix 4 Contingency Plan Procedure and Decision Trees

1 INTRODUCTION

Metropolitan Coal is a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under section 75J of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com).

The Project comprises the continuation, upgrade and extension of underground coal mining operations (Longwalls 20-27 and Longwalls 301-317) and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1. Following the completion of Longwall 27 in 2017, Longwalls 301, 302, 303 and 304 define the next mining sub-domains within the Project underground mining area (Figures 1 to 3).

1.1 PURPOSE AND SCOPE

In accordance with Condition 6(f), Schedule 3 of the Project Approval, this Built Features Management Plan – Sydney Trains (BFMP-SYDTRAINS) has been developed to manage the potential consequences of longwall extraction on the Sydney Trains assets.

The relationship of this BFMP-SYDTRAINS to Metropolitan Coal Environmental Management Structure is shown on Figure 4.

In accordance with Condition 6, Schedule 3 of the Project Approval, the suitably qualified and experienced experts that have prepared this BFMP-SYDTRAINS, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and Metropolitan Coal were endorsed by the Director-General of the Department of Planning and Environment (DP&E). This BFMP-SYDTRAINS has been prepared in consultation with Sydney Trains including consideration of prior consultation with RailCorp (now Sydney Trains) during the development of the previously approved Built Features Management Plans.

1.2 STRUCTURE OF THE BFMP-SYDTRAINS

The remainder of the BFMP-SYDTRAINS is structured as follows:

Section 2: Describes the review and update of the BFMP-SYDTRAINS.

Section 3: Outlines the statutory requirements applicable to the BFMP-SYDTRAINS.

Section 4: Provides a revised assessment of the potential subsidence impacts and environmental consequences for Longwalls 301-304.

Section 5: Details the performance measures and indicators that will be used to assess the Project.

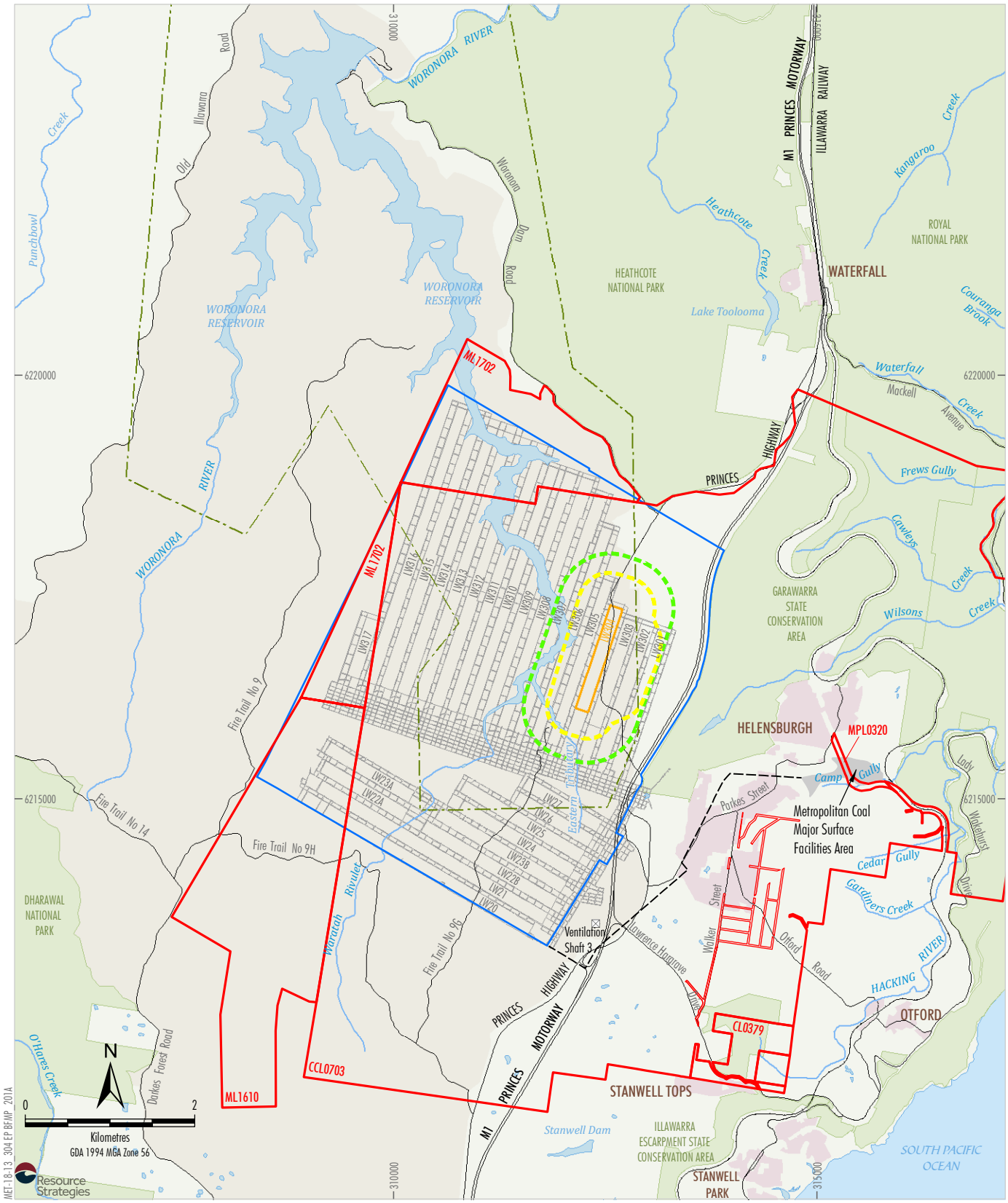
Section 6: Provides the detailed baseline data.

Section 7: Describes the monitoring program.

Section 8: Describes the management measures that will be implemented.

Section 9: Provides a contingency plan to manage any unpredicted impacts and their consequences.

Section 10: Describes the Trigger Action Response Plan (TARP) management tool.



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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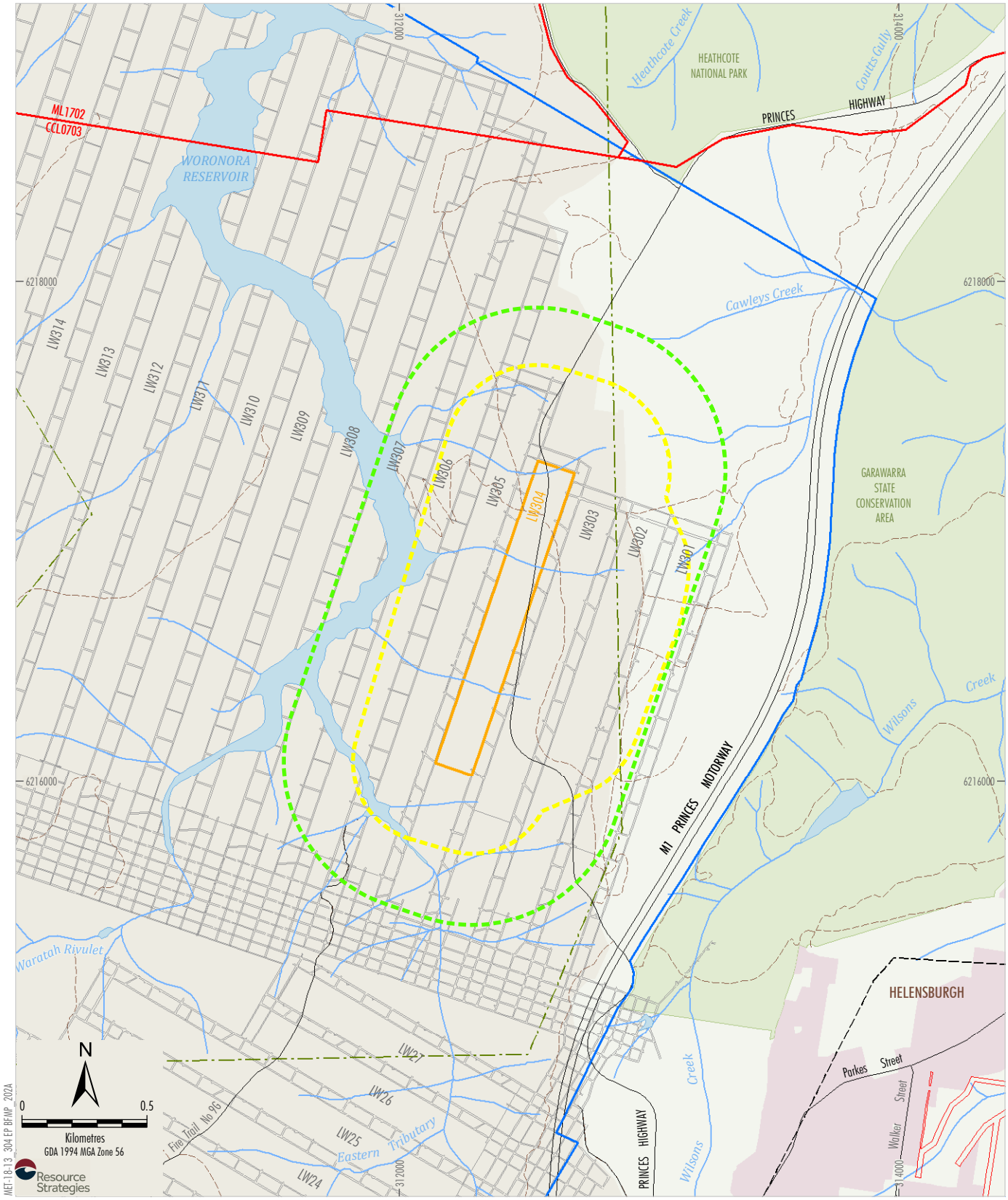
Longwalls 20-27 and Longwalls 301-317 Layout

Figure 1



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)
- Vehicular Track

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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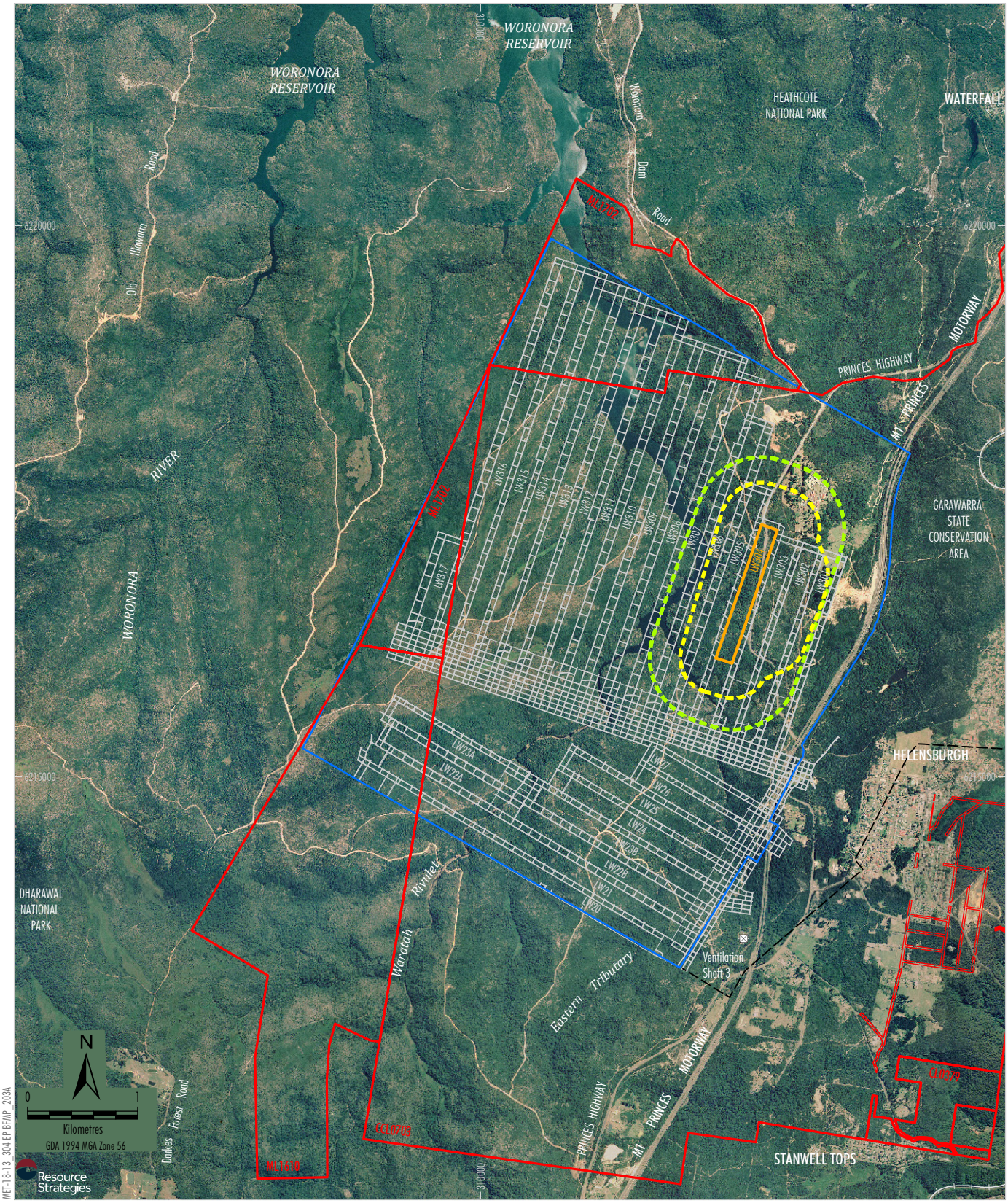
METROPOLITAN COAL

Longwalls 301-304 Layout

Figure 2



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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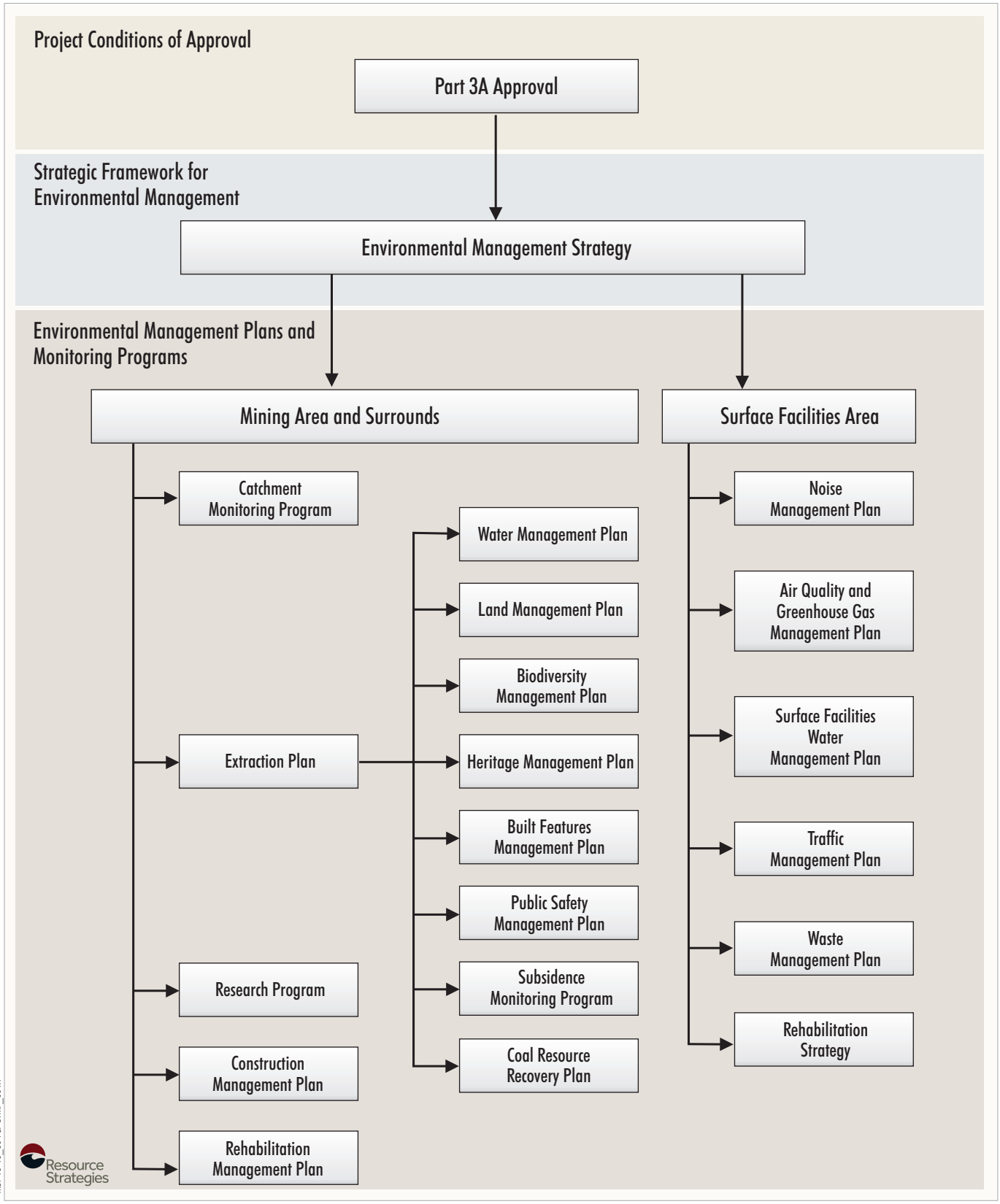
Longwalls 20-27 and Longwalls 301-317 Layout - Aerial Photograph

Figure 3



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Environmental Management Structure

Figure 4

Section 11: Describes the program to collect sufficient baseline data for future Extraction Plans.

Section 12: Describes the annual review and improvement of environmental performance.

Section 13: Outlines the management and reporting of incidents.

Section 14: Outlines the management and reporting of complaints.

Section 15: Outlines the management and reporting of non-compliances with statutory requirements.

Section 16: Lists the references cited in this BFMP-SYDTRAINS.

2 BFMP-SYDTRAINS REVIEW AND UPDATE

In accordance with Condition 4, Schedule 7 of the Project Approval, this BFMP-SYDTRAINS will be reviewed within three months of the submission of:

- an audit under Condition 8 of Schedule 7;
- an incident report under Condition 6 of Schedule 7;
- an annual review under Condition 3 of Schedule 7; and

if necessary, revised to the satisfaction of the Director-General (now Secretary) of DP&E, to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

This BFMP will also be reviewed within three months of approval of any Project modification and if necessary, revised to the satisfaction of the DP&E.

The revision status of this plan is indicated on the title page of each copy of the BFMP-SYDTRAINS. The distribution register for controlled copies of the BFMP-SYDTRAINS is described in Section 2.1.

Revisions to any documents listed within this BFMP-SYDTRAINS will not necessarily constitute a revision of this document.

2.1 DISTRIBUTION REGISTER

In accordance with Condition 10, Schedule 7 ‘Access to Information’, Metropolitan Coal will make the BFMP-SYDTRAINS publicly available on the Peabody website. A hard copy of the BFMP-SYDTRAINS will also be maintained at the Metropolitan Coal site.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format. An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom the Metropolitan Coal plans and programs, such as the BFMP-SYDTRAINS, will be distributed;
- the format (i.e. electronic or hard copy) of distribution; and
- the format of revision notification.

Metropolitan Coal will make the Distribution Register publicly available on the Peabody website.

Metropolitan Coal will be responsible for maintaining the Distribution Register and for ensuring that the notification of revisions is sent by email or post as appropriate.

In addition, Metropolitan Coal employees with local computer network access will be able to view the controlled electronic version of this BFMP-SYDTRAINS on the Metropolitan Coal local area network. Metropolitan Coal will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on the Metropolitan Coal computer system and Peabody website.

3 STATUTORY REQUIREMENTS

Metropolitan Coal's statutory obligations are contained in:

(i) the conditions of the Project Approval;

(ii) relevant licences and permits, including conditions attached to mining leases; and

(iii) other relevant legislation.

These are described below.

3.1 EP&A ACT APPROVAL

Condition 6(f), Schedule 3 of the Project Approval requires the preparation of a BFMP as a component of Extraction Plan(s) for second workings. Project Approval Condition 6(f), Schedule 3, states:

> ***SECOND WORKINGS***
>
> ***Extraction Plan***
>
> *6. The Proponent shall prepare and implement an Extraction Plan for all second workings in the mining area to the satisfaction of the Director-General. This plan must:*
>
> *…*
>
> *(f) include a:*
>
> *…*
>
> - *Built Features Management Plan, which has been prepared in consultation with the owner of the relevant feature, to manage the potential environmental consequences of the Extraction Plan on any built features;*
>
> *…*

In addition, Condition 2, Schedule 7 and Condition 7, Schedule 3 of the Project Approval outline management plan requirements that are applicable to the preparation of the BFMP-SYDTRAINS. Table 1 indicates where each component of the conditions is addressed within this BFMP-SYDTRAINS.

Table 1
Management Plan Requirements

Project Approval Condition	BFMP-SYDTRAINS Section
Condition 2 of Schedule 7	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Section 6
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 3
• any relevant limits or performance measures/criteria;	Section 5
• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 5
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Sections 7, 8, 9 and 10
d) a program to monitor and report on the:	Sections 7, 8 and 12
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 9 and Appendix 4
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Sections 7 and 12
g) a protocol for managing and reporting any;	
• incidents;	Section 13
• complaints;	Section 14
• non-compliances with statutory requirements; and	Section 15
• exceedances of the impact assessment criteria and/or performance criteria; and	Section 9 and Appendix 4
h) a protocol for periodic review of the plan.	Section 2
Condition 7 of Schedule 3	
7. In addition to the standard requirements for management plans (see condition 2 of schedule 7), the Proponent shall ensure that the management plans required under condition 6(f) above include:	
a) a program to collect sufficient baseline data for future Extraction Plans;	Section 11
b) a revised assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval;	Section 4
c) a detailed description of the measures that would be implemented to remediate predicted impacts; and	Section 8
d) a contingency plan that expressly provides for adaptive management.	Section 9 and Appendix 4

3.2 LICENCES, PERMITS AND LEASES

In addition to the Project Approval, all activities at or in association with the Metropolitan Coal Mine will be undertaken in accordance with the following licences, permits and leases which have been issued or are pending issue:

- The conditions of mining leases issued by the NSW Division of Resources and Geoscience (DRG), under the NSW *Mining Act, 1992* (e.g. Consolidated Coal Lease [CCL] 703, Mining Lease [ML] 1610, ML 1702, Coal Lease [CL] 379 and Mining Purpose Lease [MPL] 320).

- The Metropolitan Coal Mining Operations Plan 1 October 2012 to 30 September 2019 approved by the DRG.
- The conditions of Environment Protection Licence (EPL) No. 767 issued by the NSW Environment Protection Authority (EPA) under the NSW *Protection of the Environment Operations Act, 1997*. Revision of the EPL will be required prior to the commencement of Metropolitan Coal activities that differ from those currently licensed.
- The prescribed conditions of specific surface access leases within CCL 703 for the installation of surface facilities as required.
- Water Access Licences (WALs) issued by the NSW Department of Primary Industries – Water (now the Department of Industry – Water) under the NSW *Water Management Act, 2000*, including WAL 36475 under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* and WAL 25410 under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*.
- Mining and workplace health and safety related approvals granted by the NSW Resources Regulator and WorkCover NSW.
- Supplementary approvals obtained from WaterNSW for surface activities within the Woronora Special Area (e.g. fire road maintenance activities).

3.3 OTHER LEGISLATION

Metropolitan Coal will conduct the Project consistent with the Project Approval and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to the conduct of the Project (Helensburgh Coal Pty Ltd [HCPL], 2008)[1]:

- *Biodiversity Conservation Act, 2016;*
- *Biosecurity Act, 2015;*
- *Contaminated Land Management Act, 1997;*
- *Crown Land Management Act, 2016;*
- *Dams Safety Act, 2015;*
- *Dangerous Goods (Road and Rail Transport) Act, 2008;*
- *Energy and Utilities Administration Act, 1987;*
- *Fisheries Management Act, 1994;*
- *Mining Act, 1992;*
- *Protection of the Environment Operations Act, 1997;*
- *Rail Safety (Adoption of National Law) Act, 2012;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Water NSW Act, 2014;*

[1] The list of potentially applicable Acts has been updated to reflect changes to the Acts that were in force at the time of submission of the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008).

- *Work Health and Safety Act, 2011; and*
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

Relevant licences or approvals required under these Acts will be obtained as required.

4 REVISED ASSESSMENT OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

4.1 EXTRACTION LAYOUT

Longwalls 301-304 and the area of land within 600 metres (m) of Longwall 304 secondary extraction are shown on Figures 2 and 3. Longwall extraction occurs from north to south. The longwall layouts include 163 m panel widths (void) with 45 m pillars (solid).

The provisional extraction schedule for Longwalls 301-304 is provided in Table 2.

Table 2
Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
301	June 2017	6 months	February 2018
302	March 2018	7 months	October 2018
303	November 2018	7 months	May 2019
304	July 2019	6 months	December 2019

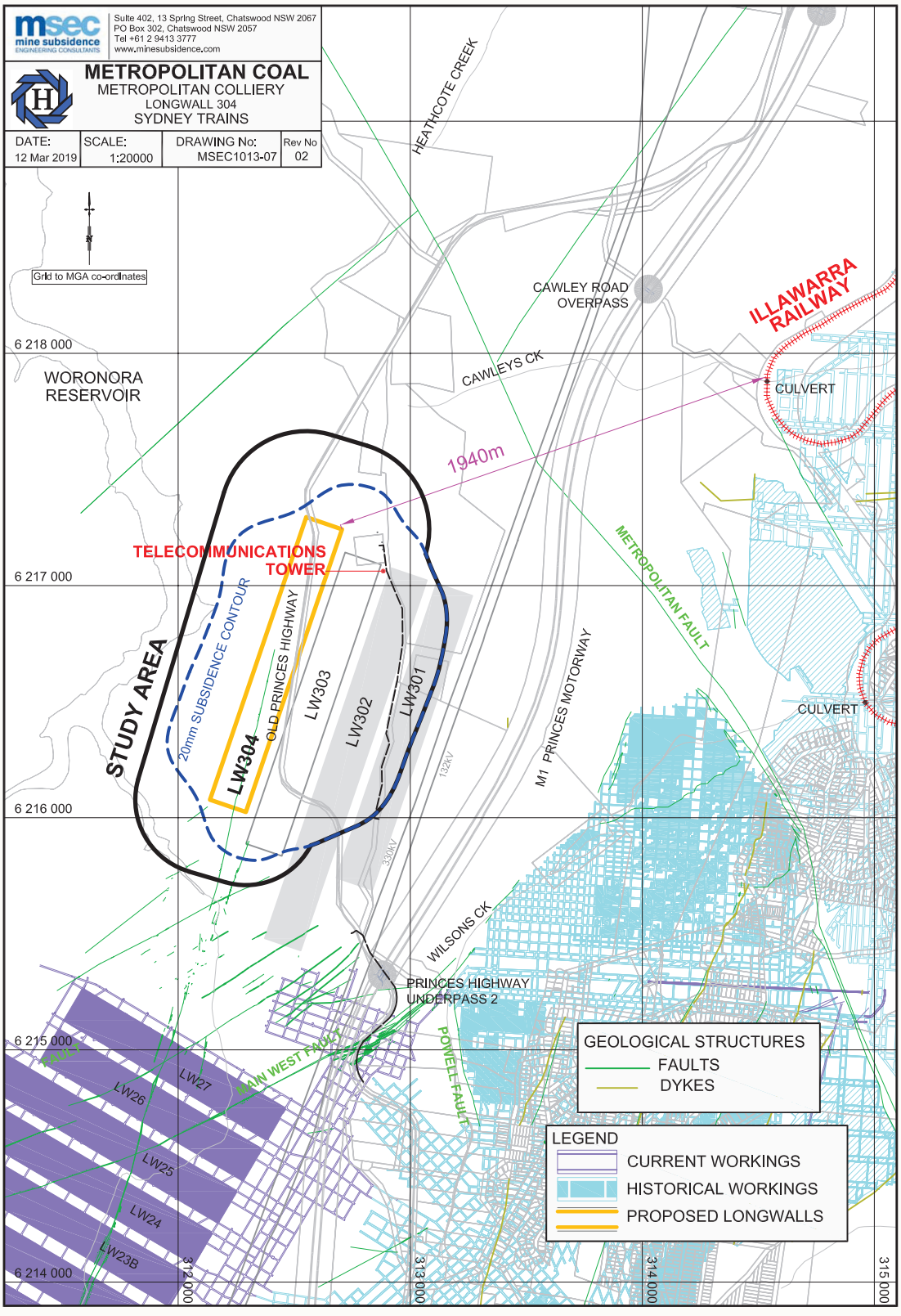
The future Extraction Plans will consider the cumulative subsidence effects, subsidence impacts and/or environmental consequences. Note that the total cumulative predicted subsidence effects, subsidence impacts and/or environmental consequences at the completion of the Project are considered in the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008) and the Preferred Project Report (HCPL, 2009).

4.1.1 Sydney Trains Assets

Figure 5 illustrates the Sydney Trains assets in relation to Longwalls 301-304 extraction. The assets include:

- Illawarra Railway Line; and
- Telecommunications Tower (and Compound).

The shortest distance from the proposed Longwalls 301-304 to the Illawarra Railway Line is approximately 1,400 m, with Longwall 304 being greater than 1,900 m. The telecommunications tower (and compound) is located above the chain pillar between Longwall 302 and Longwall 303.



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Source: MSEC (2019)

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Sydney Trains Assets

Figure 5

4.2 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

4.2.1 Revised Subsidence Predictions

Subsidence predictions for Longwalls 20-44 in relation to the Sydney Trains assets was conducted by MSEC (2008) as part of the Metropolitan Coal Project EA. MSEC (2008) includes a table summarising the incremental systematic subsidence parameters for the extraction of each longwall from Longwalls 20-44. These include:

- maximum predicted incremental subsidence (vertical movement);
- maximum predicted incremental tilt along alignment;
- maximum predicted incremental tilt across alignment;
- maximum predicted incremental tensile strain; and
- maximum predicted incremental compressive strain.

Revised subsidence and impact predictions for the extraction of Longwalls 301-303 and Longwall 304 on Sydney Trains assets were conducted by MSEC and reported in MSEC (2016) and MSEC (2019) (Appendices 1 and 2), respectively.

In relation to subsidence predictions and potential impacts for Longwalls 301-303, MSEC (2016) make the following conclusions:

- The Illawarra Railway is located more than 1.4 kilometres from the longwalls. While the railway could experience low level far-field horizontal movements, the associated tilts, curvatures or strains are not expected to be measurable.
- It is unlikely that the Illawarra Railway and associated infrastructure would experience adverse impacts as a result of Longwalls 301-303.
- The magnitude of tilt predicted at the telecommunications tower (and compound) is very small (less than 1%) and is unlikely to be adversely impacted.
- Based on the predicted conventional curvatures and strains, the building enclosure could potentially experience adverse impacts such as cracking of the brickwork or sticky entry door.
- It is expected that the building enclosure would however remain in safe and serviceable conditions during and after mining.

In relation to subsidence predictions and potential impacts for Longwall 304, MSEC (2019) make the following conclusions:

- The Illawarra Railway is located more than 1.9 km from Longwall 304. While the railway could experience low level far-field horizontal movements, the associated tilts, curvatures or strains are not expected to be measurable.
- It is unlikely that the Illawarra Railway and associated infrastructure would experience adverse impacts as a result of Longwall 304.
- The magnitude of tilt predicted at the telecommunications tower (and compound) is very small (less than 0.35% or 0.2 degrees) and is unlikely to be adversely impacted.

- Based on the predicted conventional curvatures and strains, the building enclosure could potentially experience adverse impacts such as cracking of the brickwork or sticky entry door.
- It is expected that the building enclosure would however remain in safe and serviceable conditions during and after mining.

4.2.2 Risk Assessment Meeting

In accordance with the *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) a risk assessment meeting for Longwalls 301-303 was held on 18 August 2016. Attendees at the risk assessment meeting included representatives from Sydney Trains, MSEC, Resource Strategies (on behalf of Metropolitan Coal) and Axys Consulting (risk assessment facilitator).

The investigation and analysis methods used during the risk assessment review included:

- preliminary identification of Sydney Trains assets[2];
- review of the revised subsidence predictions and potential impacts on Sydney Trains assets (including consideration of past experience in the Southern Coalfield); and
- development of a preliminary monitoring plan.

A number of risk control measures and procedures relevant to the Sydney Trains assets have been identified which considered the extraction of coal beneath (communications tower and compound) and at distance from (rail line) the assets, and are summarised as follows:

Baseline Data / Validation

1. Carry out an audit on the Sydney Trains communications compound within the Study area, as agreed with Sydney Trains, and document the current condition.
2. Obtain information from Sydney Trains Structural Engineering Group of the footing details of the communication tower.
3. Metropolitan Coal to conduct a review of footing details and provide outcomes to Sydney Trains Structural Engineering Group.
4. Obtain information from Sydney Trains Structural Engineering Group on the potential effect of mining under the communication tower and confirm within the limitation of the current tower services.
5. Obtain from relevant personnel at Sydney Trains (e.g. communications department) if the predicted tilts would have any measurable impact on services supplied by the communications tower.
6. Provide Sydney Trains with additional information on the possible long-term impact of underground mining.
7. Metropolitan Coal to consider if a dilapidation audit of Illawarra Railway, culvert, guard railings, marker posts and signage is required.

[2] Since the risk assessment meeting was held, Axicom confirmed that the telecommunication tower and compound (initially considered during the Optus risk assessment) is an Axicom asset which is managed separately in the BFMP-Axicom.

Management / Monitoring / Response Measures

8. Include in the BFMP a schedule of times/frequency of communication with Sydney Trains for the status of mining of Longwalls 301-303.
9. Develop a Trigger Action Response Plan (TARP) and include a trigger for rail line conditions that may need to be actioned by Sydney Trains.
10. Include in the BFMP contact information from Sydney Trains for liaison during implementation of management measures and contingency planning.

Contingency Planning

11. Metropolitan Coal to arrange further consultation with relevant personnel at Sydney Trains (e.g. communications department) if there is an alternative communication system that can be implemented if the main communication was to become unserviceable.

Metropolitan Coal considers all risk control measures and procedures to be feasible to manage all identified risks.

The proposed risk control measures and procedures have been incorporated where relevant in this BFMP and the program for implementation is summarised in Table 3.

Table 3
Program for Implementation of Proposed Risk Control Measures and Procedures

	Risk Control Measure / Procedure	BFMP Section	Timing
Baseline Data / Validation			
1	Carry out an audit on the Sydney Trains communications compound within the Study area	Section 6	Complete
2	Obtain information from Sydney Trains Structural Engineering Group of the footing details of the communication tower	Section 6	Complete
3	Conduct a review of footing details and provide outcomes to Sydney Trains Structural Engineering Group	Section 6	Complete
4	Obtain information from Sydney Trains Structural Engineering Group on the potential effect of mining under the communication tower and confirm within the limitation of the current Tower services	Section 6	Complete
5	Obtain from relevant personnel at Sydney Trains (e.g. communications department) if the predicted tilts would have any measurable impact on services supplied by the communications tower	Section 6	Complete
6	Provide Sydney Trains with additional information on the possible long-term impact of underground mining	Section 4.3 / Appendix 1	Complete
7	Consider if a dilapidation audit of Illawarra Railway, culvert, guard railings, marker posts and signage is required	Section 4.3	Complete
Management / Monitoring / Response Measures			
8	Include a schedule of times/frequency of communication with Sydney Trains for the status of mining of Longwalls 301-303 in the BFMP	Sections 7 and 10 / Table 2	Complete
9	Include in the TARP a trigger to rail conditions that may need to be actioned by Sydney Trains	Section 10 / Table 7	Complete
10	Include contact information from Sydney Trains for liaison in the BFMP	Section 6.1	Complete
Contingency Planning			
11	Arrange further consultation with relevant personnel (e.g. communications department) for the communications tower for consideration of specific measures (e.g. alternative communication system) and contingency planning	Section 9.1	Complete

The risk control measures and procedures identified during the risk assessment for Longwalls 301-303 will be implemented for the extraction of Longwall 304.

4.3 LONG-TERM STABILITY OF OLD MINE WORKINGS

Old (historic) underground mine workings are present beneath and in the vicinity of the Illawarra Railway as shown on Figure 5. There are no old (historic) underground mine workings directly above or below Longwalls 301-304 nor within the relevant Study Area (Figure 5).

An assessment of subsidence above old mine workings has previously been undertaken and presented at the 8th Triennial Conference on Mine Subsidence in 2011 in a paper titled "*An Analysis of Long Term Subsidence at Metropolitan Colliery*". A copy of the paper is provided in Appendix 1. Based on data covering a 14 year period of monitoring, the assessment concluded that the goaf/chain pillar system (similar to Longwalls 301-304) was in a longer term stable condition.

A typical stratigraphic section of the geology at the Metropolitan Colliery is provided in Appendix 1. The section is characteristic of the NSW Southern Coalfield with deep overburden of sedimentary rocks comprising Hawkesbury Sandstone at the surface overlying the Narrabeen Group. There is no Wianamatta Shale present at the surface at the Metropolitan Colliery.

Detailed groundwater modelling and assessment of underground mining at the Metropolitan Colliery has been undertaken including consideration of the long term recovery and flooding of old mine workings. The Groundwater Assessment (Heritage Computing, 2008) is available on the Peabody website.

At more than 1.4 km from Longwalls 301-304, it is considered unlikely that the Illawarra Railway and associated infrastructure would experience adverse impacts from subsidence of old workings as a result of extraction of Longwalls 301-304. At more than 1.4km the Illawarra Railway is not expected to experience measurable conventional vertical subsidence, tilts or curvatures. While the railway could experience low level far-field horizontal movements, the low-level movements comprise a large proportion of survey tolerance and are not expected to measurable. Culverts are located at the Illawarra Railway crossing at Cawleys and Wilsons Creeks. The valley related movements at these creek crossings are predicted to be less than 5 mm upsidence and less than 5 mm closure. The strains associated with these low levels of valley related movements are not expected to be measurable. Therefore, a dilapidation audit of the Illawarra Railway is not proposed to be undertaken for Longwalls 301-304.

4.4 UNDERGROUND BLAST VIBRATION IMPACTS

Use of explosives is not required for existing or proposed general underground coal mining. Occasionally, geological structures (e.g. dykes) may be encountered underground that have to be broken up using very low mass explosives. This underground blasting would be undertaken at significant depth (e.g. greater than 400 m below the surface).

Ground vibration and airblast levels which cause human discomfort are generally lower than the recommended structural damage limits. Therefore, compliance with the lowest applicable human comfort criteria ensures that the potential to cause structural damage is minimal. Based on the assessment results presented in the Metropolitan Coal Project Noise Impact Assessment (Heggies, 2008), ground vibration levels are predicted to meet the most stringent night-time criteria of 1 mm/s at a distance of 500 m from the blast site. As blasting is conducted at least 400 m below the surface, vibration impacts are likely to be minimal (which is consistent with the existing Metropolitan Colliery blasting practices and experience).

5 PERFORMANCE MEASURES AND INDICATORS

The Project Approval requires Metropolitan Coal not to exceed the subsidence impact performance measures outlined in Table 1 of Condition 1, Schedule 3. The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.

The performance indicators proposed to ensure that the above performance measure is achieved include:

- no defects or deformation of the Illawarra Railway Line due to mining; and
- the structural integrity of the telecommunications tower (and compound) is maintained.

Section 7 of this BFMP-SYDTRAINS describes the monitoring that will be conducted to assess the Project against the above performance measure. Sections 8 and 9 of this BFMP-SYDTRAINS provides management measures and a Contingency Plan in the event the performance indicators or performance measure is exceeded.

6 BASELINE DATA

An audit on the Sydney Trains telecommunications compound was conducted within the Study area prior to extraction of Longwall 302 to document the current condition. If available, information from Sydney Trains Structural Engineering Group of the footing details of the telecommunication tower will be obtained, and review outcomes provided to Sydney Trains to confirm within the limitation of the current tower services.

The telecommunications tower and compound are shown on Plates 1 and 2.

Plates 1 and 2 – Telecommunications Tower and Compound (Source: MSEC, 2016)

As described in Section 4.2.1 and Appendix 1, the magnitude of tilt predicted at the telecommunications tower (and compound) is very small (0.35% or 0.2 degrees).

6.1 KEY CONTACTS LIST

The list of key contacts for Peabody and Sydney Trains during the development and implementation of this BFMP are provided in Table 4.

Table 4
List of Key Contacts

Company / Agency	Peabody (Metropolitan Coal)	Sydney Trains
Position	Manager – Technical Services	Program Manager Capital & External Party Works Engineering & Maintenance
Name	Jon Degotardi	Joe O'Brien
Contact	Control Room 24hr 02 4294 7333	131 500

7 MONITORING

A monitoring program has been implemented to monitor the impacts of the Project in consultation with Sydney Trains. Table 5 summarises the BFMP-SYDTRAINS monitoring components.

It is understood that track inspections occur approximately two times per week in accordance with the Sydney Trains maintenance program.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts for comparison with baseline photographic records.

Sydney Trains or their delegates will conduct the various visual inspections. Metropolitan Coal will be notified of the timing of inspections and accompany Sydney Trains or delegates if considered necessary. All personnel will complete necessary inductions or orientation relevant to the tasks required.

The frequency of monitoring will be reviewed either:

- in accordance with the Annual Review outlined in Section 12; or
- if triggered as a component of the Contingency Plan as outlined in Section 9 of this BFMP-SYDTRAINS.

Table 5
BFMP-SYDTRAINS Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Baseline	Illawarra Railway	Survey	M1 Princes Motorway subsidence line points at approximately 20 m spacing	Establish base condition	Prior to Longwall 301 extraction	Once
	Railway Culverts Wilsons Creek Cawley Creek	Condition assessment	Visual Inspection by structural engineer	Establish base condition	Prior to Longwall 301 extraction	Once
		Survey	Relative survey of fixed survey points inside each culvert	Establish base condition	Prior to Longwall 301 extraction	Once
	Telecommunications Tower (and compound)	Survey	Adjacent optic / water subsidence line points at approximately 20 m spacing	Establish base conditions – to track general land movement*	Prior to Longwall 301 extraction	Once
			Survey marks at Tower	Establish base conditions – to track any 3D movement*	Prior to Longwall 302 extraction	Once
		Condition assessment (including infrastructure, services and cables)		Establish base condition	Prior to Longwall 302 extraction	Once
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Establish base condition	Prior to Longwall 302 extraction	Once

Table 5 (Continued)
BFMP-SYDTRAINS Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
During Mining	Illawarra Railway	Survey	M1 Princes Motorway subsidence line points at approximately 20 m spacing	Monitor subsidence effects during mining	At the completion of each longwall	Once per longwall
		Remote Continuous Survey with GNSS Telemetry	Valley closure monitoring of Wilsons Creek and Cawley Creek	Monitor for signs of any far field subsidence during mining	Commencing prior to LW303	Daily measurement
		Visual inspection (Sydney Trains)	Identify evidence of subsidence effects or any defects or deformation of the rail line and associated infrastructure		As per Sydney Trains inspection program	Two times per week
	Railway Culverts	Survey	Culvert relative monitoring of brick culverts 15 survey points at both Wilsons Creek and Cawley Creek		Mid panel and end of panel surveys	Two times per longwall
		Condition assessment	Visual Inspection by structural engineer for signs of change (Metropolitan organised)		End of Panel	Once per longwall
	Telecommunications Tower (and compound)	Survey	Adjacent optic / water subsidence line points at approximately 20 m spacing	Monitor subsidence effects during mining	On commencement of LW302, LW303 and LW304	Weekly until effects of subsidence no longer detectable
		Survey Tower monitoring	Survey 4 x ground monitoring points Survey 4 x tower leg mounted prisms.	Monitor any structural movements as per Tower TARP	On commencement of LW302, LW303 and LW304	Weekly until effects of subsidence no longer detectable
		Visual inspection (for evidence of subsidence effects on compound – movement of building/cables entering compounds)		Monitor structural integrity of compounds and cable entries	On commencement of LW302, LW303 and LW304	Weekly until effects of subsidence no longer detectable
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Monitor for surface cracks, buckling and general safety	On commencement of LW302, LW303 and LW304	Weekly until effects of subsidence no longer detectable
					As per Longwall 304 LMP	

Table 5 (Continued)
BFMP-SYDTRAINS Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Post Mining	Illawarra Railway	Visual inspection (Sydney Trains)		Validation	Post LW303 and LW304	Twice
	Railway Culverts	Visual Inspection by structural engineer (Metropolitan)		Determine level of impact of mining (if any)	Within 3 months of the completion LW303 and LW304	Twice
		Survey culvert, relative monitoring, 15 survey points at both Wilsons Creek and Cawley Creek		Determine level of impact of mining (if any)	Within 3 months of the completion LW303 and LW304	Twice
	Telecommunications Tower (and compound)	Condition assessment (including infrastructure, services and cables)		Determine level of impact of mining (if any)	Within 3 months of the completion LW303 and LW304	Twice
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Determine level of impact of mining (if any)	Within 3 months of the completion LW303 and LW304	Twice

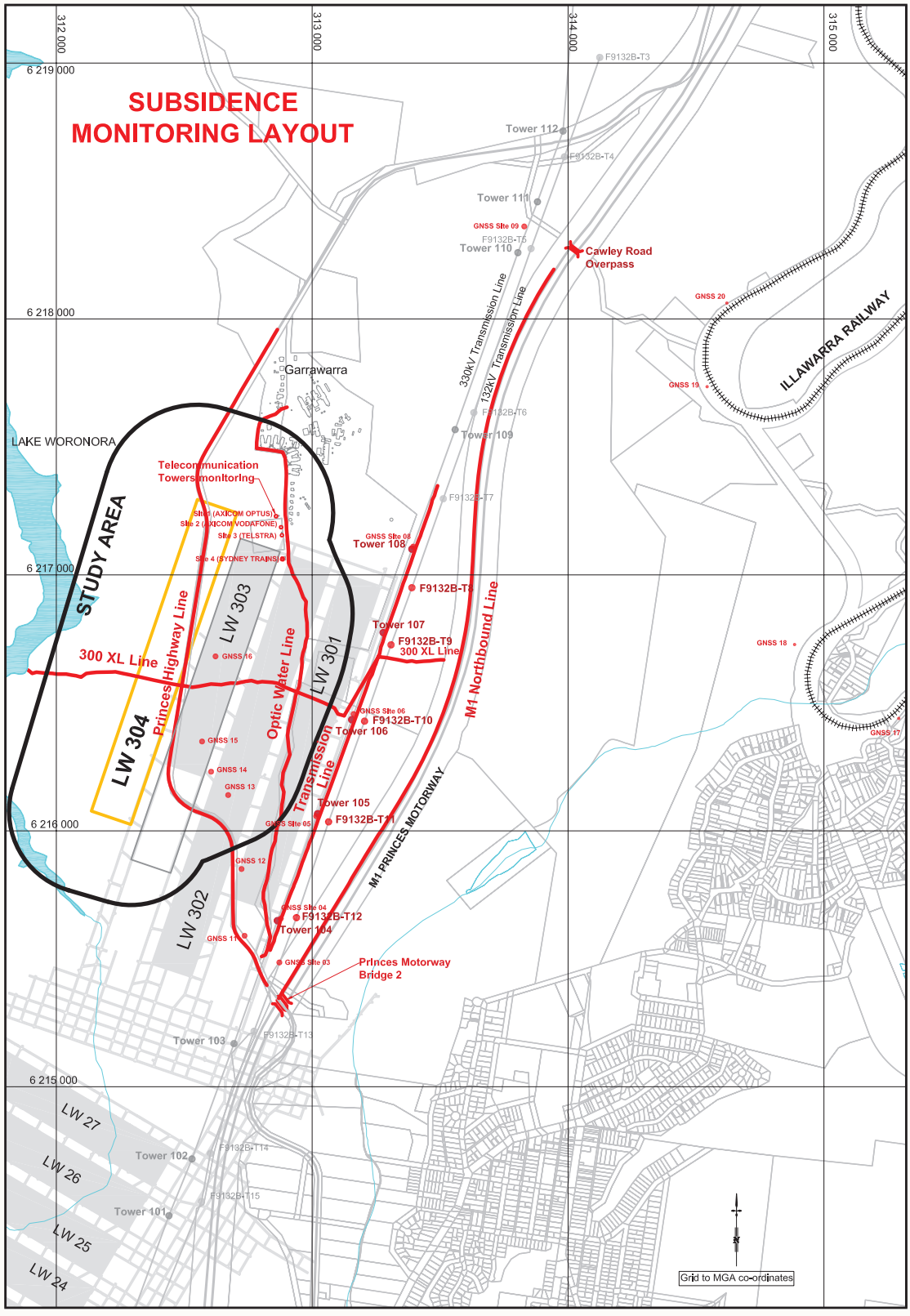
* Subsidence effects predicted for the telecommunications tower (and compound) during mining of Longwall 301 alone are minimal to nil as the total subsidence profile does not develop until after commencement of Longwall 302.

7.1 SUBSIDENCE PARAMETERS

Subsidence parameters (i.e. subsidence, tilt, tensile strain, compressive strain) associated with mining will be measured in accordance with the Longwall 304 Subsidence Monitoring Program (Figure 6).

In summary, surveys will be conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence movements (i.e. subsidence, tilt, tensile strain and compressive strain) will be measured along subsidence lines that have been positioned across the general landscape.

Subsidence parameters specific to the Sydney Trains assets include the survey line along the M1 Princes Motorway (located between the longwalls and Illawarra Railway) and the optical fibre and water lines (in the vicinity of the telecommunications tower and compound). These surveys will monitor the general movement about the longwalls and the data will allow evaluation of the likely ground movements about the railway and telecommunications tower and compound (by comparison between measured and predicted movements). Monitoring of towers will also be undertaken as shown on Figure 6.



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Source: MSEC (2019)

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Subsidence Monitoring Layout

Figure 6

7.2 SUBSIDENCE IMPACTS

7.2.1 Rail Line

Visual inspections are conducted in accordance with the Sydney Trains inspection plans for the area. This generally includes:

- track condition;
- structures condition;
- drainage changes; and
- culvert condition.

If any defects or deformation of the rail line (as a result of mining activities associated with Longwalls 301-304) are recorded by Sydney Trains and confirmed with Metropolitan Coal, the information will be recorded in the Built Features Management Plan – Subsidence Impact Register (Appendix 3) and reported in accordance with the Project Approval conditions. Monitoring for far field subsidence at the rail culverts and Wilsons Creek Valley and Cawley Creek Valley by Metropolitan Coal as described in Table 5.

7.2.2 Telecommunications Tower and Compound

Visual inspections of the telecommunications tower and compound will be conducted in consultation with the Sydney Trains. Monitoring of towers will be conducted by Metropolitan Coal as described in Table 5.

7.3 ENVIRONMENTAL CONSEQUENCES

Metropolitan Coal and Sydney Trains will compare the results of the subsidence impact monitoring against the built features performance indicators and performance measure. In the event the observed subsidence impacts exceed the performance indicators or performance measure, Metropolitan Coal and Sydney Trains will assess the consequences of the exceedance in accordance with the Contingency Plan described in Section 9.

8 MANAGEMENT MEASURES

A number of potential management measures in relation to the rail line are considered to be applicable, if required. These may include:

- speed restriction of trains; and
- minor repair of track.

Potential management measures for the telecommunications tower and compound include pre-mining bracing and/or changing splice plates to relieve any mining induced stress and/or implementation of building maintenance techniques.

Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.

Management measures will be reported in the Annual Review (Section 12).

9 CONTINGENCY PLAN

In the event the subsidence impacts observed exceed the performance indicators or measure detailed in Section 5 of this BFMP, Metropolitan Coal will implement the following Contingency Plan (Appendix 4):

- The observation will be reported to the Manager - Technical Services within 24 hours.
- The observation will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 3) consistent with the monitoring program described in Section 7 of this BFMP-SYDTRAINS.
- Metropolitan Coal will report any exceedance of the performance indicators or performance measure to the DP&E and Sydney Trains as soon as practicable after Metropolitan Coal becomes aware of the exceedance.
- Metropolitan Coal will assess public safety and where appropriate implement safety measures in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan;
- Metropolitan Coal will conduct an investigation to evaluate the potential contributing factors. The investigation will:
  - include the re-survey of relevant subsidence monitoring lines;
  - compare and critically analyse measured versus predicted subsidence parameters;
  - review measured subsidence parameters against the observed impact; and
  - review the subsidence monitoring program and update the program where appropriate.
- The course of action with respect to the identified impact(s), in consultation with specialists and relevant agencies, will include:
  - a program to review the effectiveness of the contingency measures; and
  - consideration of adaptive management.

  Contingency measures are provided in Section 9.1.
- Metropolitan Coal will submit the proposed course of action to the DP&E for approval.
- Metropolitan Coal will implement the approved course of action to the satisfaction of the DP&E.

In accordance with Condition 6, Schedule 6 of the Project Approval, Metropolitan Coal will provide a suitable offset to compensate for the impact to the satisfaction of the Director-General (now Secretary) of DP&E if either the contingency measures implemented by Metropolitan Coal have failed to remediate the impact or the Director-General (now Secretary) determines that it is not reasonable or feasible to remediate the impact.

Metropolitan Coal will comply with the NSW *Coal Mine Subsidence Compensation Act, 2017* in the event that property damages occur as a result of mining Longwalls 301-304.

9.1 CONTINGENCY MEASURES

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of consequences).

Contingency measures that could be considered in the event the performance measure for the rail line and telecommunications tower and compound is exceeded are summarised in Table 6. The decision trees for the contingency measures are shown in Appendix 4.

Table 6
Contingency Measures – Rail Line, Telecommunications Tower and Compound

Environmental Consequence	Contingency Measures	
	Measure	**Description**
Impact on:		
Rail Line	Replace lengths of track	• Temporary suspension of rail traffic and replacement of affected tracks.
Telecommunications Tower	Repair of tower	• Additional bracing and/or strengthening members to the frame. • Replace tower leg splice plates with wider aperture plates to remove and detected mining induced stress. • Replacement of tower.
Building Compound	Repair of building	• Building maintenance techniques. • Replacement of building compound.

10 TARP – MANAGEMENT TOOL

The framework for the various components of the BFMP-SYDTRAINS are summarised in the BFMP-SYDTRAINS TARP shown in Tables 7 and 8. The BFMP-SYDTRAINS TARPs illustrates how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

The TARP comprises:

- baseline conditions;
- predicted subsidence impacts;
- trigger levels from monitoring to assess performance; and
- triggers that flag implementation of contingency measures.

The TARP system provides a simple and transparent snapshot of the monitoring of performance and the implementation of management and/or contingency measures.

Table 7
Trigger Action Response Plan – Illawarra Railway Line

SYDNEY TRAINS Illawarra Railway Line		
SYDNEY TRAINS Illawarra Railway Line	*Risk: Subsidence effect on rail infrastructure resulting in impact to structural integrity and services.*	
	TRIGGER LEVEL	**RESPONSE**
	Level 1 - Normal **Expected subsidence conditions (at M1 Princes Motorway)**	
	Subsidence • less than 50 mm Absolute Horizontal Movements • less than 115 mm Strain (Tensile or Compressive) • less than 0.4 mm/m Valley Closure at Railway • equal to or less than 20 mm closure averaged over 7-day period	**Normal Operations** • Illawarra Railway Line is safe and serviceable. • Negligible impact to infrastructure and no impact to rail services. • Continue monitoring activities as planned.
	Level 2 - Monitor **Subsidence elevated up to +15% of predicted (at M1 Princes Motorway) but rail service condition normal**	
	Subsidence • between 50 and 60 mm Absolute Horizontal Movements • between 115 and 130 mm Strain • between 0.4 and 0.5 mm/m Valley Closure at Railway • greater than 20 mm closure averaged over 7-day period	**Continue operations but report on subsidence anomaly** • Illawarra Railway Line is safe and serviceable. • Negligible impact to infrastructure and no impact to rail services. **Metropolitan Coal** • Immediately resurvey subsidence line in affected area to confirm results. • Engage subsidence expert to assess results. • Confirm results are consistent with adjacent subsidence lines. • Compare and critically analyse measured versus predicted subsidence. • Inform and provide report to Sydney Trains of subsidence results. • Collaboratively share information with Sydney Trains to monitor situation. **Sydney Trains** • Assess information provided by Metropolitan Coal. • Continue to conduct twice weekly inspection program.

Table 7 (Continued)
Trigger Action Response Plan – Illawarra Railway Line

SYDNEY TRAINS Illawarra Railway Line		
SYDNEY TRAINS Illawarra Railway Line	*Risk: Subsidence effect on rail infrastructure resulting in impact to structural integrity and services.*	
	TRIGGER LEVEL	**RESPONSE**
	Level 3 - Cautionary **Anomalous service condition detected or Subsidence beyond +15% of predicted (at M1 Princes Motorway)**	
	Subsidence • greater than 60 mm Absolute Horizontal Movements • greater than 130 mm Strain • greater than 0.5 mm/m Observable subsidence ground deformations at/near railway line Defects or deformation of the rail line or associated structures (e.g. culverts, drainage)	**Investigate & Resolve** • Illawarra Railway Line is safe and serviceable. • Indication of impact to rail infrastructure. **Metropolitan Coal** • Steps as per Level 2 event, plus: o Inform Sydney Trains and NSW Principal Subsidence Engineer of subsidence results (immediately following awareness of trigger). o Increase frequency of subsidence line surveys to weekly in affected area. o In conjunction with Sydney Trains identify impact location and have Sydney Trains assess rail condition. o Review the subsidence monitoring program and update the program where appropriate. o Provide report on issue to both Sydney Trains and DP&E. **Sydney Trains** • Inform Metropolitan Coal of defects or deformations observed during twice weekly monitoring inspections. • In conjunction with Metropolitan Coal identify impact location, inspect rail infrastructure, assess condition and determine appropriate response (e.g. greater monitoring data or frequency, or schedule maintenance on the rail infrastructure). • Make determination if other measures necessary to avoid further impact.
	Level 4 – Restoration **Rail Service Outage**	
	Service Outage or Fault Occurs	**Implement Contingency Plan** • As per BFMP Section 9 and Appendix 4. **Metropolitan Coal** • As per Level 3 event, plus: o General Manager to be involved in all decision making processes. o Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwall 304 Public Safety Management Plan. o Report exceedance of the performance measure or indicators to the DP&E and Sydney Trains as soon as practicable. o Update the 'Built Features Management Plan – Subsidence Impact Register'. o Investigate circumstances of the fault and determine requirement for adaptive management of mining operations prior to future operations. **Sydney Trains** • As per Level 3 event, plus: o Sydney Trains to enact emergency measures (e.g. temporary suspension of rail traffic) and determine restoration works required. o Complete restoration works. o Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.

Table 8
Trigger Action Response Plan – Telecommunications Tower and Compound

SYDNEY TRAINS – Telecommunications Tower (and Compound)				
SYDNEY TRAINS Telecommunications Tower (and Compound)	*Risk: Subsidence effect on tower or compound resulting in impact to structural integrity.*			
	TRIGGER LEVEL			**RESPONSE**
	Level 1 - Normal **Expected subsidence conditions**			
	LW 301-302 Subsidence • less than 125 mm Tilt • less than 1.5 mm/m Strain • 0.9 mm/m tensile • 1.6 mm/m compressive Differential vertical leg movement • less than 1.0 mm Differential horizontal leg movement • less than 5.4 mm	LW 303 Subsidence • less than 250 mm Tilt • less than 3.0 mm/m Strain • 0.9 mm/m tensile • 1.6 mm/m compressive Differential vertical leg movement • less than 1.0 mm Differential horizontal leg movement • less than 5.4 mm	LW 304 Subsidence • less than 400 mm Tilt • less than 3.5 mm/m Strain • 0.9 mm/m tensile • 1.6 mm/m compressive Differential vertical leg movement • less than 1.0 mm Differential horizontal leg movement • less than 5.4 mm	**<u>Normal Operations</u>** • Telecommunications tower (and building compound) is safe and serviceable. • Negligible impact to telecommunications tower (and compound). • Continue monitoring activities as planned. • Survey data within predictions.

Table 8 (Continued)
Trigger Action Response Plan – Telecommunications Tower and Compound

<table>
<tr><th colspan="5">SYDNEY TRAINS – Telecommunications Tower (and Compound)</th></tr>
<tr><td rowspan="5">SYDNEY TRAINS Telecommunications Tower (and Compound)</td><td colspan="4">Risk: Subsidence effect on tower or compound resulting in impact to structural integrity.</td></tr>
<tr><td colspan="3">TRIGGER LEVEL</td><td>RESPONSE</td></tr>
<tr><td colspan="3">Level 2 - Monitor
Subsidence elevated up to +15% of predicted but service condition normal</td><td></td></tr>
<tr><td>LW 301-302
Subsidence
• between 125 and 145 mm
Differential vertical leg movement
• between 1.0 and 2.0 mm
Differential horizontal leg movements
• between 5.4 mm and 8.6 mm
Strain - Tensile
• between 0.9 and 1.0 mm/m
Strain - Compressive
• between 1.6 and 1.8 mm/m</td><td>LW 303
Subsidence
• between 250 and 285 mm
Differential vertical leg movement
• between 1.0 and 2.0 mm
Differential horizontal leg movements
• between 5.4mm and 8.6 mm
Strain -Tensile
• between 0.9 and 1.0 mm/m
Strain - Compressive
• between 1.6 and 1.8 mm/m</td><td>LW 304
Subsidence
• between 400 and 460 mm
Differential vertical leg movement
• between 1.0 and 2.0 mm
Differential horizontal leg movements
• between 5.4mm and 8.6 mm
Strain - Tensile
• between 0.9 and 1.0 mm/m
Strain - Compressive
• between 1.6 and 1.8 mm/m</td><td><u>Continue operations but report on subsidence anomaly</u>
• Telecommunications tower (and building compound) is safe and serviceable.
• Negligible impact to telecommunications tower (and compound).
<u>Metropolitan Coal</u>
• Immediately resurvey subsidence line (Optic / Water Line) in affected area to confirm results.
• Engage subsidence expert to assess results.
• Confirm results are consistent with other subsidence lines.
• Compare and critically analyse measured versus predicted subsidence.
• Inform and provide report to Sydney Trains of subsidence results.
• Collaboratively share information with Sydney Trains to monitor situation.
<u>Sydney Trains</u>
• Assess information provided by Metropolitan Coal.</td></tr>
</table>

Table 8 (Continued)
Trigger Action Response Plan – Telecommunications Tower and Compound

<table>
<tr><th colspan="5">SYDNEY TRAINS – Telecommunications Tower (and Compound)</th></tr>
<tr><td rowspan="6">SYDNEY TRAINS Telecommunications Tower (and Compound)</td><td colspan="4">Risk: Subsidence effect on tower or compound resulting in impact to structural integrity.</td></tr>
<tr><td colspan="3">TRIGGER LEVEL</td><td>RESPONSE</td></tr>
<tr><td colspan="4">Level 3 - Cautionary
Anomalous service condition detected or Subsidence beyond +15% of predicted</td></tr>
<tr><td>LW 301-302
Subsidence
• greater than 145 mm
Differential vertical leg movement
• greater than 2.0 mm
Differential horizontal leg movements
• greater than 8.6 mm
Strain -Tensile
• greater than 1.0 mm/m
Strain - Compressive
• Greater than 1.8 mm/m</td><td>LW 303
Subsidence
• greater than 285 mm
Differential vertical leg movement
• greater than 2.0 mm
Differential horizontal leg movements
• greater than 8.6 mm
Strain -Tensile
• greater than 1.0 mm/m
Strain - Compressive
• Greater than 1.8 mm/m</td><td>LW 304
Subsidence
• greater than 460 mm
Differential vertical leg movement
• greater than 2.0 mm
Differential horizontal leg movements
• greater than 8.6 mm
Strain -Tensile
• greater than 1.0 mm/m
Strain - Compressive
• Greater than 1.8 mm/m</td><td><u>Investigate & Resolve</u>
• Telecommunications tower (and building compound) is safe and serviceable.
• Indication of impact to telecommunications tower (and compound).
<u>Metropolitan Coal</u>
• Steps as per Level 2 event, plus:
o Increase frequency of subsidence line (Optic / Water Line) surveys to weekly in affected area.
o In conjunction with Sydney Trains identify impact location and work with Sydney Trains to resolve.
o Review the subsidence monitoring program and update the program where appropriate.
o Provide report on issue to both Sydney Trains and DP&E.
<u>Sydney Trains</u>
• In conjunction with Metropolitan Coal identify impact location, inspect tower, assess condition and determine appropriate response. (e.g. greater monitoring data or frequency, or schedule maintenance on the structure).
• Make determination if other measures necessary to avoid further impact.</td></tr>
</table>

Table 8 (Continued)
Trigger Action Response Plan – Telecommunications Tower and Compound

SYDNEY TRAINS – Telecommunications Tower (and Compound)		
SYDNEY TRAINS Telecommunications Tower (and Compound)	*Risk: Subsidence effect on tower or compound resulting in impact to structural integrity.*	
	TRIGGER LEVEL	**RESPONSE**
	Level 4 – Restoration **Fault detected**	
	Fault Detected	**Implement Contingency Plan** • As per BFMP Section 9 and Appendix 4. **Metropolitan Coal** • As per Level 3 event, plus: o General Manager to be involved in all decision making processes. o Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwall 304 Public Safety Management Plan. o Report exceedance of the performance measure or indicators to the DP&E and Sydney Trains as soon as practicable. o Update the 'Built Features Management Plan – Subsidence Impact Register'. o Investigate circumstances of the fault and determine requirement for adaptive management of mining operations prior to future operations in vicinity of the telecommunications tower (and compound). **Sydney Trains** • As per Level 3 event, plus: o Sydney Trains to enact use of alternative communications system. o Determine appropriate course of action for restoration of service (e.g. deploy temporary tower) and rebuilding (e.g. construct new tower and foundations). o Complete restoration works. o Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.

11 FUTURE EXTRACTION PLANS

In accordance with Condition 7, Schedule 3 of the Project Approval, Metropolitan Coal will collect baseline data for the next Extraction Plan (i.e. Longwalls 305-310). The collection of baseline data will be consistent with the baseline data collected for Longwalls 301-304. However, the baseline (and any post-mining) data collected for Longwalls 301-304 will be used as baseline for Longwalls 305 onward as longwall mining progressively moves further away from the Sydney Trains assets.

In addition to the baseline data collection, consideration of the environmental performance and management measures in accordance with the review(s) conducted as part of this BFMP-SYDTRAINS will inform the appropriate type and frequency of monitoring of the assets relevant to the next Extraction Plan.

12 ANNUAL REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

In accordance with Condition 3, Schedule 7 of the Project Approval, Metropolitan Coal will conduct an Annual Review of the environmental performance of the Project by the end of March each year.

The Annual Review will:

- describe the works carried out in the past year, and the works proposed to be carried out over the next year;
- include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the EA, Preferred Project Report and Extraction Plan;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

As described in Section 2, this BFMP will be reviewed within three months of the submission of an Annual Review, and revised where appropriate.

13 INCIDENTS

An incident is defined as a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval.

The reporting of incidents will be conducted in accordance with Condition 6, Schedule 7 of the Project Approval. Metropolitan Coal will notify the Director-General (now Secretary) of DP&E and any other relevant agencies of any incident associated with the Project as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of DP&E and any relevant agencies with a detailed report on the incident.

Sydney Trains will be notified within 24 hours of any access limitations or restrictions.

14 COMPLAINTS

A protocol for the managing and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

The Environment & Community Superintendent is responsible for maintaining a system for recording complaints.

Metropolitan Coal will maintain public signage advertising the telephone number on which environmental complaints can be made. The Environment & Community Superintendent is responsible for ensuring that the currency and effectiveness of the service is maintained. Notifications of complaints received are to be provided as quickly as practicable to the Environment & Community Superintendent.

Complaints and enquiries do not have to be received via the telephone line and may be received in any other form. Any complaint or enquiry relating to environmental management or performance is to be relayed to the Environment & Community Superintendent as soon as practicable. All employees are responsible for ensuring the prompt relaying of complaints. All complaints will be recorded in a complaints register.

For each complaint, the following information will be recorded in the complaints register:

- date and time of complaint;
- method by which the complaint was made;
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- nature of the complaint;
- the action(s) taken by Metropolitan Coal in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken by Metropolitan Coal, the reason why no action was taken.

The Environment & Community Superintendent is responsible for ensuring that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary.

In accordance with Condition 10, Schedule 7 of the Project Approval, the complaints register will be made publicly available on the website and updated on a monthly basis. A summary of complaints received and actions taken will be presented to the Community Consultative Committee as part of the operational performance review.

15 NON-COMPLIANCES WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with Metropolitan Coal, and will be developed through promotion of Metropolitan Coal ownership under the direction of the General Manager.

The Manager - Technical Services and/or Environment & Community Superintendent will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 13, Metropolitan Coal will notify the Director-General (now Secretary) of the DP&E and any other relevant agencies of any incident associated with Metropolitan Coal as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of the DP&E and any relevant agencies with a detailed report on the incident.

A review of Metropolitan Coal's compliance with all conditions of the Project Approval, mining leases and all other approvals and licenses will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the Peabody website.

Additionally, in accordance with Condition 8, Schedule 7 of the Project Approval, an independent environmental audit was undertaken by the end of December 2011, and is undertaken a minimum of once every three years thereafter. A copy of the audit report will be submitted to the Director-General (now Secretary) of the DP&E and made publicly available on the Peabody website. The independent audit will be undertaken by an appropriately qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General (now Secretary) of the DP&E.

16 REFERENCES

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Helensburgh Coal Pty Ltd [HCPL] (2009) *Metropolitan Coal Project Preferred Project Report.*

Heritage Computing (2008) *Metropolitan Coal Project Groundwater Assessment: A Hydrogeological Assessment in Support of Metropolitan Colliery Longwalls 20 to 44.* Appendix B in the Metropolitan Coal Project Environmental Assessment.

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Mine Subsidence Engineering Consultants (2016) *Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Sydney Trains Infrastructure*, 8 September 2016.

Mine Subsidence Engineering Consultants (2019) *Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Sydney Trains Infrastructure*.

APPENDIX 1

MSEC (2016) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 301 TO 303 - SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE SYDNEY TRAINS INFRASTRUCTURE, DATED 8 SEPTEMBER 2016

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

8th September 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-07

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Sydney Trains Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Sydney Trains infrastructure resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery.

The locations of the Sydney Trains infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC844-07. The Illawarra Railway is located to the east of the longwalls at a minimum distance of 1.4 kilometres. A telecommunications tower and compound are located above the chain pillar between Longwalls 302 and 303. Photographs of this installation are provided in Figure 1.

Figure 1 Telecommunications Tower and Compound

The predictions and impact assessments for the Sydney Trains infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the Sydney Trains Infrastructure

The following provides summaries of the maximum predicted conventional movements for the Sydney Trains infrastructure resulting from the extraction of Longwalls 301 to 303. It is possible that localised and elevated movements could develop above and in the vicinity of the longwalls as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

The Illawarra Railway is located at a minimum distance of 1.4 kilometres from the longwalls. At this distance, the railway is not expected to experience measurable conventional vertical subsidence, tilts or curvatures. The railway could experience low level far-field horizontal movement. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield.

The observed incremental far-field horizontal movements, resulting from the extraction of longwalls in the Southern Coalfield, are provided in Figure 2. The data is based on survey marks located outside of the mining area (i.e. above solid coal).

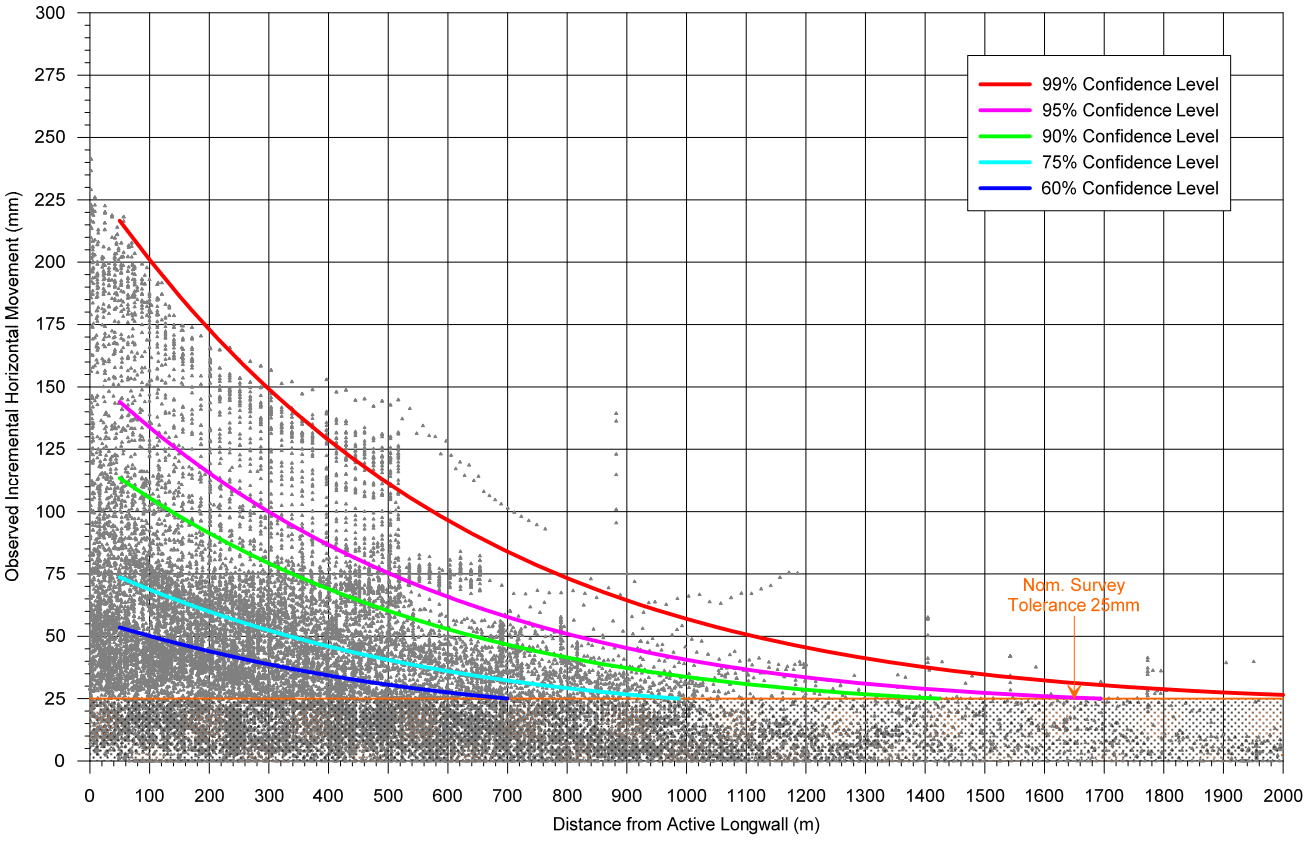

Figure 2 Observed Incremental Far-field Horizontal Movements from the Southern Coalfield (Solid Coal)

The absolute horizontal movements measured at distances greater than 1.4 kilometres from mining are in the order of 30 mm based on the 95 % confidence level. These low level movements comprise a large proportion of survey tolerance. Far-field horizontal movements tend to be bodily movements orientated towards the mining area. The strains associated with these low level horizontal movement are not expected to be measurable.

The telecommunications tower and compound are located above the chain pillar between Longwalls 302 and 303. A summary of the maximum predicted values of total subsidence, tilt and curvature for this installation, resulting from the extraction of Longwalls 301 to 303, is provided in Table 1.

Table 1 Maximum Predicted Total Subsidence, Tilt and Curvature for the Telecommunications Tower and Compound Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	< 20	< 0.5	< 0.01	< 0.01
After LW302	125	1.5	0.02	< 0.01
After LW303	500	3.5	0.02	0.04

The maximum predicted conventional tilt for the telecommunications tower and compound is 3.5 mm/m (i.e. 0.35 %, or 0.2 degrees). The maximum predicted conventional curvatures are 0.02 km^{-1} hogging and 0.04 km^{-1} sagging, which equate to minimum radii of curvature of 50 kilometres and 25 kilometres, respectively.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the Sydney Trains infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The transmission tower and compound are located above the longwalls. A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 3. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

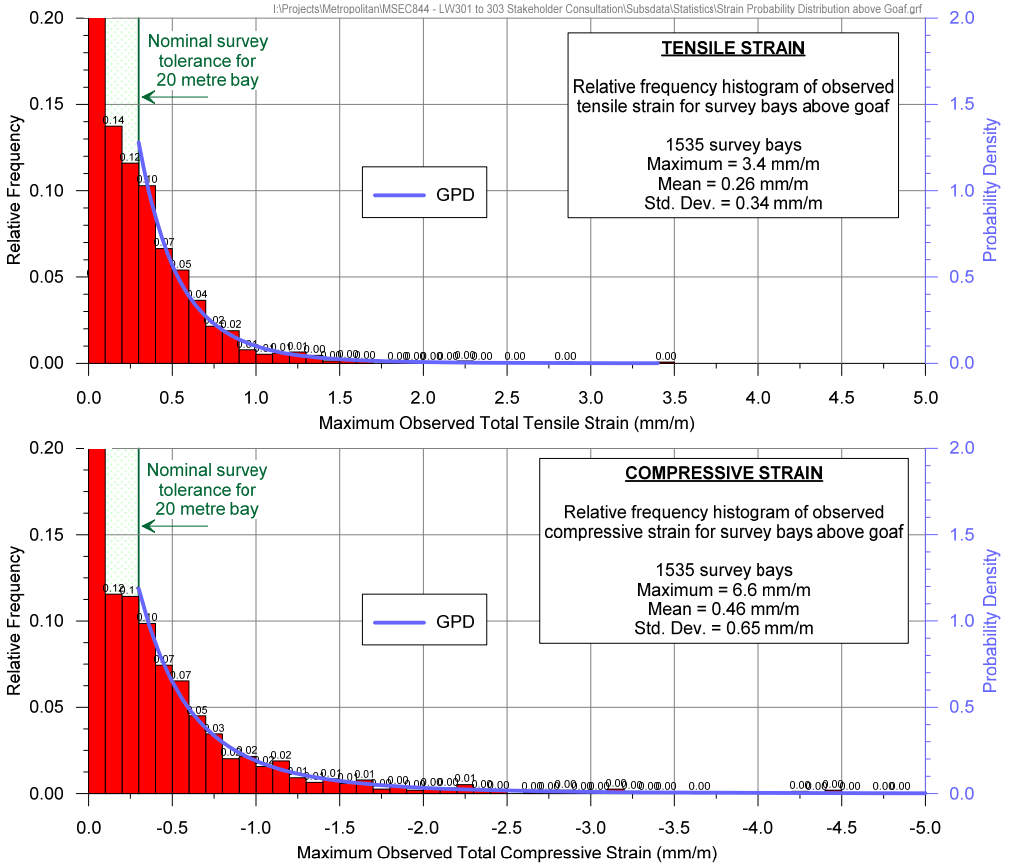

Figure 3 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based on the fitted GPDs, is provided in Table 2.

Table 2 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The Illawarra Railway is located more than 1.4 kilometres from the longwalls. At this distance, it is unlikely that the railway would experience measureable movements due to the presence of geological structures.

It is possible that the telecommunications tower and compound could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The locations of the major streams are shown in Drawing No. MSEC844-07. The Illawarra Railway crosses Cawleys and Wilsons Creeks. The valley related movements at these creek crosses are predicted to be less than 5 mm upsidence and less than 5 mm closure. The strains associated with these low levels of valley related movements are not expected to be measurable.

Impact Assessments for the Illawarra Railway

The Illawarra Railway is located more than 1.4 kilometres from the longwalls. Whilst the railway could experience low level far-field horizontal movements, the associated tilts, curvatures or strains are not expected to be measurable. It is unlikely that the railway and associated infrastructure would experience adverse impacts as a result of Longwalls 301 to 303.

Old workings are present beneath and in the vicinity of the Illawarra Railway as shown in Drawing No. MSEC844-07a. At more than 1.4 kilometres from the longwalls, it is unlikely that the railway and associated infrastructure would experience adverse impacts from old workings as a result of the extraction of Longwalls 301 to 303. An assessment of subsidence above old workings was undertaken and presented in a paper at the 8th Triennial Conference on Mine Subsidence in 2011 in a paper titled "*An Analysis of Long Term Subsidence at Metropolitan Colliery*". A copy of the paper is attached. The assessment covered data over a 14 year period of monitoring and found that the goaf/chain pillar system was in a longer term stable condition and ongoing subsidence movements appeared to be reducing to zero. The old workings beneath and in the vicinity of the Illawarra Railway as shown in Drawing No. MSEC844-07a are likely to be more than 50 years old.

Impact Assessments for the Telecommunications Tower

The telecommunications tower and compound are located above the chain pillar between Longwalls 302 and 303.

The maximum predicted tilt for this installation is 2.0 mm/m (i.e. 0.2 %, or 1 in 500). The magnitude of tilt is very small (i.e. less than 1 %) and therefore are unlikely to adversely impact on the tower or compound. Tilt can potentially effect directional antennas and therefore it is recommended that the radio engineer reviews the predicted change in alignment.

The maximum predicted conventional curvatures are 0.04 km^{-1} hogging and 0.07 km^{-1} sagging, which equate to minimum radii of curvature of 25 kilometres and 14 kilometres, respectively. The predicted strains are 0.9 mm/m tensile and 1.6 mm/m compressive based on the 95 % confidence level and 1.5 mm/m tensile and 3.2 mm/m compressive based on the 99 % confidence level.

It is recommended that the structural engineer review the structural integrity of the tower based on the predicted conventional subsidence, tilt and curvatures and the predicted distributions of strain. If adverse impacts were anticipated, then preventive measures should be installed that could include the installation of additional bracing members and/or strengthening members to the existing frame.

The building enclosure could potentially experience adverse impacts such as cracking of the brickwork or a sticky entry door. It is expected that the enclosure would remain in safe and serviceable conditions during and after mining. Adverse impacts could be remediated using normal building maintenance techniques.

Summary

The Illawarra Railway is located more than 1.4 kilometres from Longwalls 301 to 303. At this distance, it is unlikely that the railway and associated infrastructure would experience adverse impacts as a result of these longwalls.

A telecommunications tower and compound is located above the chain pillar between Longwalls 302 and 303. It is recommended that the predicted movements are reviewed by the radio and structural engineers. Preventive measures for the tower should be installed if adverse impacts are anticipated. It is expected that adverse impacts to the building enclosure could be remediated using normal building maintenance techniques.

It is expected that the potential impacts on the Sydney Trains infrastructure can be managed with the implementation of the necessary monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:

Drawing No. MSEC844-07 – Longwalls 301 to 303 – Sydney Trains Infrastructure

DeBono and Tarrant (2011). *An Analysis of Long Term Subsidence at Metropolitan Colliery.* Proceedings of the 8th Triennial Conference on Mine Subsidence, 2011, pp 81 to 88.

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COAL

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
SYDNEY TRAINS

DATE:	SCALE:	DRAWING No:	Rev No
26 Aug 2016	1:20000	MSEC844-07a	B

Grid to MGA co-ordinates

HEATHCOTE CREEK
CAWLEY ROAD OVERPASS
ILLAWARRA RAILWAY
CAWLEYS CK
STUDY AREA
WORONORA RESERVOIR
TELECOMMUNICATIONS TOWER
20mm SUBSIDENCE CONTOUR
OLD PRINCES HIGHWAY
LW303
LW302
LW301
132kV
330kV
M1 PRINCES MOTORWAY
1.4 km
1.7 km
METROPOLITAN FAULT
WILSONS CK
PRINCES HIGHWAY UNDERPASS 2
MAIN WEST FAULT
POWELL FAULT
FAULT
LW26
LW27
LW25
LW24
LW23B
6 218 000
6 217 000
6 216 000
6 215 000
6 214 000
312 000
313 000
314 000
315 000

GEOLOGICAL STRUCTURES
FAULTS
DYKES

LEGEND
CURRENT WORKINGS
HISTORICAL WORKINGS
PROPOSED LONGWALLS

An Analysis of Long Term Subsidence at Metropolitan Colliery

P. DeBono, Mine Subsidence Engineering Consultants
G. Tarrant, Metropolitan Coal

Summary

Metropolitan Coal commenced longwall extraction in 1995 and extracted 18 longwall panels to the end of 2009. Longwalls 1 to 7 were extracted at approximately 126 m void width, Longwalls 8 to 10 were extracted at 140 m void width, and Longwalls 11 to 18 were extracted at 163 m void width. The chain pillars were 35 m (rib to rib) for each longwall. A subsidence survey line (D-Line) was established perpendicular to the longwall panels and has been re-surveyed at the end of each extracted panel. The subsidence data has been analysed to better understand the long term behaviour of conventional subsidence movements at the survey monitoring peg locations. The detailed analysis focuses specifically on the long term subsidence that occurs after the active subsidence phase and residual subsidence phase during which it is typically considered that the maximum subsidence has been attained. The analysis is expected to better inform the longer term management of subsidence effects and consequential impacts on natural and built surface features.

1. Introduction

It is generally accepted that conventional vertical subsidence resulting from longwall coal mining occurs in two phases: an active dynamic subsidence phase as the face advances, and a residual subsidence phase after all extraction has been completed near a point. The dynamic subsidence over a series of longwall panels results from both caving of strata into the goaf, and yielding of the chain pillar and/or the strata above and below the pillars.

The dynamic subsidence profiles are influenced by many variables, including the rate of extraction, geological setting and longwall geometry. Time dependent residual subsidence over a series of longwalls generally reduces with time and increased distance of the active mining from a point. In most instances, subsidence is commonly considered to have been completed once subsidence rates reduce sufficiently below agreed limits, which are typically set based on the type of surface feature being monitored and its sensitivity to subsidence movements. Ongoing minor subsidence movements can occur, however, for several years beyond the cessation of monitoring as a result of factors that may include far field vertical subsidence, deterioration of the confined pillar, deterioration of the materials above and/or below the pillar, and goaf consolidation.

Prior to longwall extraction, management plans are developed to manage the various features on the surface that are likely to be influenced by subsidence. Some features that may be sensitive to small subsidence movements may require the introduction of detailed and accurate monitoring methods and/or mitigation measures, to manage the subsidence as the longwalls are extracted. Following extraction, and once subsidence is deemed to have been completed, which may be subject to an agreed rate of subsidence or some other indicator, monitoring and management of the feature is discontinued. Subsidence may, however, continue to develop at slow rates for many years following the completion of mining near or below a surface feature.

With this in mind, the rates of subsidence movements at each survey peg along the D-Line and over Longwalls 1 to 18 have been analysed to assess the long term subsidence behaviour.

2. Mine Layout and Extraction Geometry

The layout of the Metropolitan Colliery Longwalls 1 to 18 and the D Line are shown in Figure 1. The longwalls, which are extracted in the Bulli Seam, form a north westerly expansion of pillar extraction areas to the south east.

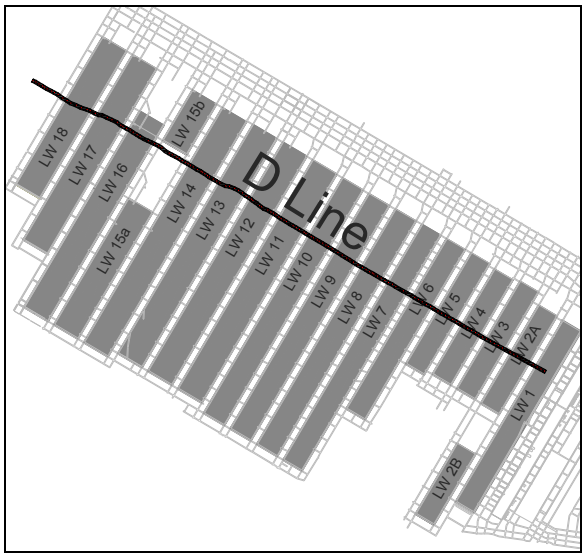


Figure 1 Metropolitan Colliery Longwalls 1 to 18 and D Line Monitoring Line

A summary of the extraction geometry of Metropolitan Colliery Longwalls 1 to 18 is provided in Table 1. The extraction direction of all of these longwalls was from the South West to the North East.

Extraction of the Longwalls 1 to 18 commenced in 1995 and was completed in 2009. The extraction dates of each of the longwalls is summarised in Table 2.

Table 1 Panel and Pillar Widths

Longwall	Panel Void Width (m)	Pillar Width (m)
LW1	123	35
LW2	126	35
LW3	126	35
LW4	125	35
LW5	127	35
LW6	127	35
LW7	140	35
LW8	140	35
LW9	140	35
LW10	163	35
LW11	163	35
LW12	163	35
LW13	163	35
LW14	163	35
LW15A	163	35
LW15B	163	35
LW16	163	35
LW17	163	35
LW18	163	35

2.1. Monitoring Data

The D-Line is located approximately perpendicular to the longwalls as shown in Figure 1. A plot of the surface levels, depth of cover, seam thickness, and observed subsidence along the D-Line is shown in Figure 2. The D-Line crosses several streams, the largest of which is the Waratah Rivulet.

Monitoring of the D-Line was carried out at the completion of each extracted longwall, which was extracted over a period ranging from 6 months to 12 months. The total monitoring period of the D-Line covers approximately 13 years.

Table 2 Extraction Dates

Longwall	Start Date	End Date
LW1	31-07-95	01-05-96
LW2	03-11-96	17-09-96
LW3	23-05-97	24-09-97
LW4	11-10-97	02-03-98
LW5	14-05-98	20-11-98
LW6	25-02-00	20-11-00
LW7	13-12-00	28-09-01
LW8	25-10-01	23-08-02
LW9	16-09-02	09-08-03
LW10	30-08-03	08-05-04
LW11	29-05-04	19-03-05
LW12	02-04-05	03-12-05
LW13	17-12-05	16-09-06
LW14	30-09-06	22-08-07
LW15A	10-09-07	08-03-08
LW15B	24-03-08	25-05-08
LW16	15-06-08	26-02-09
LW17	25-03-09	08-10-09
LW18	03-11-09	20-04-10

The layouts of Longwalls 15 and 16 were modified due to the presence of geological structures. The modified layouts can be seen in Figure 1. As a result of the modifications, Longwall 15 was not mined beneath the D-Line, which was located close to the finishing end of Longwall 16.

The subsidence profiles presented in Figure 2 show that only minor incremental subsidence profiles were observed for Longwalls 15 and 16.

The data used for the analysis of long term subsidence in this paper, are based on monitoring results for the period following active and residual subsidence. At Metropolitan Colliery, this occurs after a 5 to 6 year period from the commencement of active subsidence at a survey peg location. As a result, many of the monitoring pegs for the later, wider, longwalls (163 metres width) do not have monitoring data within this range of long term subsidence. Similarly, the survey pegs 1 to 15 were not monitored for a sufficient period to be included in the long term subsidence data.

2.2. Geology

The Metropolitan Colliery is located in the NSW Southern Coalfield which is characterised by a deep overburden of sedimentary rocks, with depths of cover over extracted coal seams commonly exceeding 300 metres.

Longwalls 1 to 18 were extracted in the Bulli Seam with thicknesses varying from 2.9 metres to 3.4 metres. The depth of cover above the Bulli Seam along the D Line varies from approximately 400 metres to 520 metres. The Bulli Seam thickness and depth of cover along the D-Line are shown in Figure 2.

The Bulli Seam is located in the upper part of the Illawarra Coal Measures. A typical stratigraphic section of the overburden material is shown in Figure 3

The major geological structures identified within the footprint of Longwalls 1 to 18 are shown in Figure 4. Most of these structures have been identified at seam level or projected from known locations. The most significant structure is the Madden Fault/Dyke Zone, which is up to approximately 700 metres in width and is associated with at least one known diatreme in Darkes Forest Colliery.

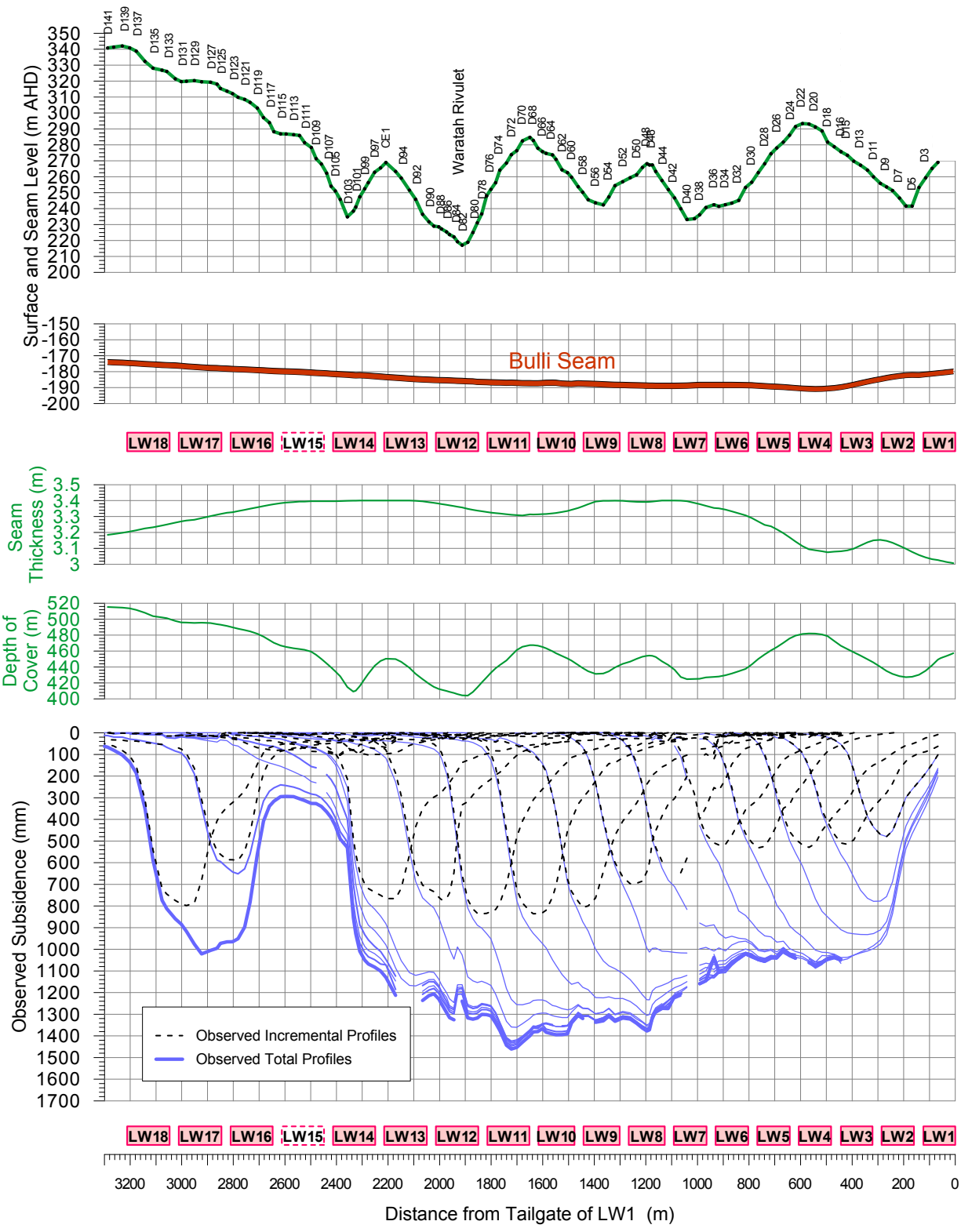


Figure 2 D-Line Monitoring Data

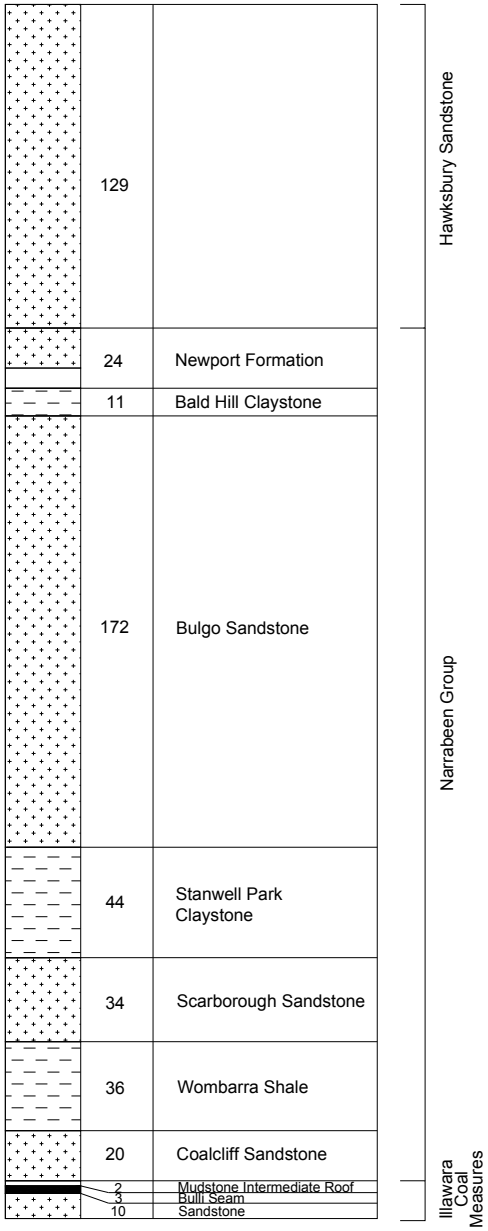


Figure 3 Typical Stratigraphic Section

The D-Line monitoring data for the longwalls in this fault/dyke zone are not however, used in the analysis, as described in Section 2.1. With the exception of the north western part of the extracted Longwalls 15 to 18, there are no significant geological structures in the vicinity of the D-Line.

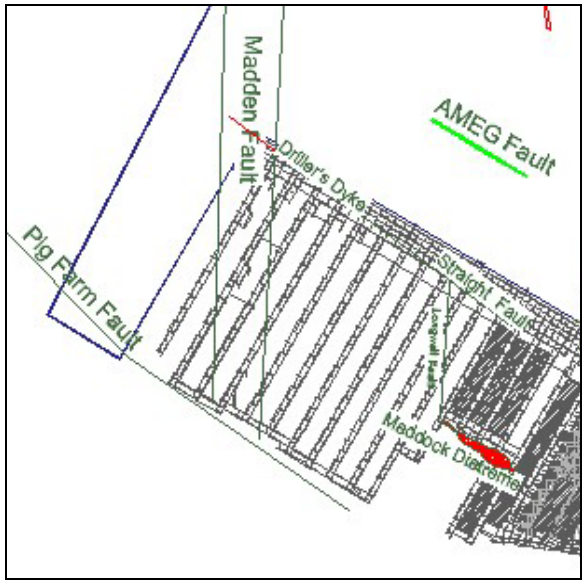


Figure 4 Geological Structures

3. Subsidence Analysis

In order to analyse the long term behaviour of subsidence it is necessary to present the temporal characteristics of subsidence to show the subsidence behaviour that occurs following the active and residual subsidence phases. The observed subsidence profiles were therefore, plotted against time. A plot of the observed total subsidence versus the date of survey for each of the D-Line monitoring pegs is shown in Figure 5

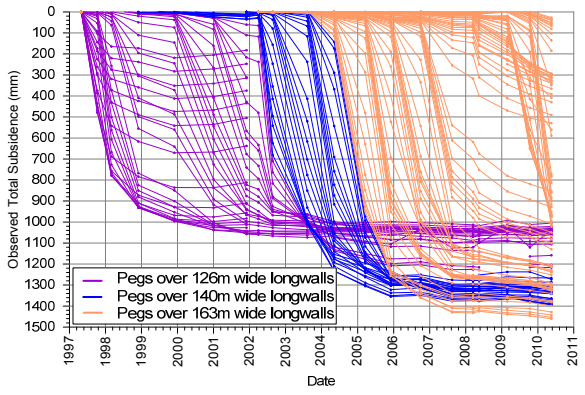


Figure 5 Observed Total Subsidence Versus Survey Date

This plot was further refined to show subsidence versus the time from the approximate commencement of active subsidence. The resulting plot is shown in Figure 6.

It is apparent from Figure 6 that following the active subsidence phase and residual subsidence phase, the subsidence reaches a relatively uniform rate after approximately 5 to 6 years from the commencement of active subsidence. The close up view of this rate from years 5 to 14 shows, however, that subsidence continues to develop at a slow, but reasonably uniform rate.

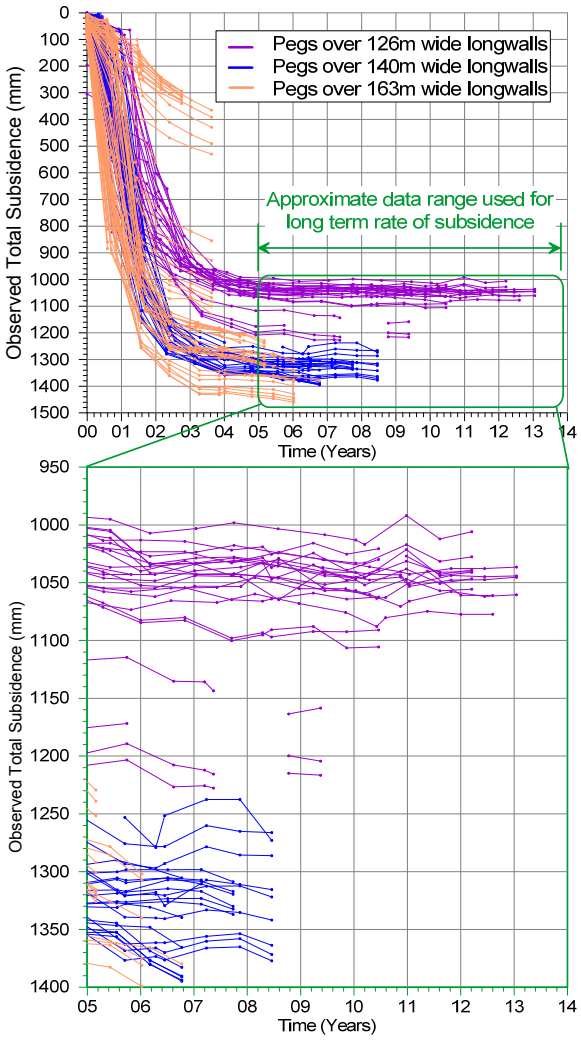


Figure 6 Observed Total Subsidence Versus Time

Most of the survey pegs located above the narrow 126 metre wide longwalls have approximately 8 years of survey data during this long term period following the active and residual subsidence phase. There is approximately 4 years of monitoring data during this period for the 140 metre wide longwalls, and only some of the data from the 163 metre wide longwalls are just entering this period.

The data in Figure 6 has been reproduced to present in Figure 7, a rate of subsidence per survey epoch for each of the monitored survey pegs, instead of observed total subsidence. The rate of subsidence was calculated as the change in subsidence over the time between survey epochs for each survey peg.

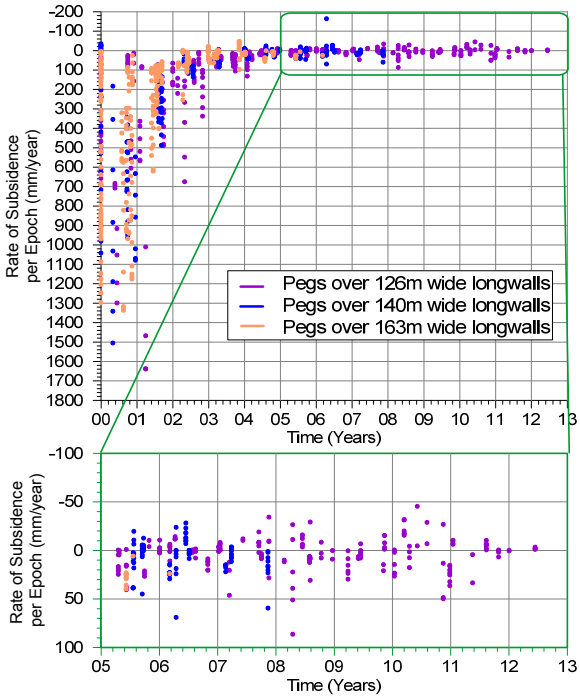


Figure 7 Observed Rate of Subsidence Versus Time

There is some scatter in the rates during this long term period in the order of ±50 mm. The distribution of data is shown in the histograms of the periods 5 to 7 years, 7 to 9 years, and 9 to 12 years presented in Figure 8.

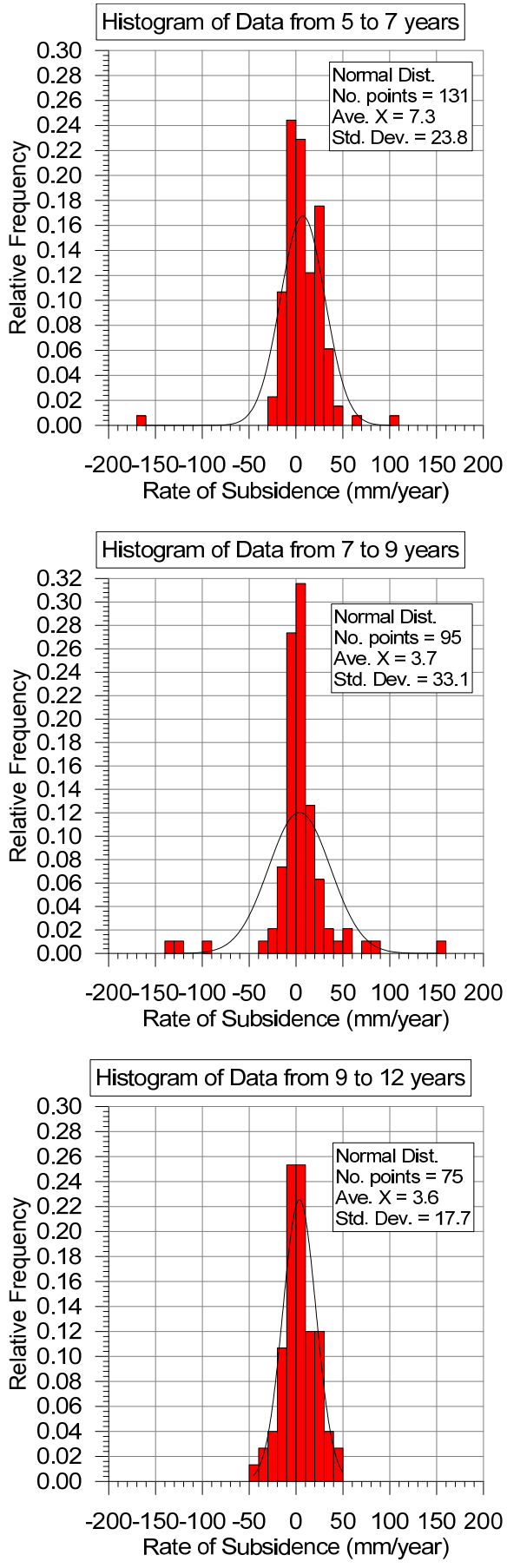


Figure 8 Rate of Subsidence Histograms

A longer period was selected for the final data subset due to the limited number of data points. The histograms show that the average rate of subsidence continues to reduce and has reduced to within 3 to 4 mm/year based on current monitoring data.

The spatial distribution of the rates of subsidence is shown in Figure 9 for the data used in the analysis. The data shows a greater scatter of the rates for the survey pegs that are located towards the base of the deep valley. It is possible that the wider scatter in these rates is the result of the influence of valley related upsidence and closure movements.

In addition to the rates of subsidence between each epoch, an average rate of subsidence was also calculated for each survey peg over the monitoring period between 5 and 14 years by taking the slope of a linear regression line through the subsidence plot for this time period. These results based on linear regression show peaks and troughs, with the peaks coinciding in most cases with the pillar locations.

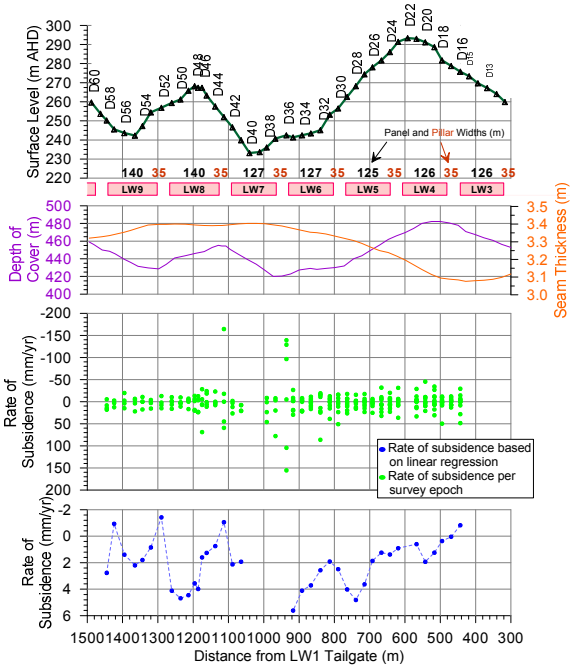


Figure 9 Rate of Subsidence at Monitoring Peg Locations

Four of the peaks have an overall negative rate of subsidence, indicating that at these locations, the ground surface may have rebounded to some degree.

4. Discussion

It is considered that there are two key points to note from this analysis of the long term subsidence monitoring data: firstly, that subsidence continues to develop for many years after mining has passed an area and the active and residual subsidence has been completed and; secondly, that the goaf/chain pillar system is indicated to be in a longer term stable condition.

It is acknowledged that the degree of ongoing subsidence is small and in many cases, these movements would have little to no effect on surface features and may be less than ground movements from other sources, such as seasonal shrink/swell behaviour. It should also be recognised, however, that while small subsidence rates were encountered at Metropolitan Colliery, much higher long term rates could be encountered at other locations depending on geological conditions and extraction geometry. Preliminary assessment of data from other collieries confirms that this is the case.

These subsidence rates may be of significance to features that are sensitive to very small ground movements. As a result, certain sensitive features may require a long term monitoring program to assess the ongoing rates of subsidence to verify that subsidence has reduced to an acceptable level and the risk of long term impact to the feature is below an acceptable level.

The indications from the analysis are that the goaf/chain pillar system is in a long term stable condition. This longer term monitoring data indicates that the continued strength and integrity of the confined pillar core is performing as it was designed to do and gives greater confidence that it will continue to do so.

It should be recognised that this assumes continuance of sufficient pillar strength and confining conditions, which potentially could change with a change to those conditions. Such changes could include future mining of other coal seams, possible seismic events, or contact with water or air.

Current methods of subsidence prediction and impact assessment do not take into account long term subsidence behaviour beyond the active and residual subsidence phase. It is considered prudent, however to recognised that these long term rates of subsidence do occur and whilst they are relatively small at Metropolitan Colliery, higher rates may encountered.

5. Conclusions

The findings of this case study indicate that the goaf/chain pillar goaf system at Metropolitan colliery is in a longer term stable condition and the ongoing subsidence movements appear to be reducing to zero. It is known that significantly higher long term rates of subsidence have occurred at other collieries.

It is hoped that further analysis of data from other collieries could be carried out to develop a more detailed database of long term subsidence movements that could be used for the management of surface features that may be sensitive to small movements, as well as to provide information on the long term behaviour of the goaf/chain pillar system.

6. References

Doyle, J., Newland, A. (2008). "*A Compilation of Surface Geological Features in the Western Portion of Metropolitan Colliery*". Geosensing Solutions.

Kratzsch, H. 1983 "*Mine Subsidence Engineering"* ISBN 3-540-11930-2, pp 320-321.

APPENDIX 2

MSEC (2019) METROPOLITAN COLLIERY – PROPOSED LONGWALL 304 – SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE SYDNEY TRAINS INFRASTRUCTURE

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

14th January 2019

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC1013-07

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Sydney Trains Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Sydney Trains infrastructure resulting from the extraction of the proposed Longwall 304 at Metropolitan Colliery.

The locations of the Sydney Trains infrastructure and the proposed Longwall 304 are shown in the attached Drawing No. MSEC1013-07. A Study Area is shown in Drawing No. MSEC1013-07 and is based on the outer limits of a 35° angle of draw line from Longwall 304 and the predicted 20mm subsidence contour for Longwall 304.

The Illawarra Railway is located to the east of the proposed and existing longwalls at a minimum distance of 1.94 kilometres from the northern end of Longwall 304. A telecommunications tower and compound are located above the chain pillar between existing Longwalls 302 and 303. Photographs of this installation are provided in Figure 1.

Figure 1 Telecommunications Tower and Compound

The predictions and impact assessments for the Sydney Trains infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the Sydney Trains Infrastructure

The following provides summaries of the maximum predicted conventional movements for the Sydney Trains infrastructure following the extraction of Longwall 303 and after extraction of Longwall 304. It is possible that localised and elevated movements could develop above and in the vicinity of the longwalls as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

The Illawarra Railway is located at a minimum distance of 1.94 kilometres from the proposed longwalls. At this distance, the railway is not expected to experience measurable conventional vertical subsidence, tilts or curvatures. The railway could experience low level far-field horizontal movement. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield.

The observed incremental far-field horizontal movements, resulting from the extraction of longwalls in the Southern Coalfield, are provided in Figure 2. The data is based on survey marks located outside of the mining area (i.e. above solid coal).

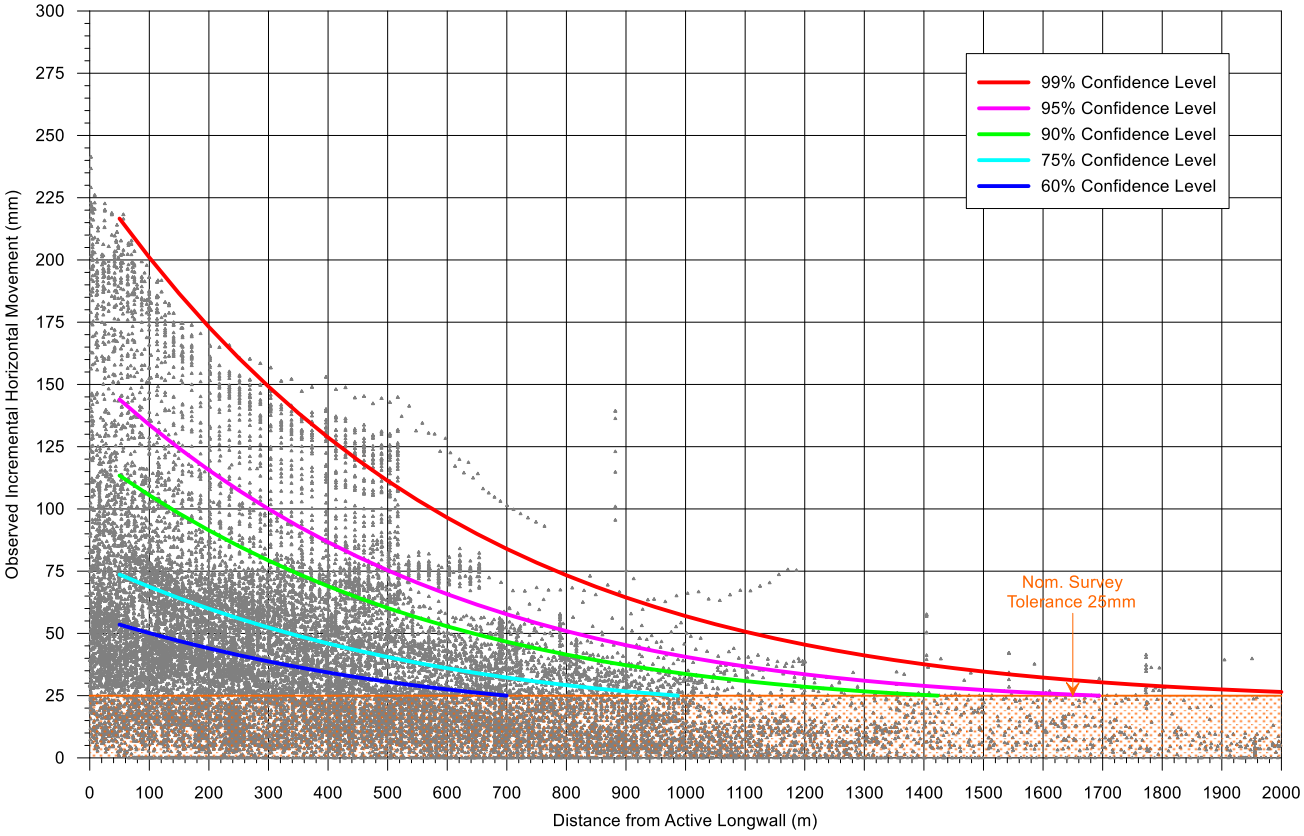


Figure 2 Observed Incremental Far-field Horizontal Movements from the Southern Coalfield (Solid Coal)

The absolute horizontal movements measured at distances greater than 1.9 kilometres from mining are less than the order of survey accuracy of nominal 25 mm based on the 95 % confidence level. These low level movements comprise a large proportion of survey tolerance. Far-field horizontal movements tend to be bodily movements orientated towards the mining area. The strains associated with these low level horizontal movement are not expected to be measurable.

The telecommunications tower and compound are located above the chain pillar between existing Longwalls 302 and 303. A summary of the maximum predicted values of total subsidence, tilt and curvature for this installation, following the extraction of Longwall 303 and after extraction of Longwall 304, is provided in Table 1.

Table 1 Maximum Predicted Total Subsidence, Tilt and Curvature for the Telecommunications Tower and Compound after the Extraction of Longwalls 303 and 304

Longwall	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})
After LW303	250	3.0	0.03	< 0.01
After LW304	400	3.5	0.03	< 0.01

The maximum predicted conventional tilt for the telecommunications tower and compound is 3.5 mm/m (i.e. 0.35 %, or 0.2 degrees). The maximum predicted conventional curvatures are 0.03 km^{-1} hogging and < 0.01 km^{-1} sagging, which equate to minimum radii of curvature of 33 kilometres and greater than 100 kilometres, respectively.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the Sydney Trains infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The transmission tower and compound are located above the pillar between existing longwalls but not directly above the proposed Longwall 304. A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 3. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

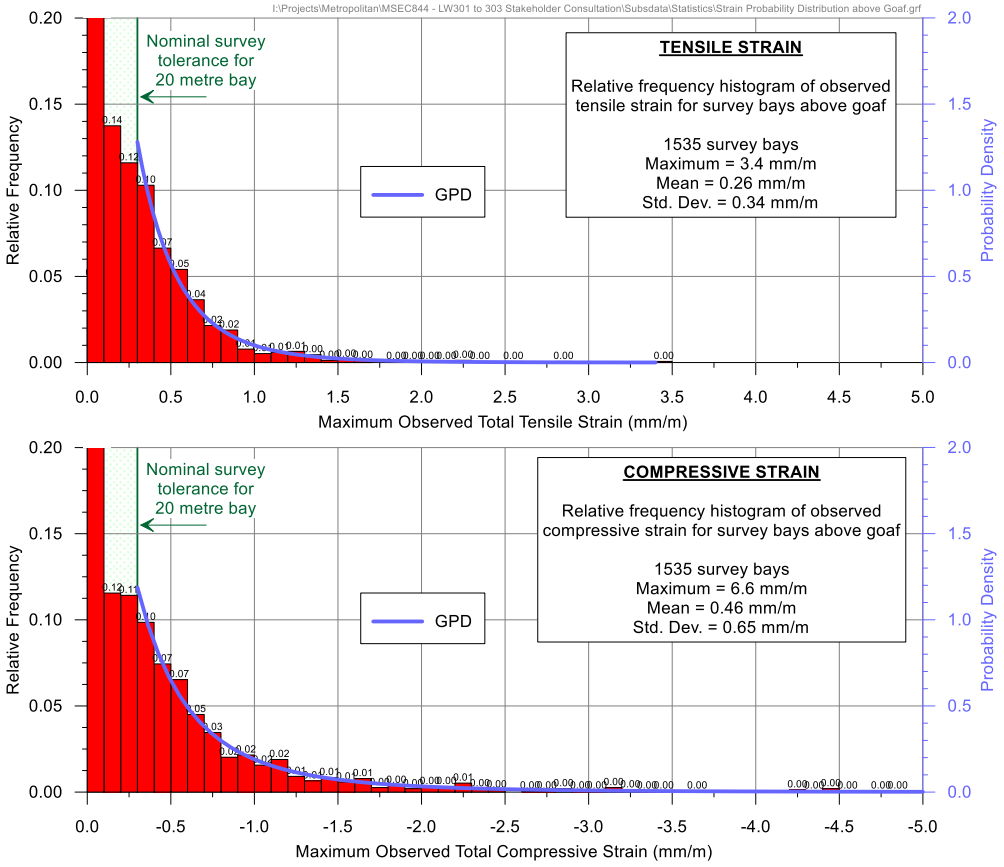


Figure 3 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based on the fitted GPDs, is provided in Table 2.

Table 2 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The Illawarra Railway is located more than 1.9 kilometres from the proposed Longwall 304. At this distance, it is unlikely that the railway would experience measureable movements due to the presence of geological structures.

The locations of the known geological structures at seam level and the major streams are shown in Drawing No. MSEC1013-07. There are no mapped faults located within the Study Area that extend beneath the Sydney Trains infrastructure. It is possible that the infrastructure located above the longwalls could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). Non-conventional or anomalous movements have not been identified during the extraction of Longwalls 301 and 302 and part extraction of Longwall 303. The range of strains provided in the previous section include those resulting from irregular anomalous movements.

Two culverts are located along the Illawarra Railway at Cawleys and Wilsons Creeks as shown on MSEC1013-07. The valley related movements at these creek crossings are predicted to be less than relative survey accuracy of 5 mm upsidence and less than 5 mm closure due to the extraction of Longwall 304. The strains associated with these low levels of valley related movements are not expected to be measurable. Total station survey within the culverts has been conducted since the commencement of Longwall 301 and real time 3D monitoring of the valley sides of both culverts, including closure, has been conducted since the commencement of Longwall 303. Observed movements to date have been within limits of accuracy of the survey methods.

Impact Assessments for the Illawarra Railway

The Illawarra Railway is located more than 1.9 kilometres from the proposed Longwall 304. Whilst the railway could experience low level far-field horizontal movements, the associated tilts, curvatures or strains are not expected to be measurable. It is unlikely that the railway and associated infrastructure would experience adverse impacts as a result of extracting Longwall 304.

Old workings are present beneath, and in the vicinity of, the Illawarra Railway as shown in Drawing No. MSEC1013-07. At more than 1.9 kilometres from the proposed Longwall 304, it is unlikely that the railway and associated infrastructure would experience adverse impacts from old workings as a result of the extraction of the proposed Longwall 304. An assessment of subsidence above old workings was undertaken and presented at the 8th Triennial Conference on Mine Subsidence in 2011 in a paper titled "*An Analysis of Long Term Subsidence at Metropolitan Colliery*". A copy of the paper is attached. The assessment covered data over a 14 year period of monitoring and found that the goaf/chain pillar system was in a longer term stable condition and ongoing subsidence movements appeared to be reducing to zero. The old workings beneath, and in the vicinity of, the Illawarra Railway as shown in Drawing No. MSEC1013-07, are likely to be more than 50 years old.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301 to 303 are updated and continued, in consultation with Sydney Trains, to manage the railway for potential irregular ground movements.

Impact Assessments for the Telecommunications Tower

The telecommunications tower and compound are located within the Study Area above the chain pillar between existing Longwalls 302 and 303 and not above the proposed Longwall 304.

The maximum predicted tilt for this installation is 3.5 mm/m (i.e. 0.35 %, or 0.2 degrees). The magnitude of tilt is very small and therefore is unlikely to adversely impact on the tower or compound. Tilt can potentially effect directional antennas and therefore it is recommended that the radio engineer reviews the predicted change in alignment.

The maximum predicted conventional curvatures are 0.03 km^{-1} hogging and < 0.01 km^{-1} sagging, which equate to minimum radii of curvature of 33 kilometres and less than 100 kilometres, respectively. The predicted strains are 0.9 mm/m tensile and 1.6 mm/m compressive based on the 95 % confidence level and 1.5 mm/m tensile and 3.2 mm/m compressive based on the 99 % confidence level.

The structural integrity of the tower was assessed for the extraction of Longwalls 301 to 303. It can be seen from Table 1 that there is an increase in subsidence and tilt but no change to the predicted curvatures after the extraction of Longwall 304 compared to Longwall 303. It is recommended that the structural engineer review the structural integrity of the tower based on the predicted conventional subsidence, tilt and curvatures and the predicted distributions of strain. If adverse impacts are anticipated, then preventive measures should be installed that could include the installation of additional bracing members and/or strengthening members to the existing frame.

The building enclosure could potentially experience adverse impacts such as cracking of the brickwork or a sticky entry door. It is expected that the enclosure would remain in safe and serviceable conditions during and after mining. Adverse impacts could be remediated using normal building maintenance techniques.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301 to 303 are updated and continued, in consultation with Sydney Trains, to manage the tower and compound during the extraction of Longwall 304.

Summary

The Illawarra Railway is located more than 1.9 kilometres from the proposed Longwall 304. At this distance, it is unlikely that the railway and associated infrastructure would experience adverse impacts as a result of extracting this proposed Longwall 304.

A telecommunications tower and compound are located above the chain pillar between existing Longwalls 302 and 303, but not directly above the proposed Longwall 304. It is recommended that the predicted movements are reviewed by the radio and structural engineers. Preventive measures for the tower should be installed if adverse impacts are anticipated. It is expected that adverse impacts to the building enclosure could be remediated using normal building maintenance techniques.

It is expected that the potential impacts on the Sydney Trains infrastructure can be managed with the implementation of the necessary monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:

Drawing No. MSEC1013-07 – Longwall – Sydney Trains Infrastructure

DeBono and Tarrant (2011). *An Analysis of Long Term Subsidence at Metropolitan Colliery.* Proceedings of the 8th Triennial Conference on Mine Subsidence, 2011, pp 81 to 88.

I:\Projects\Metropolitan\MSEC1013 - LW304 Stakeholders Consultation\AcadData\MSEC1013-07 Sydney Trains.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COAL

METROPOLITAN COLLIERY
LONGWALL 304
SYDNEY TRAINS

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	1:20000	MSEC1013-07	02

Grid to MGA co-ordinates

HEATHCOTE CREEK
CAWLEY ROAD OVERPASS
ILLAWARRA RAILWAY
CULVERT
CAWLEYS CK
WORONORA RESERVOIR
1940m
METROPOLITAN FAULT
TELECOMMUNICATIONS TOWER
STUDY AREA
20mm SUBSIDENCE CONTOUR
OLD PRINCES HIGHWAY
LW303
LW302
LW301
LW304
132kV
330kV
M1 PRINCES MOTORWAY
CULVERT
WILSONS CK
PRINCES HIGHWAY UNDERPASS 2
POWELL FAULT
MAIN WEST FAULT
FAULT
LW27
LW26
LW25
LW24
LW23B

6 218 000
6 217 000
6 216 000
6 215 000
6 214 000
312 000
313 000
314 000
315 000

GEOLOGICAL STRUCTURES
FAULTS
DYKES

LEGEND
CURRENT WORKINGS
HISTORICAL WORKINGS
PROPOSED LONGWALLS

An Analysis of Long Term Subsidence at Metropolitan Colliery

P. DeBono, Mine Subsidence Engineering Consultants
G. Tarrant, Metropolitan Coal

Summary

Metropolitan Coal commenced longwall extraction in 1995 and extracted 18 longwall panels to the end of 2009. Longwalls 1 to 7 were extracted at approximately 126 m void width, Longwalls 8 to 10 were extracted at 140 m void width, and Longwalls 11 to 18 were extracted at 163 m void width. The chain pillars were 35 m (rib to rib) for each longwall. A subsidence survey line (D-Line) was established perpendicular to the longwall panels and has been re-surveyed at the end of each extracted panel. The subsidence data has been analysed to better understand the long term behaviour of conventional subsidence movements at the survey monitoring peg locations. The detailed analysis focuses specifically on the long term subsidence that occurs after the active subsidence phase and residual subsidence phase during which it is typically considered that the maximum subsidence has been attained. The analysis is expected to better inform the longer term management of subsidence effects and consequential impacts on natural and built surface features.

1. Introduction

It is generally accepted that conventional vertical subsidence resulting from longwall coal mining occurs in two phases: an active dynamic subsidence phase as the face advances, and a residual subsidence phase after all extraction has been completed near a point. The dynamic subsidence over a series of longwall panels results from both caving of strata into the goaf, and yielding of the chain pillar and/or the strata above and below the pillars.

The dynamic subsidence profiles are influenced by many variables, including the rate of extraction, geological setting and longwall geometry. Time dependent residual subsidence over a series of longwalls generally reduces with time and increased distance of the active mining from a point. In most instances, subsidence is commonly considered to have been completed once subsidence rates reduce sufficiently below agreed limits, which are typically set based on the type of surface feature being monitored and its sensitivity to subsidence movements. Ongoing minor subsidence movements can occur, however, for several years beyond the cessation of monitoring as a result of factors that may include far field vertical subsidence, deterioration of the confined pillar, deterioration of the materials above and/or below the pillar, and goaf consolidation.

Prior to longwall extraction, management plans are developed to manage the various features on the surface that are likely to be influenced by subsidence. Some features that may be sensitive to small subsidence movements may require the introduction of detailed and accurate monitoring methods and/or mitigation measures, to manage the subsidence as the longwalls are extracted. Following extraction, and once subsidence is deemed to have been completed, which may be subject to an agreed rate of subsidence or some other indicator, monitoring and management of the feature is discontinued. Subsidence may, however, continue to develop at slow rates for many years following the completion of mining near or below a surface feature.

With this in mind, the rates of subsidence movements at each survey peg along the D-Line and over Longwalls 1 to 18 have been analysed to assess the long term subsidence behaviour.

2. Mine Layout and Extraction Geometry

The layout of the Metropolitan Colliery Longwalls 1 to 18 and the D Line are shown in Figure 1. The longwalls, which are extracted in the Bulli Seam, form a north westerly expansion of pillar extraction areas to the south east.

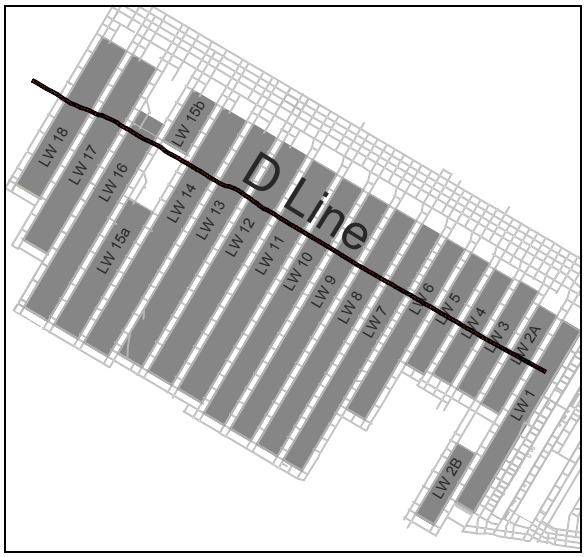


Figure 1 Metropolitan Colliery Longwalls 1 to 18 and D Line Monitoring Line

A summary of the extraction geometry of Metropolitan Colliery Longwalls 1 to 18 is provided in Table 1. The extraction direction of all of these longwalls was from the South West to the North East.

Extraction of the Longwalls 1 to 18 commenced in 1995 and was completed in 2009. The extraction dates of each of the longwalls is summarised in Table 2.

Table 1 Panel and Pillar Widths

Longwall	Panel Void Width (m)	Pillar Width (m)
LW1	123	35
LW2	126	35
LW3	126	35
LW4	125	35
LW5	127	35
LW6	127	35
LW7	140	35
LW8	140	35
LW9	140	35
LW10	163	35
LW11	163	35
LW12	163	35
LW13	163	35
LW14	163	35
LW15A	163	35
LW15B	163	35
LW16	163	35
LW17	163	35
LW18	163	35

2.1. Monitoring Data

The D-Line is located approximately perpendicular to the longwalls as shown in Figure 1. A plot of the surface levels, depth of cover, seam thickness, and observed subsidence along the D-Line is shown in Figure 2. The D-Line crosses several streams, the largest of which is the Waratah Rivulet.

Monitoring of the D-Line was carried out at the completion of each extracted longwall, which was extracted over a period ranging from 6 months to 12 months. The total monitoring period of the D-Line covers approximately 13 years.

Table 2 Extraction Dates

Longwall	Start Date	End Date
LW1	31-07-95	01-05-96
LW2	03-11-96	17-09-96
LW3	23-05-97	24-09-97
LW4	11-10-97	02-03-98
LW5	14-05-98	20-11-98
LW6	25-02-00	20-11-00
LW7	13-12-00	28-09-01
LW8	25-10-01	23-08-02
LW9	16-09-02	09-08-03
LW10	30-08-03	08-05-04
LW11	29-05-04	19-03-05
LW12	02-04-05	03-12-05
LW13	17-12-05	16-09-06
LW14	30-09-06	22-08-07
LW15A	10-09-07	08-03-08
LW15B	24-03-08	25-05-08
LW16	15-06-08	26-02-09
LW17	25-03-09	08-10-09
LW18	03-11-09	20-04-10

The layouts of Longwalls 15 and 16 were modified due to the presence of geological structures. The modified layouts can be seen in Figure 1. As a result of the modifications, Longwall 15 was not mined beneath the D-Line, which was located close to the finishing end of Longwall 16.

The subsidence profiles presented in Figure 2 show that only minor incremental subsidence profiles were observed for Longwalls 15 and 16.

The data used for the analysis of long term subsidence in this paper, are based on monitoring results for the period following active and residual subsidence. At Metropolitan Colliery, this occurs after a 5 to 6 year period from the commencement of active subsidence at a survey peg location. As a result, many of the monitoring pegs for the later, wider, longwalls (163 metres width) do not have monitoring data within this range of long term subsidence. Similarly, the survey pegs 1 to 15 were not monitored for a sufficient period to be included in the long term subsidence data.

2.2. Geology

The Metropolitan Colliery is located in the NSW Southern Coalfield which is characterised by a deep overburden of sedimentary rocks, with depths of cover over extracted coal seams commonly exceeding 300 metres.

Longwalls 1 to 18 were extracted in the Bulli Seam with thicknesses varying from 2.9 metres to 3.4 metres. The depth of cover above the Bulli Seam along the D Line varies from approximately 400 metres to 520 metres. The Bulli Seam thickness and depth of cover along the D-Line are shown in Figure 2.

The Bulli Seam is located in the upper part of the Illawarra Coal Measures. A typical stratigraphic section of the overburden material is shown in Figure 3

The major geological structures identified within the footprint of Longwalls 1 to 18 are shown in Figure 4. Most of these structures have been identified at seam level or projected from known locations. The most significant structure is the Madden Fault/Dyke Zone, which is up to approximately 700 metres in width and is associated with at least one known diatreme in Darkes Forest Colliery.

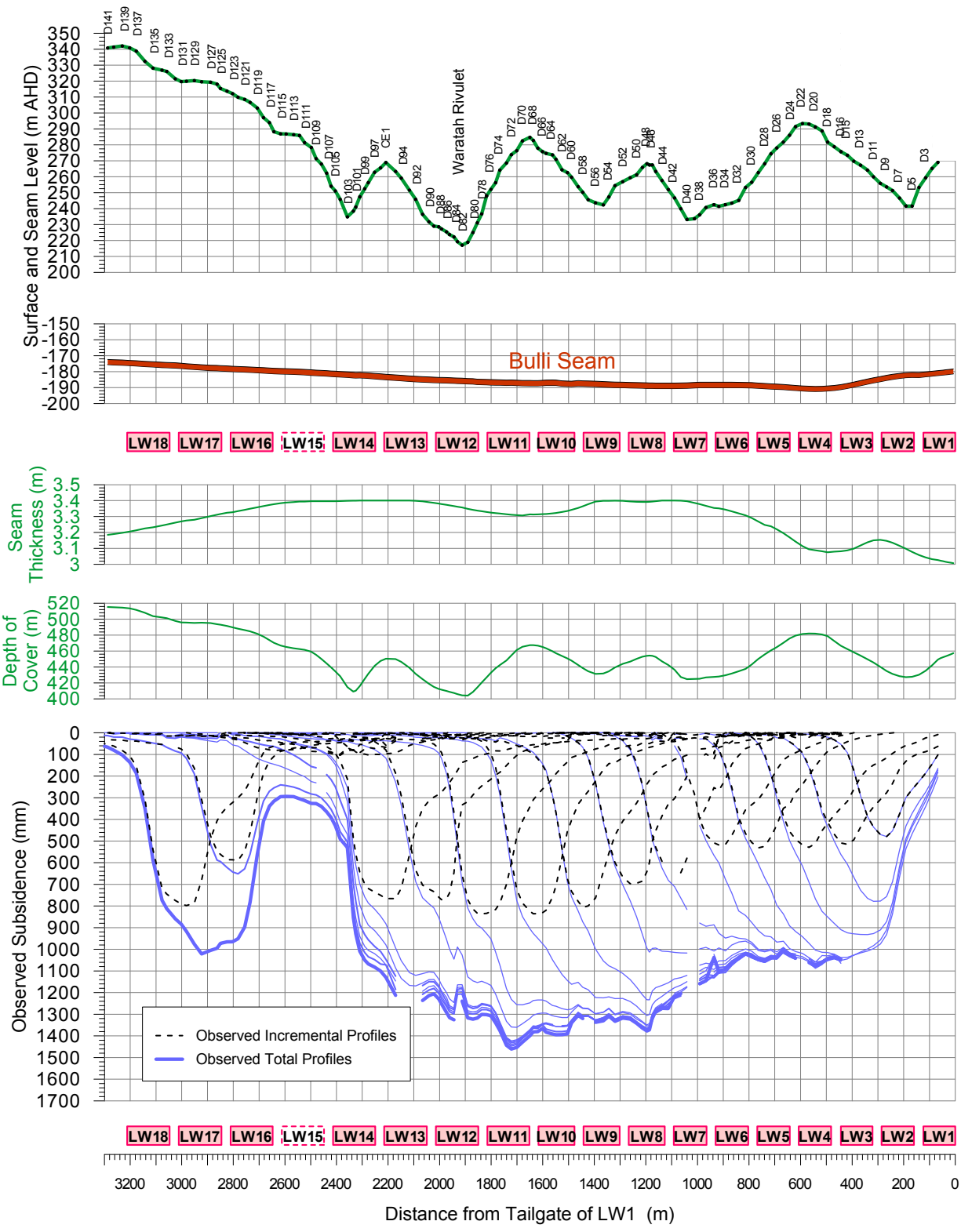


Figure 2 D-Line Monitoring Data

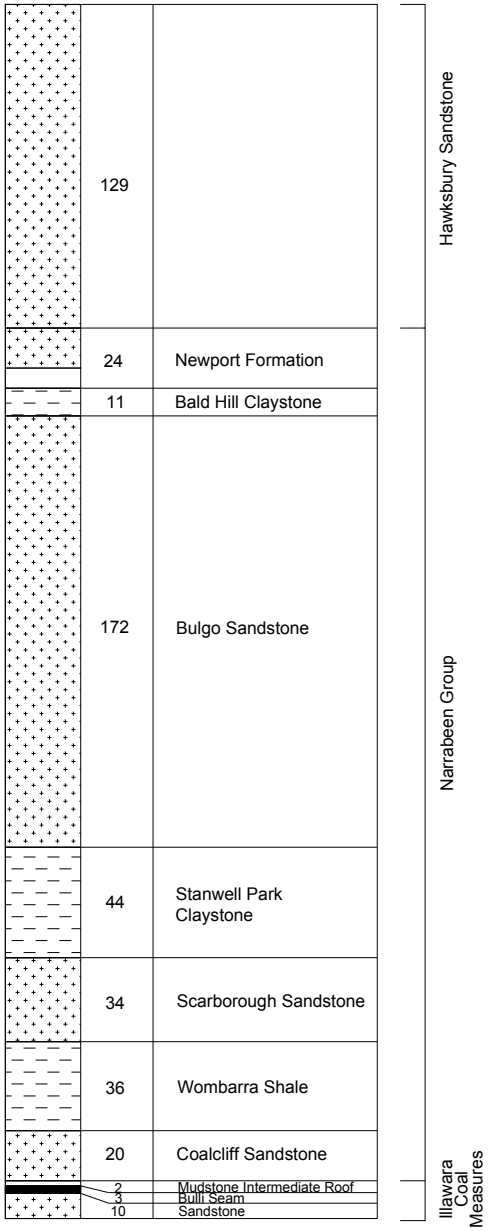


Figure 3 Typical Stratigraphic Section

The D-Line monitoring data for the longwalls in this fault/dyke zone are not however, used in the analysis, as described in Section 2.1. With the exception of the north western part of the extracted Longwalls 15 to 18, there are no significant geological structures in the vicinity of the D-Line.

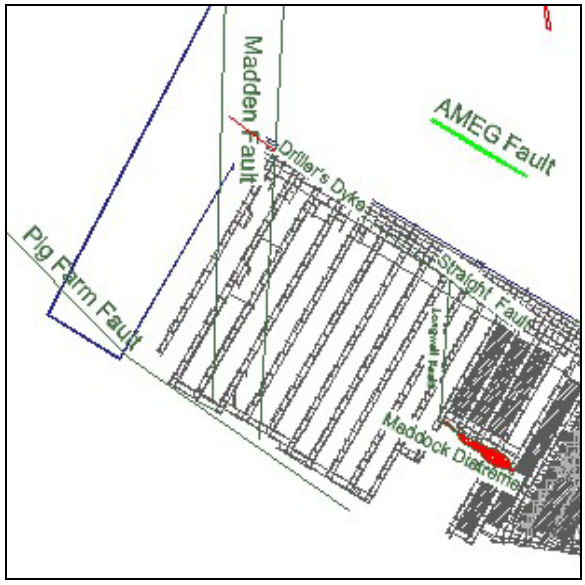


Figure 4 Geological Structures

3. Subsidence Analysis

In order to analyse the long term behaviour of subsidence it is necessary to present the temporal characteristics of subsidence to show the subsidence behaviour that occurs following the active and residual subsidence phases. The observed subsidence profiles were therefore, plotted against time. A plot of the observed total subsidence versus the date of survey for each of the D-Line monitoring pegs is shown in Figure 5

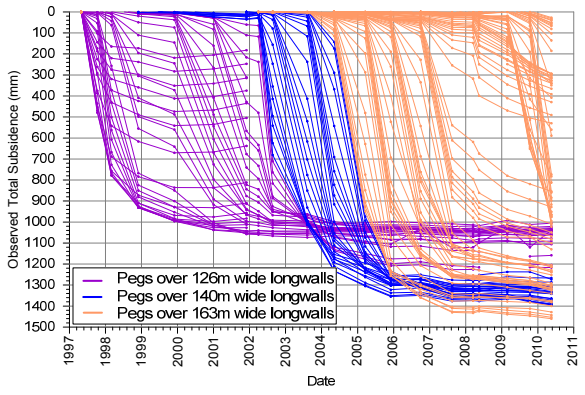


Figure 5 Observed Total Subsidence Versus Survey Date

This plot was further refined to show subsidence versus the time from the approximate commencement of active subsidence. The resulting plot is shown in Figure 6.

It is apparent from Figure 6 that following the active subsidence phase and residual subsidence phase, the subsidence reaches a relatively uniform rate after approximately 5 to 6 years from the commencement of active subsidence. The close up view of this rate from years 5 to 14 shows, however, that subsidence continues to develop at a slow, but reasonably uniform rate.

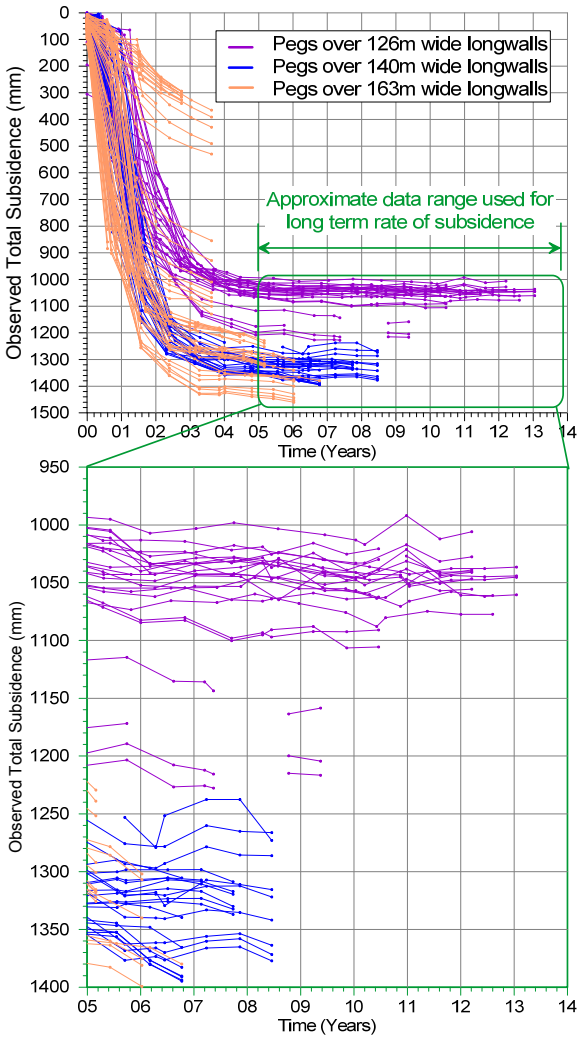


Figure 6 Observed Total Subsidence Versus Time

Most of the survey pegs located above the narrow 126 metre wide longwalls have approximately 8 years of survey data during this long term period following the active and residual subsidence phase. There is approximately 4 years of monitoring data during this period for the 140 metre wide longwalls, and only some of the data from the 163 metre wide longwalls are just entering this period.

The data in Figure 6 has been reproduced to present in Figure 7, a rate of subsidence per survey epoch for each of the monitored survey pegs, instead of observed total subsidence. The rate of subsidence was calculated as the change in subsidence over the time between survey epochs for each survey peg.

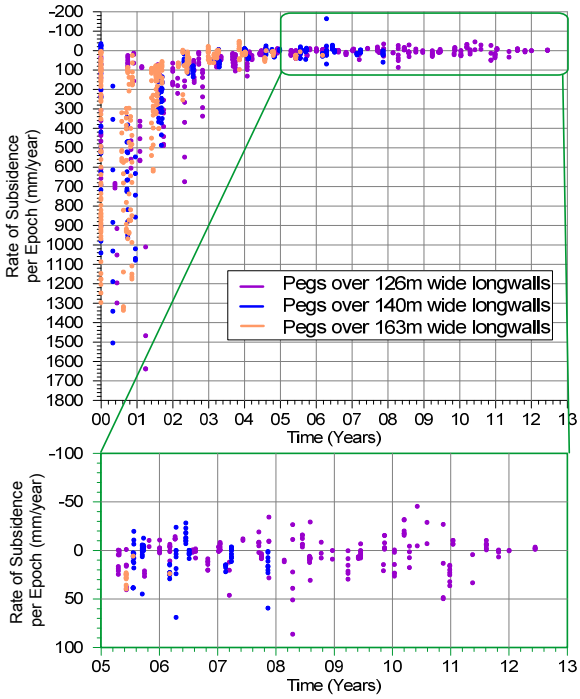


Figure 7 Observed Rate of Subsidence Versus Time

There is some scatter in the rates during this long term period in the order of ±50 mm. The distribution of data is shown in the histograms of the periods 5 to 7 years, 7 to 9 years, and 9 to 12 years presented in Figure 8.

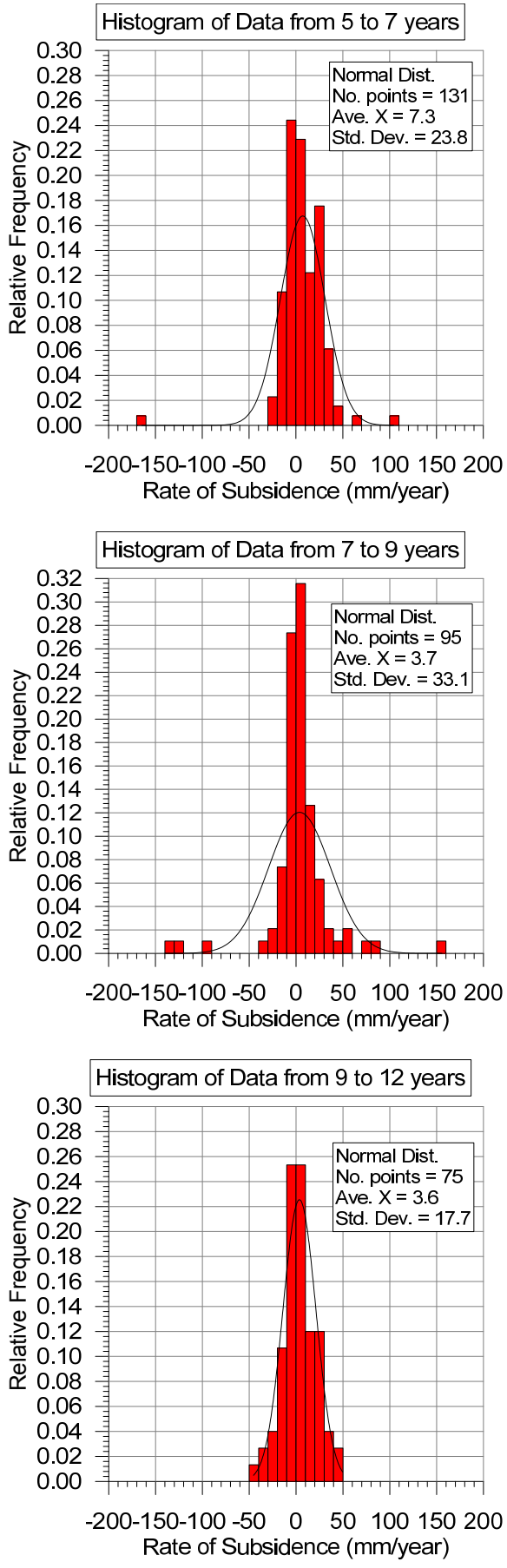


Figure 8 Rate of Subsidence Histograms

A longer period was selected for the final data subset due to the limited number of data points. The histograms show that the average rate of subsidence continues to reduce and has reduced to within 3 to 4 mm/year based on current monitoring data.

The spatial distribution of the rates of subsidence is shown in Figure 9 for the data used in the analysis. The data shows a greater scatter of the rates for the survey pegs that are located towards the base of the deep valley. It is possible that the wider scatter in these rates is the result of the influence of valley related upsidence and closure movements.

In addition to the rates of subsidence between each epoch, an average rate of subsidence was also calculated for each survey peg over the monitoring period between 5 and 14 years by taking the slope of a linear regression line through the subsidence plot for this time period. These results based on linear regression show peaks and troughs, with the peaks coinciding in most cases with the pillar locations.

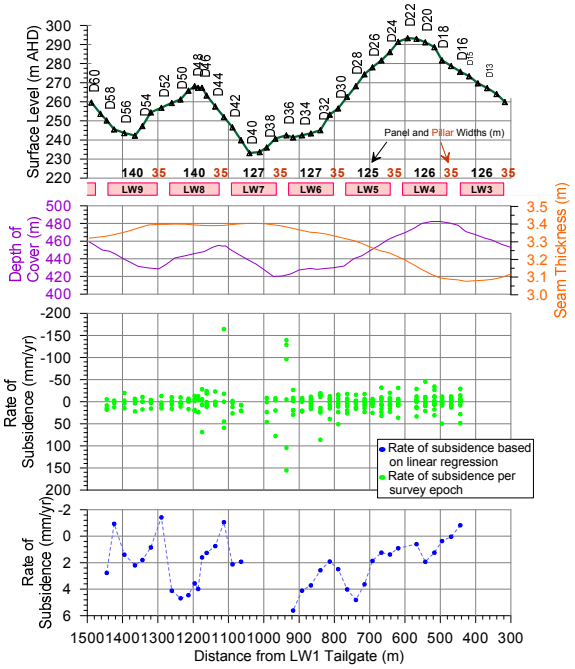


Figure 9 Rate of Subsidence at Monitoring Peg Locations

Four of the peaks have an overall negative rate of subsidence, indicating that at these locations, the ground surface may have rebounded to some degree.

4. Discussion

It is considered that there are two key points to note from this analysis of the long term subsidence monitoring data: firstly, that subsidence continues to develop for many years after mining has passed an area and the active and residual subsidence has been completed and; secondly, that the goaf/chain pillar system is indicated to be in a longer term stable condition.

It is acknowledged that the degree of ongoing subsidence is small and in many cases, these movements would have little to no effect on surface features and may be less than ground movements from other sources, such as seasonal shrink/swell behaviour. It should also be recognised, however, that while small subsidence rates were encountered at Metropolitan Colliery, much higher long term rates could be encountered at other locations depending on geological conditions and extraction geometry. Preliminary assessment of data from other collieries confirms that this is the case.

These subsidence rates may be of significance to features that are sensitive to very small ground movements. As a result, certain sensitive features may require a long term monitoring program to assess the ongoing rates of subsidence to verify that subsidence has reduced to an acceptable level and the risk of long term impact to the feature is below an acceptable level.

The indications from the analysis are that the goaf/chain pillar system is in a long term stable condition. This longer term monitoring data indicates that the continued strength and integrity of the confined pillar core is performing as it was designed to do and gives greater confidence that it will continue to do so.

It should be recognised that this assumes continuance of sufficient pillar strength and confining conditions, which potentially could change with a change to those conditions. Such changes could include future mining of other coal seams, possible seismic events, or contact with water or air.

Current methods of subsidence prediction and impact assessment do not take into account long term subsidence behaviour beyond the active and residual subsidence phase. It is considered prudent, however to recognised that these long term rates of subsidence do occur and whilst they are relatively small at Metropolitan Colliery, higher rates may encountered.

5. Conclusions

The findings of this case study indicate that the goaf/chain pillar goaf system at Metropolitan colliery is in a longer term stable condition and the ongoing subsidence movements appear to be reducing to zero. It is known that significantly higher long term rates of subsidence have occurred at other collieries.

It is hoped that further analysis of data from other collieries could be carried out to develop a more detailed database of long term subsidence movements that could be used for the management of surface features that may be sensitive to small movements, as well as to provide information on the long term behaviour of the goaf/chain pillar system.

6. References

Doyle, J., Newland, A. (2008). "*A Compilation of Surface Geological Features in the Western Portion of Metropolitan Colliery*". Geosensing Solutions.

Kratzsch, H. 1983 "*Mine Subsidence Engineering"* ISBN 3-540-11930-2, pp 320-321.

APPENDIX 3

BUILT FEATURES MANAGEMENT PLAN – SUBSIDENCE IMPACT REGISTER

Built Features Management Plan - Subsidence Impact Register

Impact Register Number[1]	Built Feature[2]	Impact Description	Does Impact Exceed the Built Feature Performance Measure/Indicators? (Yes/No)	Management Measures Implemented	Were Management Measures Effective? (Yes/No)

Notes:

1: Fill out all details in the Assessment Form and record the register number here.

2: Built feature (e.g. tower, rail line, etc.).

Built Feature Management Plan – Subsidence Impact Register
Assessment Form

Date:

Observer (Name and position):

Register Number (i.e. Number 1, 2, etc.):

Longwall Number and Chainage:

Location of Observed Impact:

(Examples: location of viaduct, include GPS co-ordinates and a sketch)

Description of Observed Impact:

(Examples: nature and extent of impact - cracks in road etc any relevant information, attach photographs)

Person Notified:	Manager - Technical Services	☐

Description of Photographs:

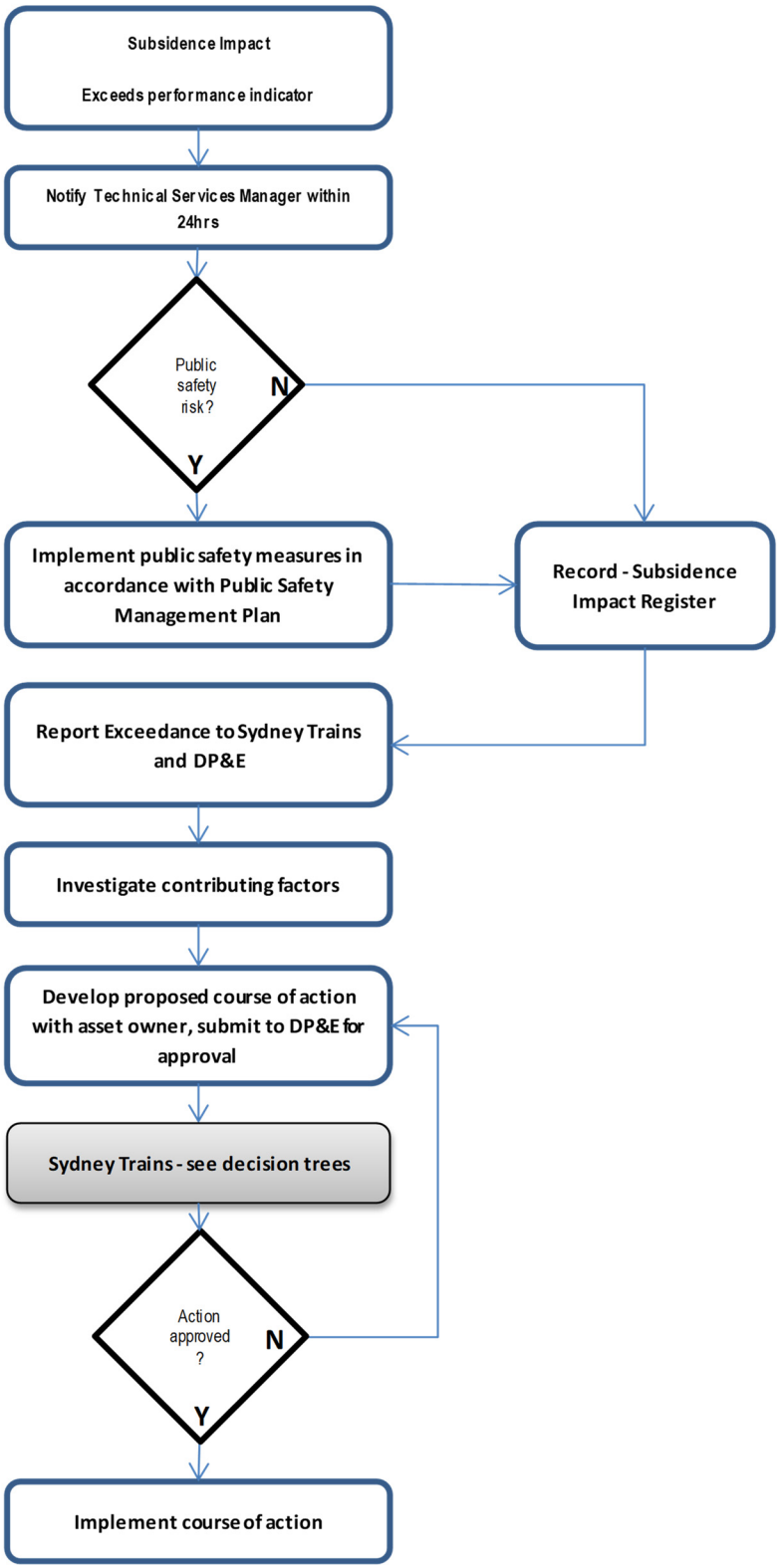
Actions Required:	Contingency Plan Initiated	☐
	Incident Notification	☐
	Safety Measures/Public Safety Management Plan Requirements	☐

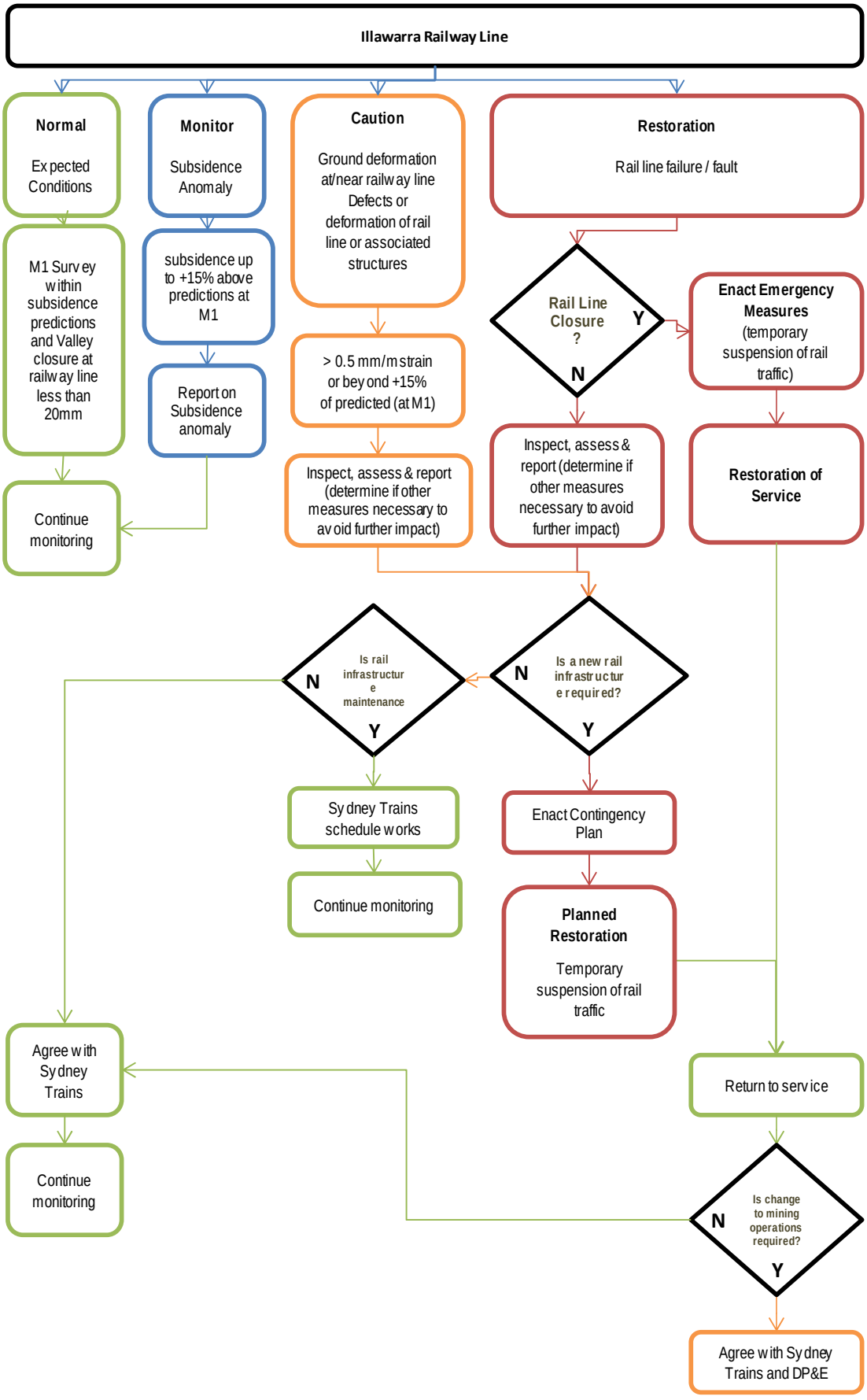
Management or Contingency Measures Implemented:

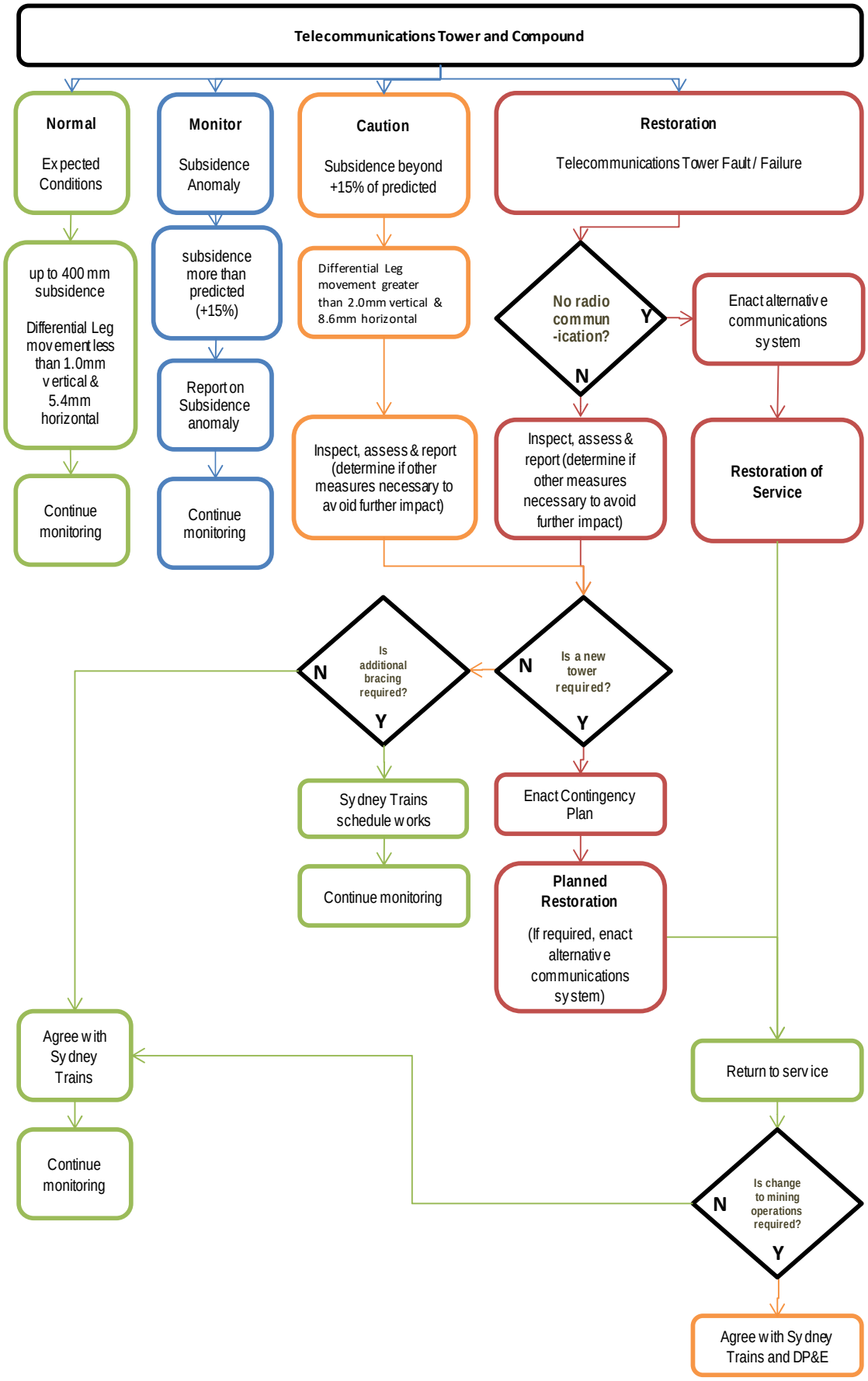
Effectiveness of Management or Contingency Measures:

APPENDIX 4

CONTINGENCY PLAN PROCEDURE AND DECISION TREES


Subsidence Impact
Exceeds performance indicator
Notify Technical Services Manager within 24hrs
Public safety risk?
N
Y
Implement public safety measures in accordance with Public Safety Management Plan
Record - Subsidence Impact Register
Report Exceedance to Sydney Trains and DP&E
Investigate contributing factors
Develop proposed course of action with asset owner, submit to DP&E for approval
Sydney Trains - see decision trees
Action approved ?
N
Y
Implement course of action


Illawarra Railway Line
Normal
Expected Conditions
Monitor
Subsidence Anomaly
Caution
Ground deformation at/near railway line Defects or deformation of rail line or associated structures
Restoration
Rail line failure / fault
M1 Survey within subsidence predictions and Valley closure at railway line less than 20mm
subsidence up to +15% above predictions at M1
> 0.5 mm/m strain or beyond +15% of predicted (at M1)
Rail Line Closure ?
Y
N
Enact Emergency Measures (temporary suspension of rail traffic)
Report on Subsidence anomaly
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration of Service
Continue monitoring
Is rail infrastructure maintenance
N
Y
Is a new rail infrastructure required?
N
Y
Sydney Trains schedule works
Enact Contingency Plan
Continue monitoring
Planned Restoration
Temporary suspension of rail traffic
Agree with Sydney Trains
Return to service
Continue monitoring
Is change to mining operations required?
N
Y
Agree with Sydney Trains and DP&E


Telecommunications Tower and Compound
Normal
Expected Conditions
Monitor
Subsidence Anomaly
Caution
Subsidence beyond +15% of predicted
Restoration
Telecommunications Tower Fault / Failure
up to 400 mm subsidence
Differential Leg movement less than 1.0mm vertical & 5.4mm horizontal
subsidence more than predicted (+15%)
Differential Leg movement greater than 2.0mm vertical & 8.6mm horizontal
No radio commun -ication?
Y
N
Enact alternative communications system
Report on Subsidence anomaly
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration of Service
Continue monitoring
Continue monitoring
Is additional bracing required?
N
Y
Is a new tower required?
N
Y
Sydney Trains schedule works
Enact Contingency Plan
Continue monitoring
Planned Restoration
(If required, enact alternative communications system)
Agree with Sydney Trains
Return to service
Continue monitoring
Is change to mining operations required?
N
Y
Agree with Sydney Trains and DP&E

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BUILT FEATURES MANAGEMENT PLAN
ROADS AND MARITIME SERVICES

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&E Approval Date
All	LW301-303 BFMP_RMS-R01-A	Original – Draft for Consultation	RMS (Technical Committee)	-
All	LW301-303 BFMP_RMS-R01-B	Revised – Incorporating RMS (Technical Committee) Comments	RMS (Technical Committee)	-
TOC, Sections 1.1, 4.2, 4.5, 4.6, 4.8, 5.2.1, 6.3, and 7.2, 7.3.3, 7.4, 7.7, 7.8, 8.2, 9.1 & 16 and Tables 4, 9, 10 & 11	LW301-303 BFMP_RMS-R01-C	Revised – Incorporating RMS (Technical Committee) Comments	RMS (Technical Committee) and DRG	-
Section 4.2.1, Figure 4 and Appendix 3	LW301-303 BFMP_RMS-R01-D	Revised – Incorporating Final Risk Assessment and Figure 4 update	RMS (Technical Committee) and DRG	11 May 2017*
Tables 3, 9 & 11-15 and Appendix 5	LW301-303 BFMP_RMS-R01-E	Revised – Addressing DP&E and DRG requirements	RMS (Technical Committee)	-
Tables 11-15	LW301-303 BFMP_RMS-R01-F	Revised – Incorporating RMS (Technical Committee) Comments	RMS (Technical Committee) DRG and DP&E	-
Preface, Tables 1, 3 and 9	LW301-303 BFMP_RMS-R01-G	Revised for LW 303 extraction, incorporating changes as consulted with TCM on strain	RMS (Technical Committee) and DRG	
Sections 7.5.3, 7.7.1, 7.8.3, Table 9	W301-303 BFMP_RMS-R01-H	Incorporating revision to wording as consulted with TCM on strain	RMS (Technical Committee)	8 November 2018#
All	BFMP_RMS-R01-I	Inclusion of Longwall 304 into BFMP	RMS (Technical Committee)	

* This approval allows for the extraction of Longwalls 301 and 302 only.
# Approval for the extraction of Longwall 303.

April 2019

AUTHORISATION OF MANAGEMENT PLAN

Authorised on behalf of RMS	**Authorised on behalf of Metropolitan Coal**
…….....	....……..
Date : ……..….	Date : ……..….
Position : Asset Manager, Southern Region	Position : …….....

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1 INTRODUCTION

Metropolitan Coal is a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under section 75J of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com).

The Project comprises the continuation, upgrade and extension of underground coal mining operations (Longwalls 20-27 and Longwalls 301-317) and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1. Following the completion of Longwall 27 in 2017, Longwalls 301, 302, 303 and 304 define the next mining sub-domain within the Project underground mining area (Figures 1 to 3).

1.1 PURPOSE AND SCOPE

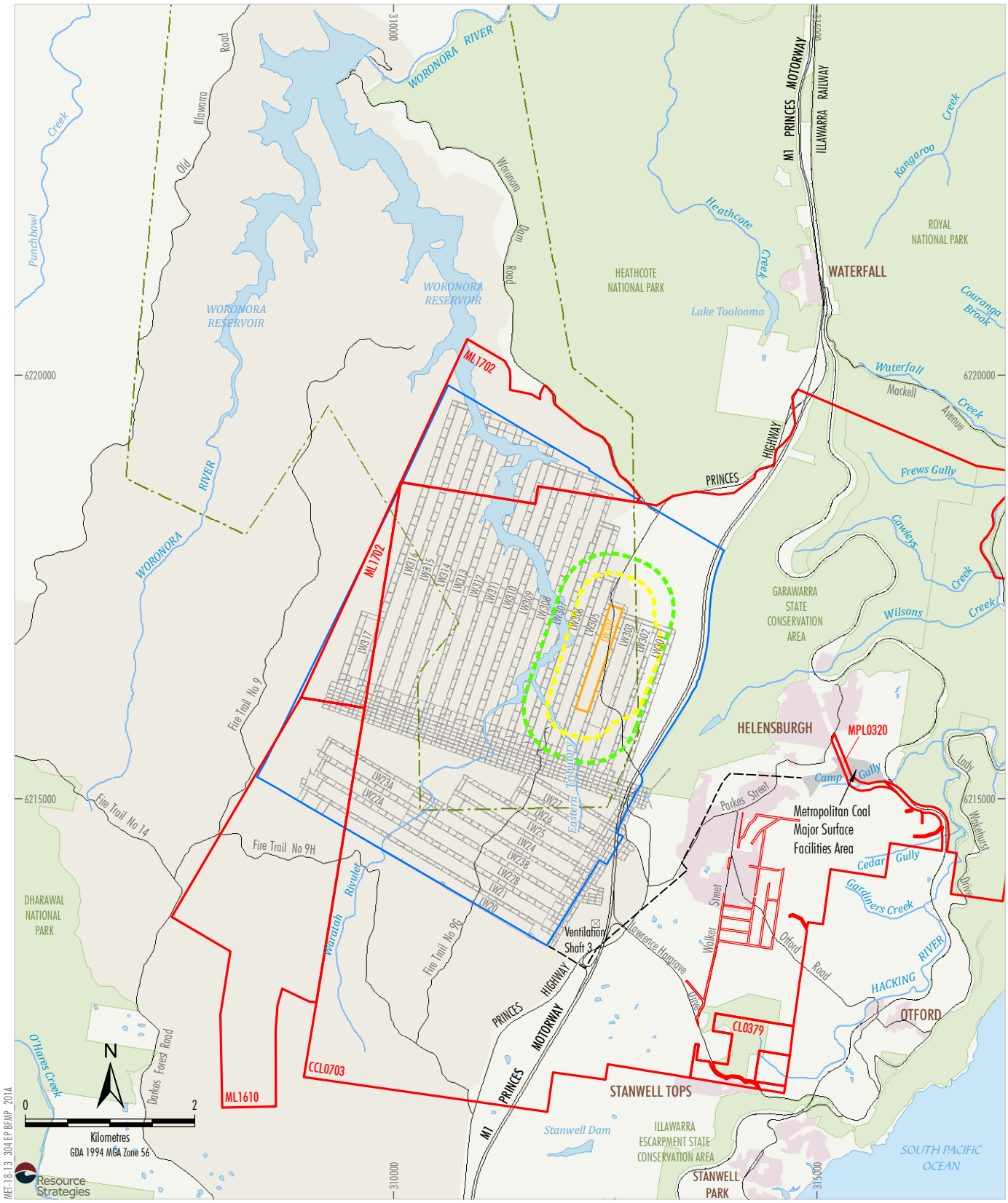
In accordance with Condition 6(f), Schedule 3 of the Project Approval, this Built Features Management Plan – Roads and Maritime Services (BFMP-RMS) has been developed to manage the potential consequences of Longwalls 301-304 extraction on the RMS assets. The relationship of this BFMP-RMS to the Metropolitan Coal Environmental Management Structure is shown on Figure 4.

The RMS assets to which this BFMP-RMS applies are shown in Figure 5. These include:

- Bridge works:
  - bridge structures (RMS reference BN616-southbound and BN617-northbound) at the Old Princes Highway Underpass [referred to herein as 'Bridge 2'], located approximately 330 metres (m) south-east of Longwall 301; and
  - bridge structures (RMS reference BN615) at the Cawley Road[1] Overbridge, located approximately 1.43 kilometres (km) north-east of Longwall 303;
- Road works:
  - carriageway pavement, located from approximately 210 m east of the southern end of Longwall 301 to 335 m east of the northern end of Longwall 301;
  - cuttings (RMS slope numbers: 10425, 10426, 10427, 10428, 13560, 13561, 13562 and 13563) up to maximum height of 20 m;
  - embankments;
  - drainage and drainage structures (including kerbs, gutters, pits and culverts with pipes of varying diameters from 375 millimetres (mm) to 1,800 mm); and
  - RMS roadside furniture.

In accordance with Condition 6, Schedule 3 of the Project Approval, the suitably qualified and experienced experts that have managed the preparation of this BFMP-RMS, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and Metropolitan Coal were endorsed by the Director-General (now Secretary) of the Department of Planning and Environment (DP&E) on 6 June 2016.

[1] Also referred as Cawleys Road.



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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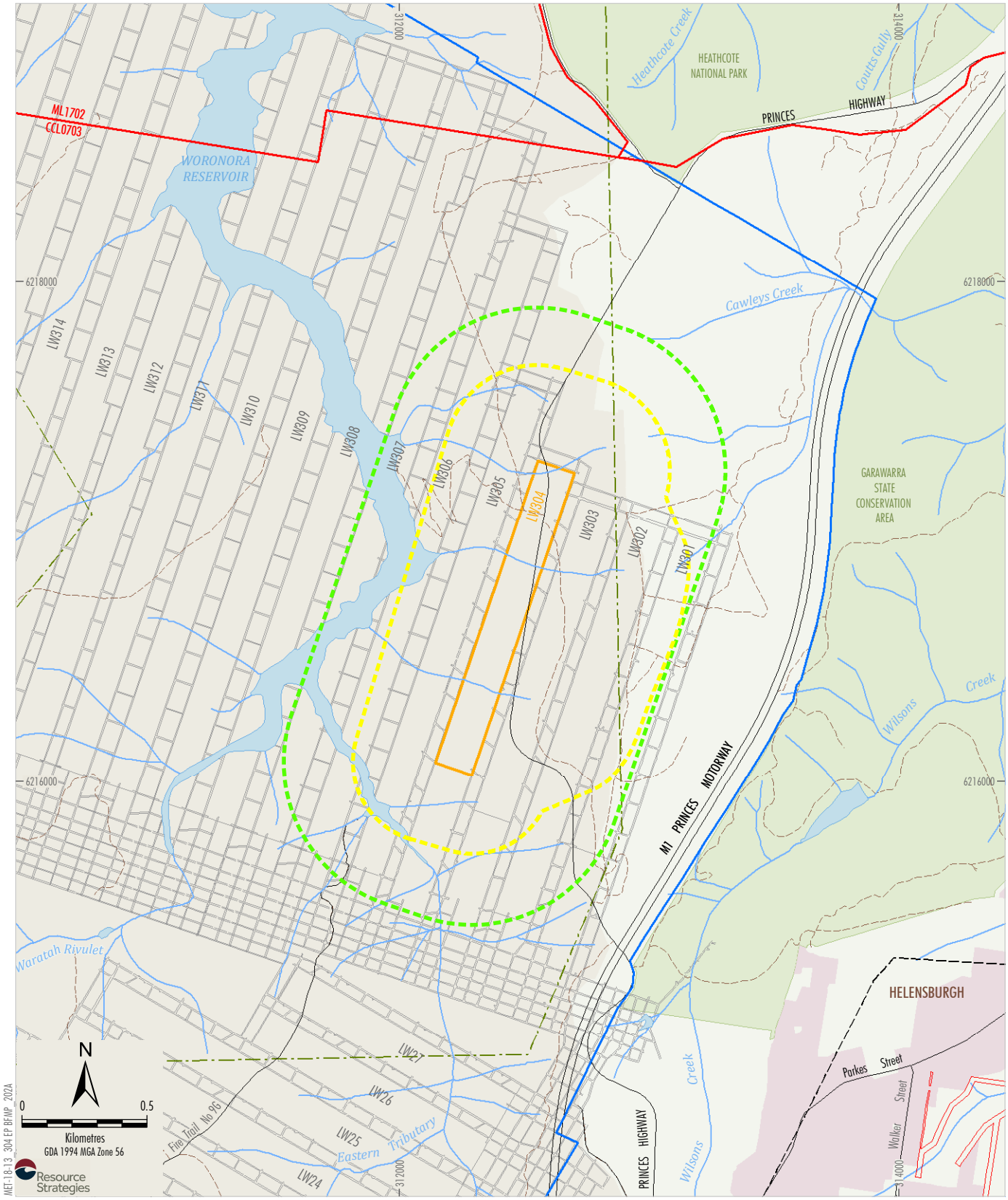
Longwalls 20-27 and Longwalls 301-317 Layout

Figure 1



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)
- Vehicular Track

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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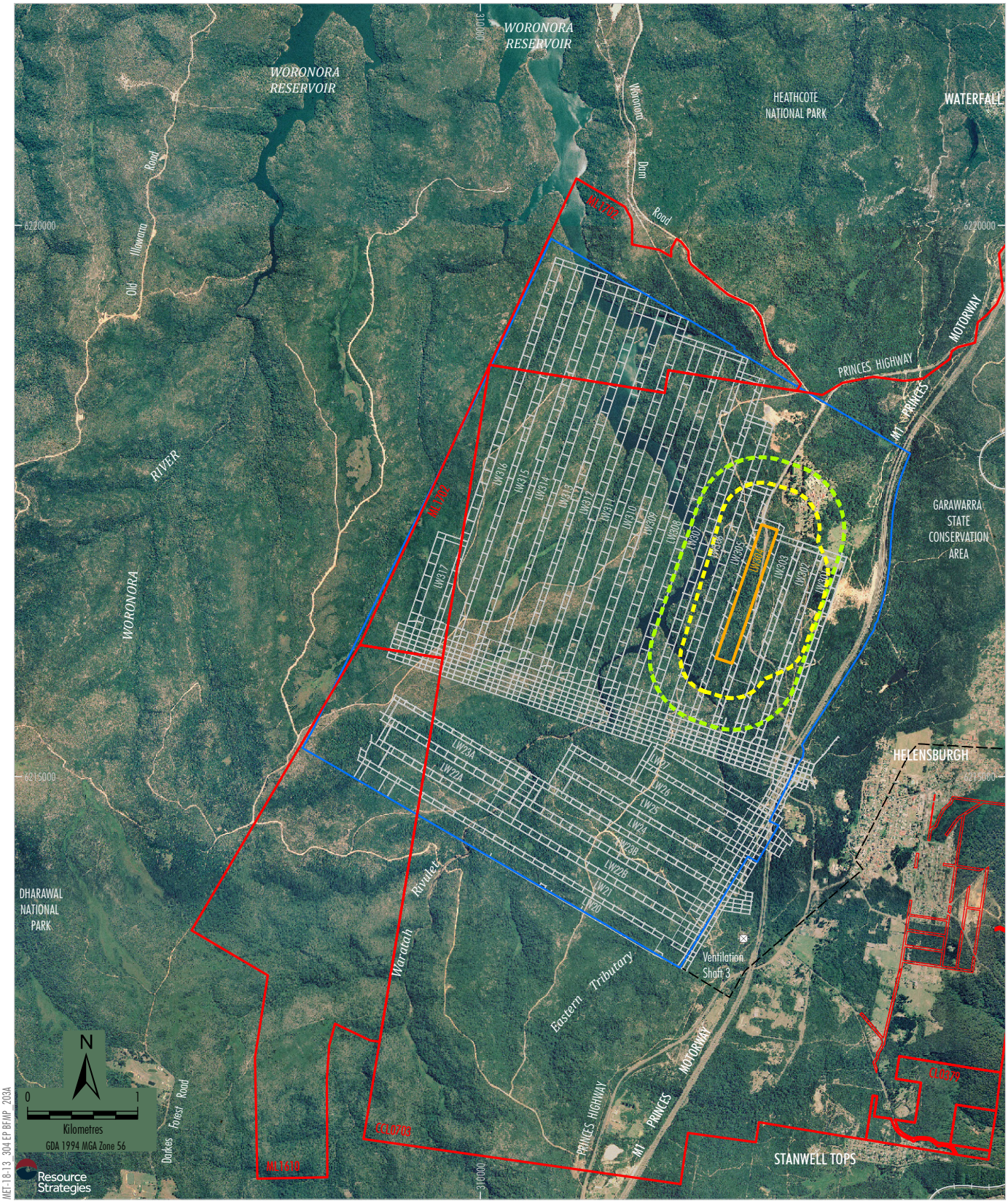
Longwalls 301-304 Layout

Figure 2



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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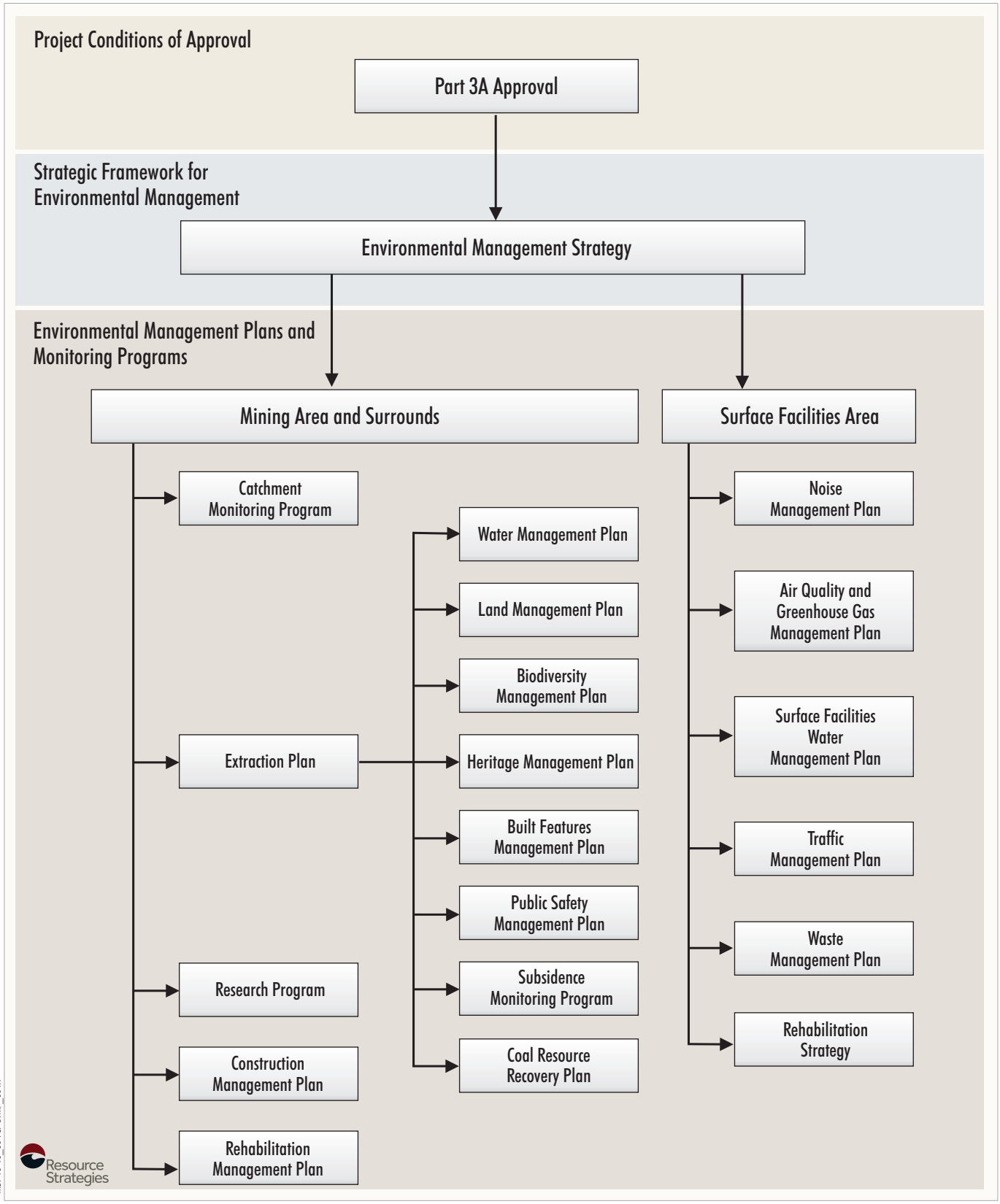
Longwalls 20-27 and Longwalls 301-317 Layout - Aerial Photograph

Figure 3



MET-18-13_304 EP BHMP_001A

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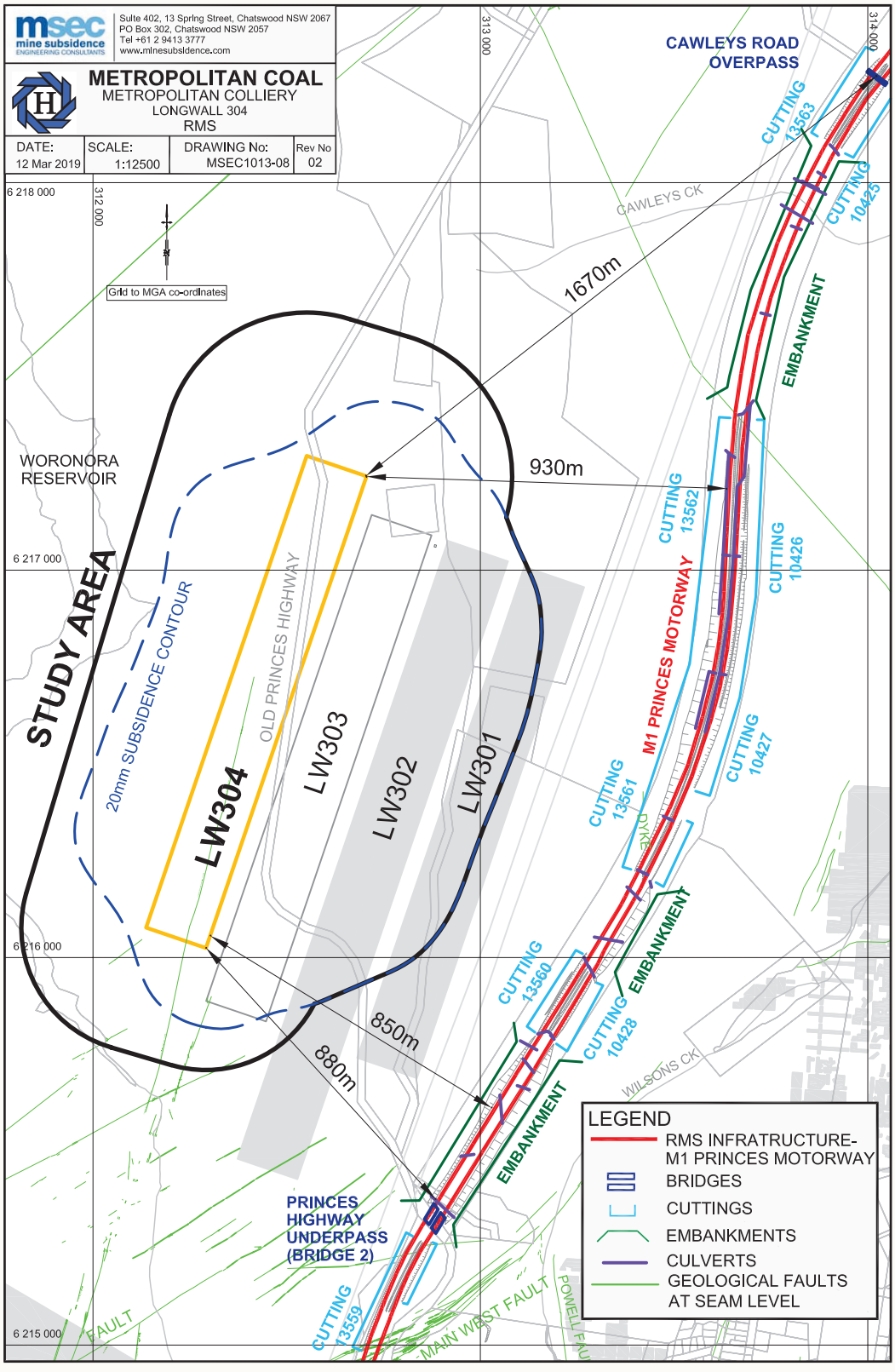
Environmental Management Structure

Figure 4



MET-18-13_304 EP BFMP_012A

Source: MSEC (2019)

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Roads and Maritime Services Assets

Figure 5

This BFMP-RMS has been prepared with the assistance of a Technical Committee (TC) comprising representatives of the RMS and Metropolitan Coal together with technical specialists, AECOM, Cardno and MSEC as nominated in Table 1. This BFMP-RMS has been endorsed by each TC member in their area of expertise.

Table 1
Technical Committee

Organisation	Member
RMS (Project Manager)	Dick Lee Shoy
RMS (Maintenance Planners)	Cyril Gunaratne, Dony Castro
Metropolitan Coal – Primary Contact	Jon Degotardi
Mine Subsidence Engineering Consultants (MSEC)	Peter DeBono
AECOM (Technical Director)	Henk Buys
Cardno	Richard Woods
NSW Police	May attend as Observer
Subsidence Advisory NSW	May attend as Observer

1.2 STRUCTURE OF THE BFMP-RMS

The remainder of the BFMP-RMS is structured as follows:

Section 2: Describes the review and update of the BFMP-RMS.

Section 3: Outlines the statutory requirements applicable to the BFMP-RMS.

Section 4: Provides a revised assessment of the potential subsidence impacts and environmental consequences for Longwalls 301-304.

Section 5: Details the performance measures and indicators that will be used to assess the Project.

Section 6: Provides the detailed baseline data.

Section 7: Describes the monitoring program.

Section 8: Describes the management measures that will be implemented.

Section 9: Provides a contingency plan to manage any unpredicted impacts and their consequences.

Section 10: Describes the Trigger Action Response Plan (TARP) management tool.

Section 11: Describes the program to collect sufficient baseline data for future Extraction Plans.

Section 12: Describes the annual review and improvement of environmental performance.

Section 13: Outlines the management and reporting of incidents.

Section 14: Outlines the management and reporting of complaints.

Section 15: Outlines the management and reporting of non-compliances with statutory requirements.

Section 16: Lists the references cited in this BFMP-RMS.

2 BFMP-RMS REVIEW AND UPDATE

In accordance with Condition 4, Schedule 7 of the Project Approval, BFMP-RMS will be reviewed within three months of the submission of:

- an audit under Condition 8 of Schedule 7;
- an incident report under Condition 6 of Schedule 7;
- an annual review under Condition 3 of Schedule 7; and

if necessary, revised to the satisfaction of the Director-General (now Secretary) of DP&E, to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

This BFMP will also be reviewed within three months of approval of any Project modification and if necessary, revised to the satisfaction of the DP&E.

The revision status of this plan is indicated on the title page of each copy of the BFMP-RMS. The distribution register for controlled copies of the BFMP-RMS is described in Section 2.1.

Revisions to any documents listed within this BFMP-RMS will not necessarily constitute a revision of this document.

2.1 DISTRIBUTION REGISTER

In accordance with Condition 10, Schedule 7 'Access to Information', Metropolitan Coal will make the BFMP-RMS publicly available on the Peabody website. A hard copy of the BFMP-RMS will also be maintained at the Metropolitan Coal site.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format. An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom the Metropolitan Coal plans and programs, such as the BFMP-RMS, will be distributed;
- the format (i.e. electronic or hard copy) of distribution; and
- the format of revision notification.

Metropolitan Coal will make the Distribution Register publicly available on the Peabody website.

Metropolitan Coal will be responsible for maintaining the Distribution Register and for ensuring that the notification of revisions is sent by email or post as appropriate.

In addition, Metropolitan Coal employees with local computer network access will be able to view the controlled electronic version of this BFMP-RMS on the Metropolitan Coal local area network. Metropolitan Coal will be responsible for maintaining controlled copies, ensuring the most recent version is maintained on Metropolitan Coal's computer system and the Peabody website.

3 STATUTORY REQUIREMENTS

Metropolitan Coal's statutory obligations are contained in:

(i) the conditions of the Project Approval;

(ii) relevant licences and permits, including conditions attached to mining leases; and

(iii) other relevant legislation.

These are described below.

3.1 EP&A ACT APPROVAL

Condition 6(f), Schedule 3 of the Project Approval requires the preparation of a BFMP as a component of Extraction Plan(s) for second workings. Project Approval Condition 6(f), Schedule 3 states:

> ***SECOND WORKINGS***
>
> ***Extraction Plan***
>
> *6. The Proponent shall prepare and implement an Extraction Plan for all second workings in the mining area to the satisfaction of the Director-General. This plan must:*
>
> *…*
>
> *(f) include a:*
>
> *…*
>
> - *Built Features Management Plan, which has been prepared in consultation with the owner of the relevant feature, to manage the potential environmental consequences of the Extraction Plan on any built features;*
>
> *…*

In addition, Condition 2, Schedule 7 and Condition 7, Schedule 3 of the Project Approval outline management plan requirements that are applicable to the preparation of the BFMP-RMS. Table 2 indicates where each component of the conditions is addressed within this BFMP-RMS.

Table 2
Management Plan Requirements

Project Approval Condition	BFMP-RMS Section
Condition 2 of Schedule 7	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Section 6
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 3
• any relevant limits or performance measures/criteria;	Section 5
• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 5.2
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Sections 7, 8, 9 and 10
d) a program to monitor and report on the:	Sections 7, 8 and 12
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 9 and Appendix 7
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Sections 7 and 12
g) a protocol for managing and reporting any;	
• incidents;	Section 13
• complaints;	Section 14
• non-compliances with statutory requirements; and	Section 15
• exceedances of the impact assessment criteria and/or performance criteria; and	Section 9 and Appendix 7
h) a protocol for periodic review of the plan.	Section 2
Condition 7 of Schedule 3	
7. In addition to the standard requirements for management plans (see condition 2 of schedule 7), the Proponent shall ensure that the management plans required under condition 6(f) above include:	
a) a program to collect sufficient baseline data for future Extraction Plans;	Section 11
b) a revised assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval;	Section 4
c) a detailed description of the measures that would be implemented to remediate predicted impacts; and	Section 8
d) a contingency plan that expressly provides for adaptive management.	Section 9 and Appendix 7

3.2 LICENCES, PERMITS AND LEASES

In addition to the Project Approval, all activities at or in association with Metropolitan Coal will be undertaken in accordance with the following licences, permits and leases which have been issued or are pending issue:

- The conditions of mining leases issued by the NSW Division of Resources and Geoscience (DRG), under the NSW *Mining Act, 1992* (e.g. Consolidated Coal Lease [CCL] 703, Mining Lease [ML] 1610, ML 1702, Coal Lease [CL] 379 and Mining Purpose Lease [MPL] 320).
- The Metropolitan Coal Mining Operations Plan 1 October 2012 to 30 September 2019 approved by the DRG.
- The conditions of Environment Protection Licence (EPL) No. 767 issued by the NSW Environment Protection Authority (EPA) under the NSW Protection of the Environment Operations Act, 1997. Revision of the EPL will be required prior to the commencement of Metropolitan Coal activities that differ from those currently licensed.
- The prescribed conditions of specific surface access leases within CCL 703 for the installation of surface facilities as required.
- Water Access Licences (WALs) issued by the NSW Department of Primary Industries – Water (now the Department of Industry – Water) under the NSW Water Management Act, 2000, including WAL 36475 under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 and WAL 25410 under the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011.
- Mining and workplace health and safety related approvals granted by the NSW Resources Regulator and WorkCover NSW.
- Supplementary approvals obtained from WaterNSW for surface activities within the Woronora Special Area (e.g. fire road maintenance activities).

3.3 OTHER LEGISLATION

Metropolitan Coal will conduct the Project consistent with the Project Approval and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to the conduct of the Project (Helensburgh Coal Pty Ltd [HCPL], 2008)[2]:

- *Biodiversity Conservation Act, 2016;*
- *Biosecurity Act, 2015;*
- *Contaminated Land Management Act, 1997;*
- *Crown Land Management Act, 2016;*
- *Dams Safety Act, 1978;*
- *Dangerous Goods (Road and Rail Transport) Act, 2008;*
- *Energy and Utilities Administration Act, 1987;*
- *Fisheries Management Act, 1994;*

[2] The list of potentially applicable Acts has been updated to reflect changes to the Acts that were in force at the time of submission of the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008).

- *Mining Act, 1992;*
- *Protection of the Environment Operations Act, 1997;*
- *Rail Safety (Adoption of National Law) Act, 2012;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Water NSW Act, 2014;*
- *Work Health and Safety Act, 2011; and*
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

Relevant licences or approvals required under these Acts will be obtained as required.

4 REVISED ASSESSMENT OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

4.1 EXTRACTION LAYOUT

Longwalls 301-304 and the area of land within 600 m of Longwall 304 secondary extraction are shown on Figures 2 and 3. Longwall extraction occurs from north to south. The longwall layouts include 163 m panel widths (void) with 45 m pillars (solid).

The provisional extraction schedule for Longwalls 301-304 is provided in Table 3.

Table 3
Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
301	June 2017	6 months	February 2018
302	March 2018	7 months	October 2018
303	November 2018	7 months	May 2019
304	July 2019	6 months	December 2019

The future Extraction Plans will consider the cumulative subsidence effects, subsidence impacts and/or environmental consequences. Note that the total cumulative predicted subsidence effects, subsidence impacts and/or environmental consequences at the completion of the Project are considered in the Metropolitan Coal Project EA (Project EA) (HCPL, 2008) and the Preferred Project Report (HCPL, 2009).

4.2 OVERVIEW – SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS

The RMS assets relevant to the extraction of Longwalls 301-304 are illustrated in Figure 5. The revised predicted subsidence movements due to Longwalls 301-303 and Longwall 304 have been provided by MSEC (2016, 2019) (Appendices 1 and 2) and are summarised below.

The M1 Princes Motorway will not be directly mined beneath by Longwalls 301-304. The nearest point from the longwalls to the M1 Princes Motorway is approximately 210 metres (m) from finishing end of Longwall 301.

Bridge 2 (where a program of high accuracy monitoring has been implemented by the Technical Committee) is located approximately 330 m and 890 m from the finishing end of Longwall 301 and Longwall 304 respectively.

Cawley Road Overbridge is located 1.43 km and 1.67 km from the northern ends of Longwall 301 and Longwall 304 respectively.

The maximum predicted total conventional subsidence is very small (50 mm after Longwall 302). The predicted conventional subsidence parameters for much of the M1 Princes Motorway resulting from the extraction of Longwalls 301-304 are generally less than the expected limits of survey tolerance (normally ±20 mm). The maximum predicted conventional tilt and curvature are less than the expected limits of survey accuracy (i.e. 0.5 mm/m for tilt and 0.01 km^{-1} for curvature). There is, however, the potential for far-field horizontal movements (up to 115 mm, based on a 95% confidence level from a database of observed far-field horizontal movements in the Southern Coalfield) and non-conventional movements to occur at the RMS built features.

Similarly, from the Southern Coalfields survey database, the 95% confidence levels for the maximum total strains that the individual survey bays above solid coal (100-250 m) experienced at any time during mining are 0.4 mm/m tensile and compressive.

A drainage line crosses beneath the M1 Princes Motorway to the east of the finishing end of Longwall 301. Predicted valley closure across the culvert at the location of the M1 Princes Motorway is less than 20 mm. Valley closure is not expected to occur in the cuttings along the M1 Princes Motorway, however, minor closure movements could be observed due to potential horizontal movements.

The features along the M1 Princes Motorway considered to be most sensitive to relative movements arising from far-field effects are Bridge 2 (at the location where the Old Princes Highway passes below the M1 Princes Motorway) and Cawley Road Overbridge.

Details of Bridge 2 are provided in Table 4. Based on far-field horizontal movement data, the predicted incremental relative opening and closing and mid ordinate deviation have been used to assess differential horizontal movement of the ground at Bridge 2 and their respective probabilities of exceedance are provided in Table 5.

For Bridge 2, the predicted incremental relative open or closing movement at a 1 in 2,000 probability is 44 mm and the predicted mid-ordinate deviation is 32 mm.

Table 4
Summary of Bridge 2 and Cawley Road Overbridge Details along the M1 Princes Motorway

Bridge Name	RMS Name	RMS Chainage from Sydney	Nearest Longwall	Approximate Distance to Nearest Longwall (m)
Old Princes Highway Underpass 2 (Bridge 2)	Twin Bridges over Old Princes Highway BN616 on S/B carriageway BN617 on N/B carriageway	30 miles 1,326 feet (48 kilometres 684.5 m)	301	330
Cawley Road Overbridge	BN615	28 miles 1,350 feet (45.47 kilometres south of Sydney)	301	1,430

Table 5
Incremental Relative Opening, Closing and Mid-Ordinate Deviation at Approximately 880 Metres Distance from the Active Longwall 304

	1 in 20 Probability of Exceedance (95% Confidence Level)	1 in 100 Probability of Exceedance (99% Confidence Level)	1 in 2000 Probability of Exceedance (99.95% Confidence Level)
Opening	6 mm	10 mm	20 mm
Closing	5 mm	10 mm	21 mm
Mid-Ordinate Deviation	8 mm	13 mm	18 mm

While located at a distance of 1.67 km from the northern end of Longwall 304, the predicted incremental relative opening and closing and mid ordinate deviation (based on far-field horizontal movements) have been used to assess differential horizontal movement of the ground at the Cawley Road Overbridge and their respective probability are provided in Table 6.

Table 6
Incremental Relative Opening, Closing and Mid-Ordinate Deviation at Approximately 1.67 Kilometres Distance from the Active Longwall

	1 in 20 Probability of Exceedance (95% Confidence Level)	1 in 100 Probability of Exceedance (99% Confidence Level)	1 in 2000 Probability of Exceedance (99.95% Confidence Level)
Opening	4 mm	7 mm	14 mm
Closing	5 mm	9 mm	19 mm
Mid-Ordinate Deviation	7 mm	10 mm	16 mm

For Cawley Road Overbridge, the predicted incremental relative open and closing movement at a 1 in 2,000 probability of exceedance is 14 mm and 19 mm respectively and the predicted mid-ordinate deviation is 16 mm.

MSEC (2016) also identified potential movements at geological faults in cuttings (Appendix 1).

4.2.1 Risk Assessment

In accordance with the *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) a risk assessment was conducted on 25 August 2016 for Longwalls 301-303 and on 18 September 2018 for Longwalls 304-306 by Arup Risk Consulting with representatives from the Technical Committee (RMS, 2018) (Appendices 4 and 5).

The RMS assets considered in the risk assessment included:

- Bridge 2 – BN616 (southbound) and BN617 (northbound);
- Cawley Road Overbridge – BN615;
- carriageway;
- culverts;
- kerb;

- cuttings;
- embankments;
- roadside furniture;
- drains;
- Variable Message Sign (VMS); and
- other structures such as power lines (which are not RMS assets but failure may affect RMS assets).

Subsidence management procedures considered in the risk assessment included:

- High Accuracy Fibre Optic Monitoring System;
- Conventional Survey/Visual Inspections;
- Management Measures; and
- Contingency Measures.

The Longwalls 304-306 risk assessment used the risk register from previous studies (Longwalls 301-303, 23-27 and 20-22) as a basis of discussion. In summary, a total of 18 risk events were identified during the workshop, of which 11 were not considered to present a credible risk (i.e. the level of possible impacts was not measurable).

This BFMP-RMS for Longwalls 301-304 addresses the events and activities identified in the risk assessment workshop and also takes into account the progression of potential mining impacts predicted from Longwalls 301-304.

The report *Metropolitan Colliery Longwall Mining – LW304-306 – Risk Assessment as Applied to RMS Assets* (Arup, 2019) is included in Appendix 5, and its details are referred to as required in the consideration of RMS assets below.

4.3 BRIDGE 1 – OLD PRINCES HIGHWAY UNDERPASS (SOUTHERN)

Bridge 1 (RMS Reference BN618-northbound and BN619-southbound) is considered unlikely to experience any movement of concern for Longwalls 301-304 since it had only experienced minor observed movements from the extraction of Longwalls 20 to 27 and the extraction of Longwall 301-304 would occur further away from Bridge 1. Bridge 1 is therefore not considered any further in this BFMP-RMS.

4.4 BRIDGE 2 – OLD PRINCES HIGHWAY UNDERPASS

At the direction of the RMS Technical Committee, a detailed assessment of the potential effects on Bridge 2 – Old Princes Highway Underpass of the 1 in 100 and 1 in 2000 predicted relative ground movements (Table 5) resulting from extraction of Longwalls 301-304 was carried out by Cardno.

The findings of the assessment were provided in Cardno's report titled *Investigation of Potential Effects on Underpass 2 over Princes Highway of Ground Movement Due to Mining* issued in May 2015 (Cardno, 2015a) and a supplement to that report issued in July 2015 (Cardno, 2015b). Other past reports relating to Bridge 2 are provided in the reference list (Cardno, 2008; 2009a; 2009b; 2009c; and 2013).

As for Bridge 1, it was determined that ground movement effects only needed to be considered in the Serviceability Limit State, not the Ultimate Limit State, provided that the structures have sufficient plastic capacity and this approach is in accordance with AS 5100. In the Serviceability Limit State, the control of the widths of cracks in concrete members is the primary focus.

The analysis showed that, with the effects of the 1 in 100 probability relative horizontal ground movements included, the flexural crack control provisions generally still complied with the requirements of Australian Standard (AS) 5100:2007 – *Bridge Design.* Under adverse patterns of differential ground movement, crack widths at only two sections in Abutment B could exceed the allowable limits with a maximum estimated crack width of 0.65 mm. As required by AS 5100, the abutment and pier structures would have sufficient capacity for plastic deformations under this loading. Flexural cracks of width less than 0.5 to 1mm only affect the appearance of the bridge and will not otherwise affect the strength or durability of the structure. They can readily be repaired.

However, the analysis showed that, with the effects of the 1 in 2000 probability relative horizontal ground movements included, the flexural crack widths at particular sections of the abutment and pier frames could significantly exceed allowable limits under adverse patterns of differential ground movement with the potential for stresses in reinforcement to exceed the tensile capacity of reinforcing bars. This effectively would mean failure of the concrete sections.

The assessment determined that the bridge superstructures and bearings are generally not adversely affected by differential ground movements because the articulation allows for such movements. However, it was determined that there is potential for local crushing of the girder concrete at the contact point of the dowel restraints at the piers. The short term ramifications of such limited local crushing are considered to be acceptable structurally as the girders would continue to be adequately supported and an alternative mechanism to provide horizontal restraint of the superstructure is available and has sufficient capacity.

As the crushing could develop after only a few millimetres of differential ground movement (if the pattern of ground movement is adverse) the magnitude of horizontal movement of girders relative to their supporting headstocks should be limited to 10 to 15 mm. It is noted that the bearing and dowel restraint details at Bridge 2 are different to those at Bridge 1 resulting in Bridge 2 being significantly more sensitive to forces on dowel restraints from ground movement effects.

Cardno was also asked by the RMS Technical Committee to investigate and report on the methods and implementation of monitoring of Bridge 2 to detect the effects of relative ground movements. The final version of the Monitoring Report for Bridge 2 was issued in July 2015. The report included details of the implementation of an additional system of higher accuracy distortion measurements based on the use of Fibre Bragg Grating “extensometers” (measuring change in distance between two points) and tiltmeters.

4.5 CAWLEY ROAD OVERBRIDGE

At the direction of the RMS Technical Committee, a detailed assessment of the potential effects on Cawley Road Overbridge of the 1 in 100 and 1 in 2000 predicted relative ground movements (Table 6) resulting from extraction of Longwalls 301-303 was carried out by Cardno.

The findings of the assessment were provided in Cardno’s report titled *Investigation of Potential Effects on Cawley Road Overbridge of Ground Movement Due to Mining* issued in October 2016 (Cardno, 2016).

It should be noted that Cawley Road Overbridge is currently not in regular use and is only open to traffic in emergency situations.

As for Bridges 1 and 2, it was determined that ground movement effects only needed to be considered in the Serviceability Limit State, not the Ultimate Limit State, provided that the structures have sufficient plastic capacity and this approach is in accordance with AS 5100. In the Serviceability Limit State, the control of the widths of cracks in concrete members is the primary focus.

The assessment found that differential ground movements in the longitudinal direction of the bridge, either opening or closing, between the abutments do not result in any unacceptable effects for either the 99.95% confidence level (1 in 2000 probability) or the 99.0% confidence level (1 in 100 probability) ground movements when combined with normal in service permanent and transient loads.

The effects of differential ground movements in the transverse direction of the bridge depend on the transverse capacity of the guided sliding bearings at the abutments but these are unknown.

If the lateral capacity of the bearings is high, significant horizontal bending of the deck and transverse force on the pier could occur. However, in the worst case scenario for these effects in which the lateral capacity of the bearings is not exceed, the effects on the deck and pier are within allowable limits.

Alternatively, if the lateral capacity of the guided sliding bearings is low, they could "fail" under differential transverse ground movements. However, "failure" of these bearings simply means that slip will occur at the interfaces near the top of the bearing. The magnitude of the slip could result in contact between the upper steel plate of the bearing and the concrete nib of the end diaphragm beam, resulting in minor spalling and possible minor distortion of the steel traffic railing and safety screen.

4.6 CARRIAGEWAY

Whilst measurable conventional subsidence movements are anticipated to be very small for the M1 Princes Motorway, potential movement of fault lines may result in impacts to the pavement. The M1 Princes Motorway crosses the Metropolitan Fault approximately 500 m to the north-east of Longwall 301. Several other faults to the south-east of Longwalls 301-304 also intersect the M1 Princes Motorway at distances of approximately 340 m.

The approximate locations of the faults are illustrated in Figure 5. There are no identified geological features directly above the longwalls.

It is possible that irregular movements could develop at the location of the faults or that anomalous movements could occur at unknown geological features as a result of the extraction of the longwalls. These have occurred in the past in the Southern Coalfield, though is less likely at these distances.

Previous impacts have occurred as a result of mining operations below the M1 Princes Motorway during the late 1970s. The majority of impacts to the pavement during mining at the Coal Cliff and Metropolitan Collieries consisted of pavement cracking. However, steps in the order of 40 mm to 80 mm in height also occurred at two locations during mining.

The first step occurred during total extraction mining at Coal Cliff Colliery and ground monitoring indicated that irregular movements had developed at this location, comprising a local upsidence bump at the impact location coupled with a localised high compressive ground strain of approximately 1.6 mm/m after the step had occurred.

The second step occurred during mining at Metropolitan Colliery where the M1 Princes Motorway crossed above a large valley at Kelly's Creek. It is considered likely that valley upsidence and closure movements developed in the base of the valley, though no ground monitoring had been installed at the valley base to confirm this. Ground monitoring along the top of the embankment (maximum height of approximately 25 m), however, measured compressive strains over a long length of the embankment.

The steps in the M1 Princes Motorway pavement occurred only at locations where mining extended below the carriageway. Whilst it is expected that there is a low risk of impacts to the M1 Princes Motorway pavement due to the extraction of Longwalls 301-304, it was agreed by the Technical Committee that monitoring along the M1 Princes Motorway would be conducted for the extraction of Longwalls 301-304.

The M1 Princes Motorway pavements are located some 200 m or more from the longwalls. The MSEC (2016) letter report for Longwalls 301-303 (Appendix 1) provides an assessment of the level of strain that can be expected in the pavements at these distances (100 to 250 metres) for individual survey bays above solid coal. The report indicates that at a 95 % confidence interval the maximum total strain recorded was 0.4 mm/m tensile and compressive. The 99 % confidence intervals maximum total strains are 0.7 mm/m tensile and 0.6 mm/m compressive.

The pavement is not expected to experience measurable conventional strain due to the extraction of Longwall 304 (MSEC, 2019) (Appendix 2).

These strain levels are expected to occur over relatively short bay lengths and are hence unlikely to cause impacts to the pavement of any concern.

Monitoring in relation to fault movement is described in Section 7 of this report.

4.7 CULVERTS AND DRAINAGE STRUCTURES

There are several culverts in the vicinity of Longwalls 301-304 (Figure 5). In addition to the culverts, there are also a number of other drainage structures, such as kerbs, gutters, pits and drainage pipes. There is the potential for far-field movements and non-conventional movements to impact the culverts and other drainage structures, however these movements are expected to be of a small order (refer Appendices 1 and 2). Valley closure movements have also been considered (refer Appendices 1 and 2), however these are expected to be less than 20 mm. Hence adverse impacts on drainage structures associated with these movements are considered unlikely.

The risk assessments (Appendices 4 and 5) identified that cracking of culverts that contain asbestos was a potential risk. Based on previous assessments, it was deemed very unlikely that the asbestos fibres (which are bound into the cement) would be released into the environment and be hazardous to the health and safety of the public, if cracking of the asbestos cement pipes was to occur. The proposed mitigation in the case of culverts cracking is to inspect the area of damage and to sleeve the pipe if necessary to contain the asbestos.

4.8 M1 PRINCES MOTORWAY CUTTINGS

There are several rock cuttings along the M1 Princes Motorway east of Longwalls 301-304. The locations of the cuttings are shown in Figure 5.

There is the potential for far-field movements and non-conventional movements to impact the rock cuttings, however potential impacts and the consequences associated with these movements are considered to be very low.

The cuttings were stabilised and rerated prior to the extraction of Longwall 301 as part of the RMS slope maintenance program to improve their Assessed Risk Level (ARL) in accordance with the RMS Guide to Slope Risk Analysis (RMS, 2014). The stabilisation measures changed the ARL from the pre-stabilisation ARL2 to a post-stabilisation ARL3 or ARL4. During the extraction of Longwall 303 in 2018 the cuttings were reassessed as follows:

- Cutting 10425: ARL2 to ARL3;
- Cutting 13560: ARL4 to ARL3; and
- Cutting 13562: ARL4 to ARL3.

The cuttings rerating was due to natural effects and were not related to mining.

The low levels of movement expected as a result of extraction of Longwalls 301 to 304 are not expected to have any impacts on the ARL of the stabilised slopes.

4.9 VARIABLE MESSAGE SIGN STRUCTURES AND ROADSIDE FURNITURE

Negligible impact is predicted for the Variable Message Sign structures and roadside furniture.

5 PERFORMANCE MEASURES AND INDICATORS

5.1 PERFORMANCE MEASURES

The Project Approval requires Metropolitan Coal not to exceed the subsidence impact performance measures outlined in Table 1 of Condition 1, Schedule 3. The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

> *Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.*

5.2 PERFORMANCE INDICATORS

A summary of the performance indicators proposed to ensure that the above performance measure is achieved include:

- measured absolute horizontal movements;
- distortion of bridge elements;
- cracking of bridge elements;
- pavement cracking and deformation;
- visual consequences of slope movement; and
- defects in culverts.

These are described in more detail below.

Section 7 of this BFMP-RMS describes the monitoring that will be conducted to assess the Project against the above performance indicators. Section 8 describes the management measures that will be implemented in the event that one or more of the performance indicators are exceeded. Section 9 of this BFMP-RMS provides a Contingency Plan in the event the performance measure is exceeded or is considered likely to be exceeded.

5.2.1 Bridge Distortion and Cracking

The following limits are used for monitoring the performance of the bridges:

- absolute 3D horizontal movement of survey lines (M1 Northbound Line and Transmission Line) of 30 mm or more at key points on the ground near the bridge;
- relative movement of 5 mm or more between any two points monitored by the conventional survey system;
- relative movement of 2 mm or more between any two points monitored by the FBG sensor system; and
- crack in concrete elements exceeding 0.2 mm width.

The above limits were adopted to provide a reasonable indicator of ground movements, including differential movements, and distortion of the bridge as a result of extraction of the longwalls. Should any of these limits be exceeded, structural analysis along with more detailed monitoring would be used to assess the ongoing performance of the bridges.

The monitoring systems, locations and frequency are outlined in Section 7.

5.2.2 M1 Princes Motorway Pavement Deformation

The performance indicators for the pavement include:

- a measured compressive ground strain of greater than 0.5 mm/m;
- pavement cracking;
- deterioration in ride quality; and
- defects in minor structures such as kerbs and gutters, pits, etc.

5.2.3 Cuttings and Faults

The performance indicators for the cuttings include:

- a measured ground strain of greater than 0.5 mm/m;
- rock falls;
- cracking or visual deterioration at the rock face; and
- visual displacement at joints.

5.2.4 Culverts

The performance indicators for the culverts include:

- visual displacement at joints;
- cracks in culverts; and
- ponding.

6 BASELINE DATA

6.1 GENERAL

The reports on the baseline data will be made available in accordance with the distribution register outlined in Section 2.1.

6.2 BRIDGE 2 – OLD PRINCES HIGHWAY UNDERPASS

An inspection of the Bridge 2 structure to record its existing (baseline) condition was conducted prior to the commencement of Longwall 20. The baseline condition of this bridge was confirmed by further inspections in 2013, 2015 and 2016 prior to Longwall 301 extraction.

The conventional survey monitoring points were installed on this bridge prior to the commencement of Longwall 20. Then initial (baseline) relative 3D survey was carried out in February 2011. A further survey was conducted prior to the commencement of Longwall 301 in 2016.

6.3 CAWLEY ROAD OVERBRIDGE

An inspection of the Cawley Road Overbridge was conducted prior to extraction of Longwall 301.

Conventional survey monitoring points are installed on this bridge and the initial (baseline) relative 3D survey was carried out prior to extraction of Longwall 301.

6.4 M1 PRINCES MOTORWAY PAVEMENT

Ground monitoring pegs are established along the M1 Princes Motorway in accordance with the ground monitoring plan, which is described below. The ground monitoring pegs were surveyed by 3D survey methods prior to the commencement of Longwall 301.

The existing pavement condition will be assessed from data obtained using the RMS RoadCrack, Gipsicam and Laser Profilometer pavement assessment systems which are conducted in accordance with the RMS inspection program.

In addition to the pavement assessment system, a visual inspection of the kerbs and gutters, pits signs and other road infrastructure was carried out by the RMS to provide an assessment of the baseline of condition of these features prior to the extraction of Longwall 301.

6.5 CUTTINGS

There are several rock cuttings along the M1 Princes Motorway (Figure 5). A summary of the RMS rock cuttings is provided in Table 7.

Stabilisation of the cuttings has been carried out as part of the RMS slope maintenance program prior to extraction of Longwall 301. Post stabilisation slope risk assessments in accordance with the RMS Guide to Slope Risk Analysis (RMS, 2014) form the baseline survey for these slopes.

Table 7
RMS Rock Cutting Details

RMS Slope Number	Length (m)	Maximum Slope Height (m)	Average Slope Angle (degrees)
10425	188	9	66
10426	503	15	55
10427	452	14	55
10428	192	9	65
13560	231	8	70
13561	599	13	62
13562	531	18	70
13563	202	17	65

6.6 CULVERTS

A site inspection of the culverts will occur prior to commencement of Longwall 301 to establish the condition of the culverts. The inspection will include:

- recording of existing cracks;
- recording of other defects and general condition;
- two dimensional image records of the affected structures; and
- condition of the access roads with specific attention to surface cracks.

The site inspection will be conducted by representative(s) from the RMS.

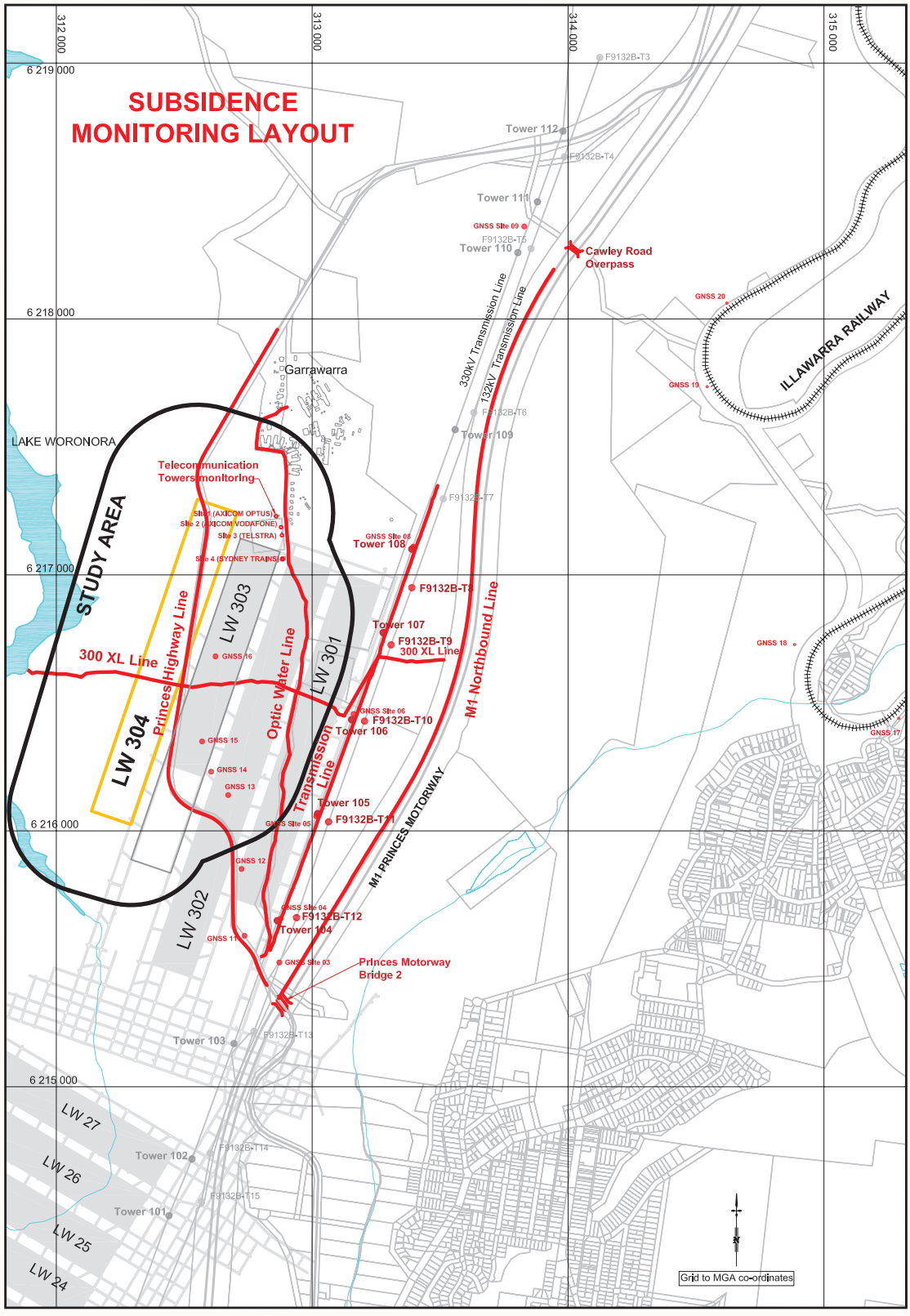
6.7 GROUND MONITORING

Several ground monitoring points are established over and near Longwalls 301-304. The details of ground monitoring are provided in Metropolitan Coal Longwall 304 Subsidence Monitoring Program (SMP). The monitoring locations include:

- 3D monitoring along the M1 Princes Motorway (Northbound Line);
- 3D monitoring along the transmission tower easement (Transmission Line); and
- 3D monitoring of 300 XL Line.

The locations of the monitoring lines are shown in Figure 6.

All ground monitoring locations have been installed and surveyed prior to the commencement of Longwall 301.



MEF-18-13_304 EP BFMP_017A

Source: MSEC (2019)

Peabody

METROPOLITAN COAL

Subsidence Monitoring Layout

Figure 6

7 MONITORING

7.1 GENERAL

A number of monitoring and inspection programs will be undertaken during mining, which are described in this section.

The results of monitoring and inspections will be reported to the Technical Committee within 48 hours of gathering the monitoring or inspection data.

All performance indicators and monitoring frequency would be reviewed by the Technical Committee in the event that performance indicators are exceeded.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts for comparison with baseline photographic records.

The RMS or their delegates will conduct the various visual inspections. Metropolitan Coal will be notified of the timing of inspections and accompany the RMS or delegates if considered necessary. All personnel will complete necessary inductions or orientation relevant to the tasks required.

An orientation meeting will be coordinated with the RMS Network Safety inspectors to ensure that they have an understanding of the information provided in this management plan.

7.2 BRIDGE MONITORING METHODS

As for Bridge 1 during the mining of Longwalls 20 to 27, Bridge 2 and Cawley Road Overbridge will be monitored by visual inspections and by measurements to determine the distortion of, and movements within, the structures.

Baseline visual inspections are carried out to identify any defects in the bridge that are present before ground movements due to mining can occur. Further visual inspections are carried out at key stages during longwall mining and when measurements taken indicate that ground movements may have caused adverse effects on the bridge. A baseline visual inspection of Bridges 1 and 2 was carried out before commencement of Longwall 20 and before commencement of Longwall 23. A further inspection of Bridge 2 and the initial baseline inspection of Cawley Road Overbridge was carried out prior to the extraction of Longwall 301.

As for Bridge 1, measurements of Bridge 2 and Cawley Road Overbridge to determine distortion and movements will include conventional survey of targets fixed to key points on the structures to determine relative movement between those points. These relative 3D survey measurements will be undertaken using an automated total station to an accuracy of ±2.5 mm. Relative 3D movements between each point and every other point on the same structure will be calculated from the survey measurements. Shade air temperatures will be recorded during any bridge survey to give an indication of change in temperature of the bridge structure, and hence thermal expansion.

Absolute 3D survey measurements of at least one key point on or fixed to the ground near each bridge will be taken to determine the overall movement of the bridge site. The absolute 3D survey will be undertaken using total station survey methods to an accuracy of ±12 mm, or using a new real time survey system that tracks absolute movements in real time (see below under heading ***Real-Time Monitoring***).

The absolute movements of the bridge sites from these surveys will be used to determine the commencement and frequency of relative 3D surveys on the basis that differential ground movement can only occur if there is significant absolute movement of the site.

Because the accuracy of the conventional 3D survey of targets is significantly less than desirable for the detection of structural distortions, an additional measurement system has been set up on Bridge 2. This system uses high accuracy FBG (Fibre Bragg Grating) sensors to measure the change in distance between key points on the bridge. The FBG sensor "cables" are suspended between their attachment points on the bridge, within protective conduits. The accuracy of length change measurement is better than 0.1mm.

While far more accurate that conventional survey, it is only feasible to monitor relative movement of some of the key points on the bridge using the FBG sensor system.

When of sufficient (triggered) magnitude, relative 3D movements between each point and every other point, calculated from the survey and FBG sensor measurements will be fed into the structural computer model of the bridge to determine whether the ground movement effects, in combination with other "in service" design loads and effects on the bridge (both existing permanent and potential transient) would have unacceptable consequences (excessive crack widths, crushing of concrete, etc).

Real-Time Monitoring

Metropolitan Coal trialled a new survey monitoring system during the extraction of Longwall 301 and Longwall 302 to provide single point real time absolute movements with higher accuracy and consistencies than traditional survey methods. A review by the Technical Committee has confirmed the system effectiveness and endorsed the use of real time monitoring in the BFMP-RMS as an additional management tool particularly effective when considering TARP triggers.

Shown in Figure 6, GNSS stations are installed nearby Bridge 2 and Cawley Road Bridge, additionally a line of GNSS stations provide real time data parallel to Longwall 301 and between the motorway and Longwall 301.

7.3 MONITORING OF BRIDGE 2 – OLD PRINCES HIGHWAY UNDERPASS

7.3.1 Relative 3D Survey

The system for relative 3D survey of this bridge using conventional survey equipment was installed prior to the commencement of Longwall 20. Subsequently, improvements to the survey monitoring system were identified and implemented to provide better quality survey results, particularly for the ground targets.

The locations of the bridge monitoring points (targets) are illustrated in Figures 7 to 15 and are summarised in Table 8.

It is noted that it has not been possible to achieve the ideal arrangement of monitoring points in which there would be points attached at each pier and abutment foundation. These are buried a significant distance below the ground surface. The diagrams have been drawn for Bridge 1. At Bridge 2, the pier pad footings are much closer to the ground surface so targets near the bottom of columns (suffix C) are much closer to the pad footings than indicated.

Table 8
Bridge 2 - 3D Survey Monitoring Locations

Carriageway	Location	Abutment A	Pier 1	Pier 2	Abutment B
North Bound Carriageway	South Column or Blade Wall	1H, 1D, 1D2	17H, 17D1, 17D2,17C, 17G	25H, 25D1,25D2, 25C, 25G	9H, 9D1, 9D2, 12.5G
	Internal Column or Blade Wall	-	18H, 18C, 18G	26H, 26C, 26G	-
	Internal Column or Blade Wall	-	19H, 19C, 19G	27H, 27C, 27G	-
	North Column or Blade Wall	4H, 4D1, 4D2, 4.5G	20H, 20D1, 20D2, 20C, 20G	28H, 28D1, 28D2 28C, 28G	12H, 12D1, 12D2, 12.5G
South Bound Carriageway	South Column or Blade Wall	5H, 5D, 4.5G	21H, 21D1, 21D2, 12G	29H, 29D1, 29D2, 29C, 29G	13H, 13D
	Internal Column or Blade Wall	-	22H, 22C, 22G	30H, 30C, 30G	-
	Internal Column or Blade Wall	-	23H, 23C, 23G	31H, 31C, 31G	-
	North Column or Blade Wall	8H, 8D	24H, 24D1, 24D2, 24C, 24G	32H, 32D1, 32D2 32C, 32G	16H, 16D

Notes:
H = face of headstock (facing old Princes Highway).
D = Deck girder – outside face on the bottom flange.
C = Column – close to ground level.
G = Ground adjacent to pier column or blade wall.

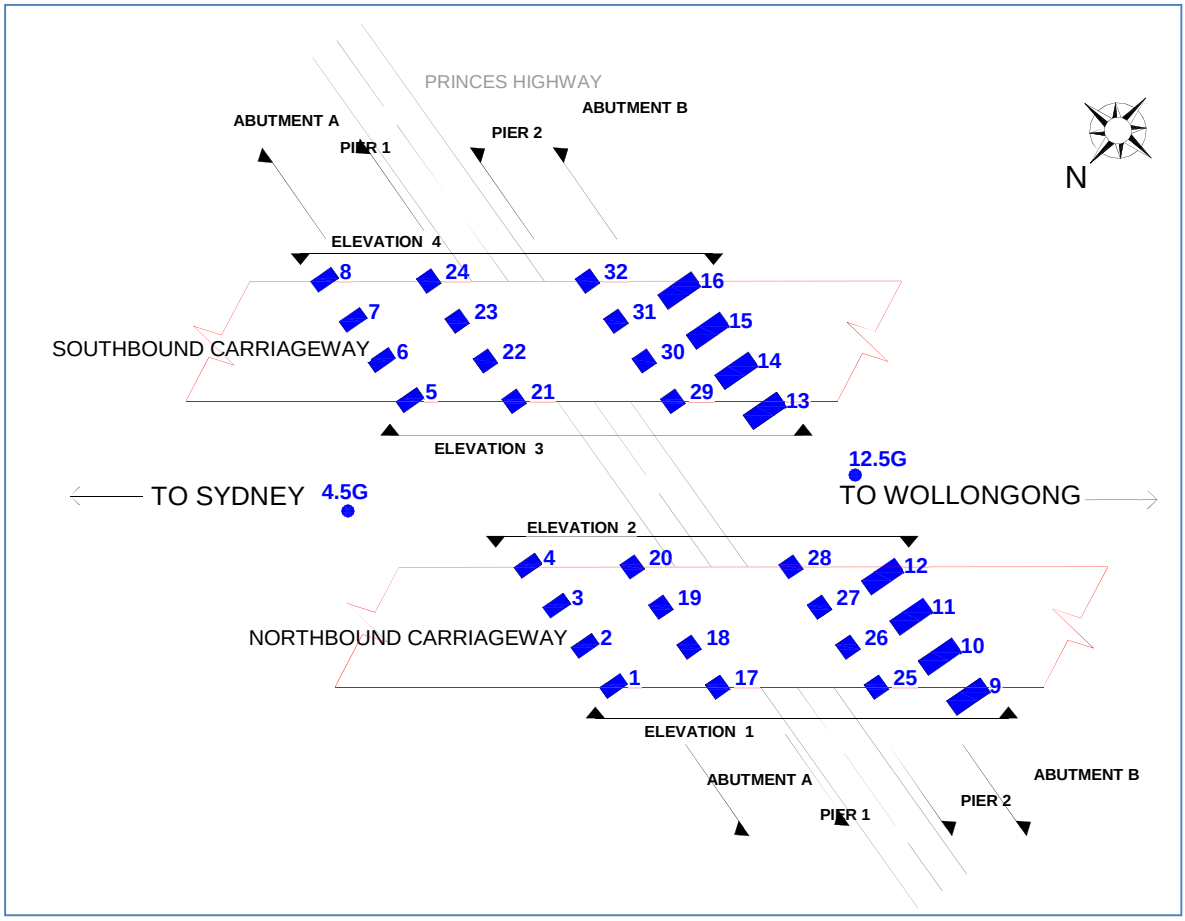


Figure 7: Bridge 2 - Column and Blade Wall Plan View

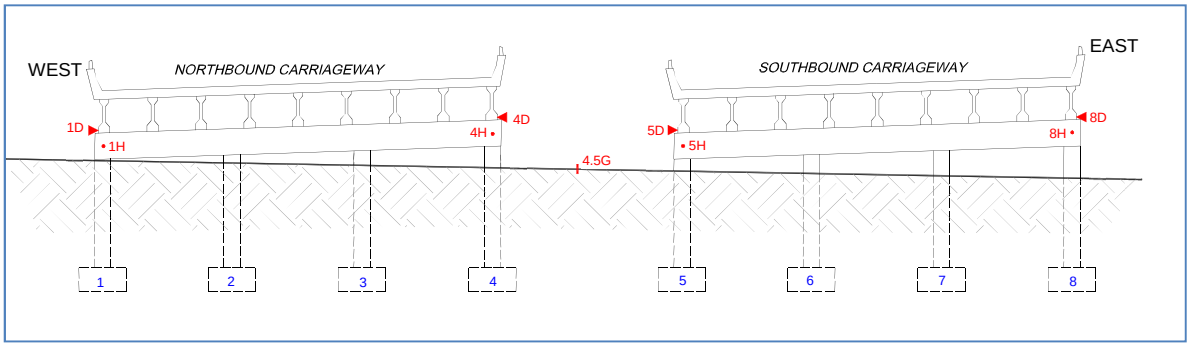


Figure 8: Bridge 2 - Abutment A – Relative 3D Monitoring Locations

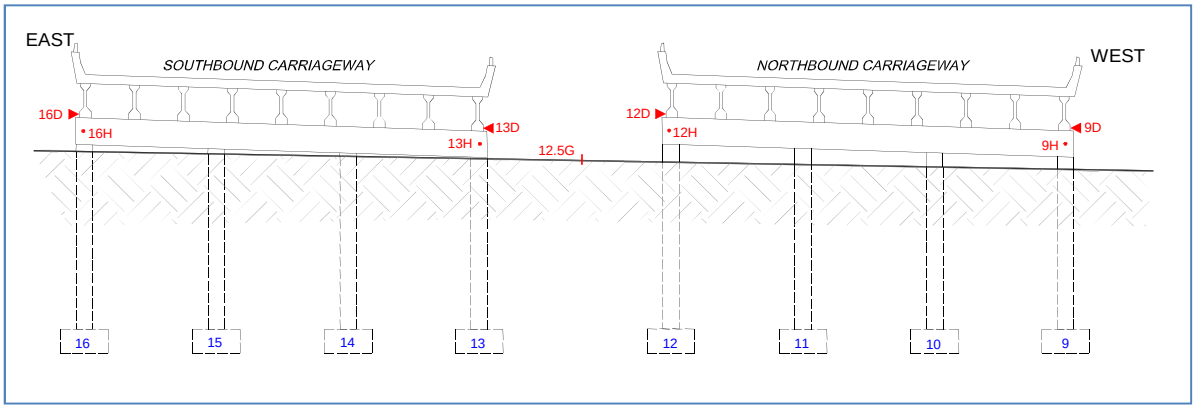


Figure 9: Bridge 2 - Abutment B – Relative 3D Monitoring Locations

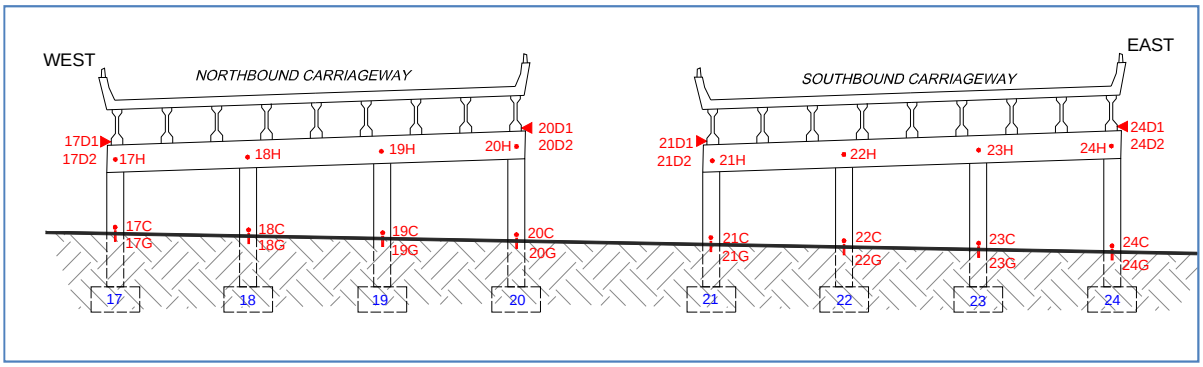


Figure 10: Bridge 2 - Pier 1 – Relative 3D Monitoring Locations

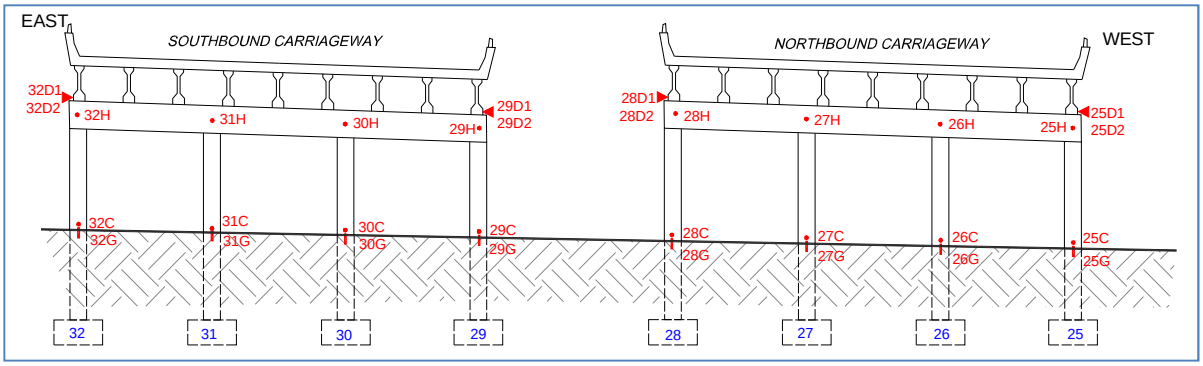


Figure 11: Bridge 2 - Pier 2 – Relative 3D Monitoring Locations

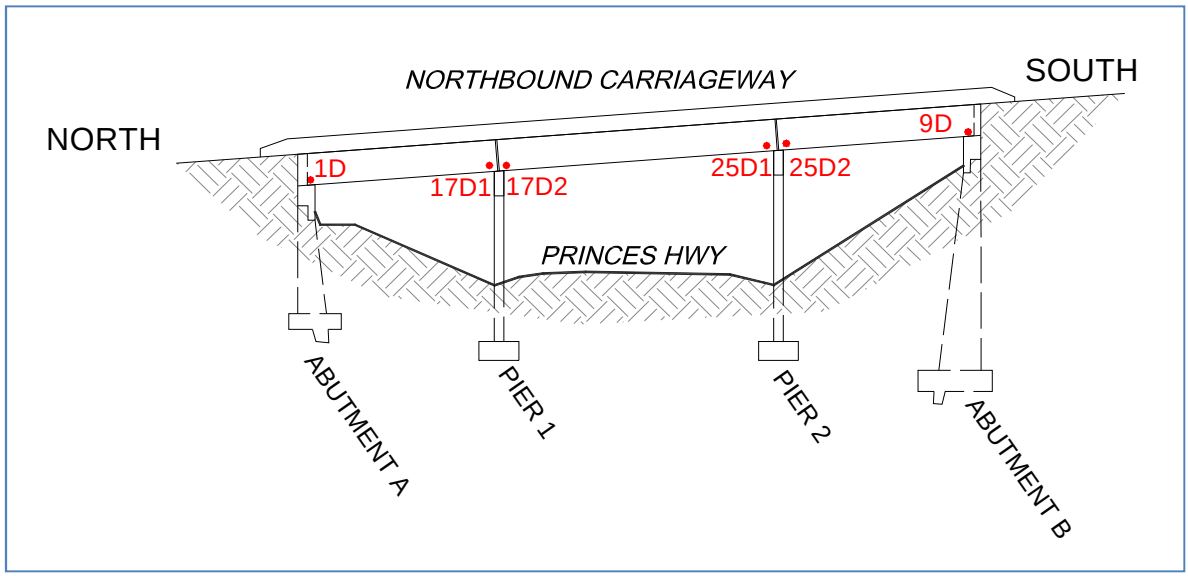


Figure 12: Bridge 2 - Deck Girders – Elevation 1 – Relative 3D Monitoring Locations

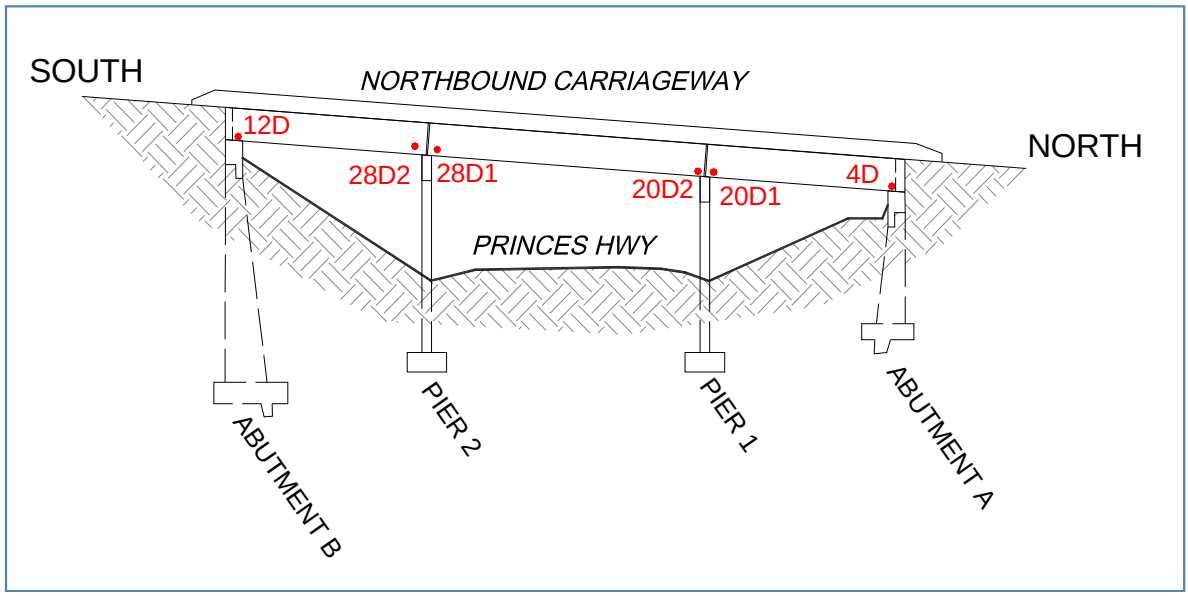


Figure 13: Bridge 2 - Deck Girders – Elevation 2 – Relative 3D Monitoring Locations

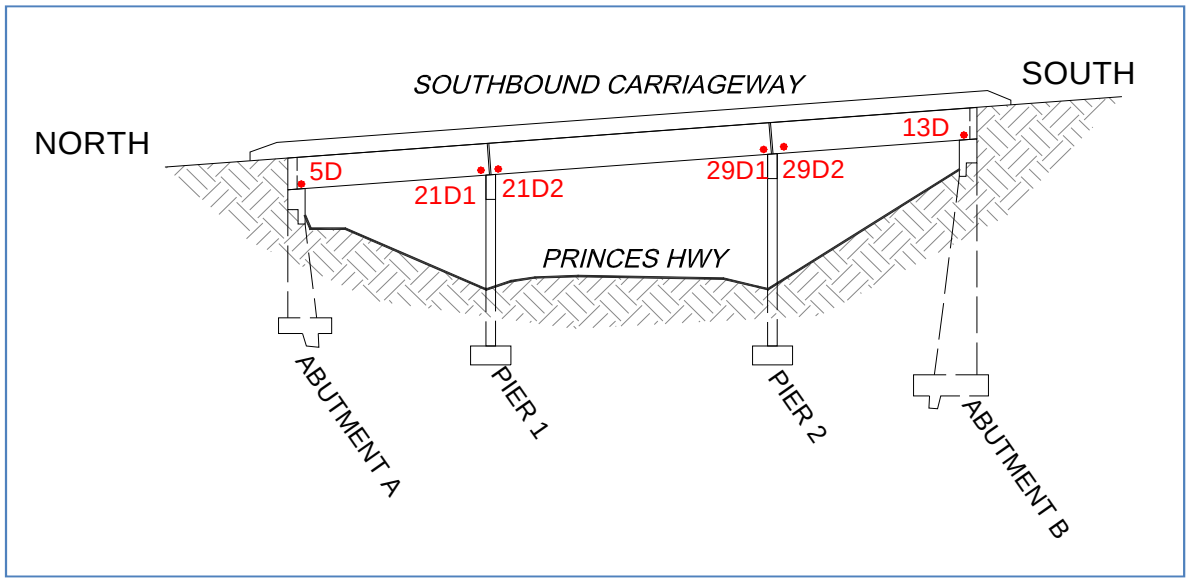


Figure 14: Bridge 2 - Deck Girders – Elevation 3 – Relative 3D Monitoring Locations

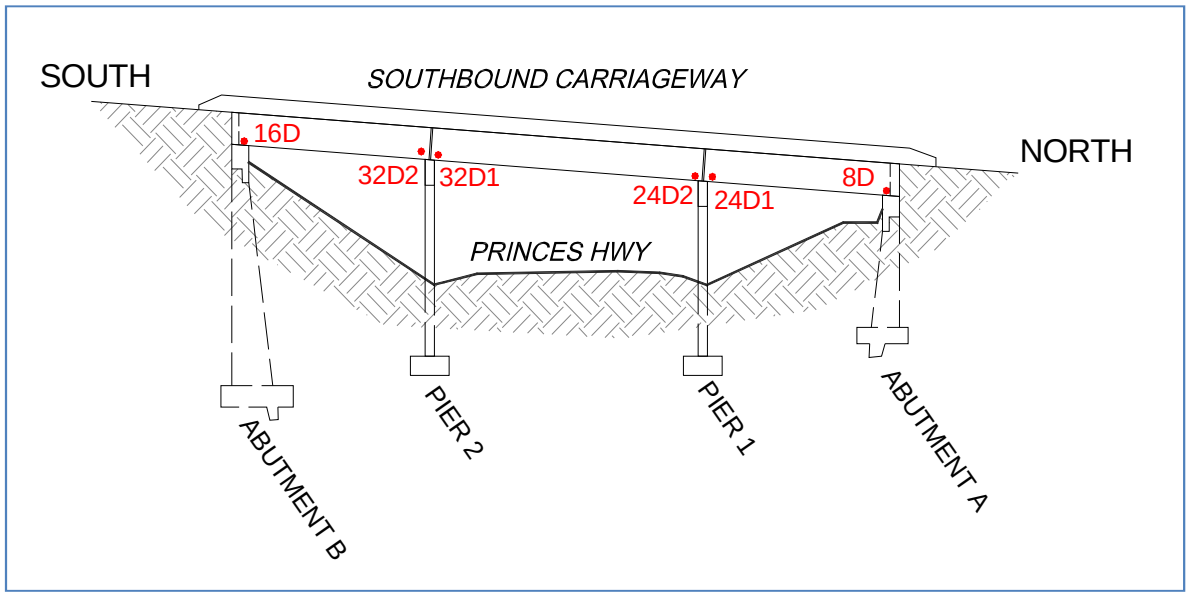


Figure 15: Bridge 2 - Deck Girders – Elevation 4 – Relative 3D Monitoring Locations

7.3.2 FBG Sensor Measurements

The Technical Committee decided that a system for high accuracy measurement of structure distortions using FBG sensors should be installed to monitor the relative horizontal movement between points at the end of each pier and abutment headstock and the transverse tilts of one outer column at each pier. Monitoring of in-plane and out-of–plane distortions of the pier frames using FBG ”extensometer” sensors was considered impractical to implement and monitoring of relative movements of other key points on the structure using these sensors was not physically possible.

Although only a limited number of key points on the bridge could be monitored using this system, it was considered to be beneficial because the high accuracy would allow early detection of small relative ground movements which could then be monitored more closely using all available methods.

The FBG sensor layout for monitoring the relative horizontal movement between points at the end of each pier and abutment headstock is shown on Figure 16. The FBG tiltmeter layout is shown on Figure 17.

From the change in length of each of the sensors shown in Figure 16, the horizontal movement of each attachment point, in the X and Y coordinate directions can be calculated mathematically. Those movements can then be fed into the computer model of the structure for assessment of the effects of the movement. Note that the capture of FBG sensor readings is largely automated.

The frequency of readings will be adjusted to suit monitoring requirements once diurnal and seasonal trends have been established with more frequent sampling rates, and will be conditioned to filter out changes due to traffic effects.

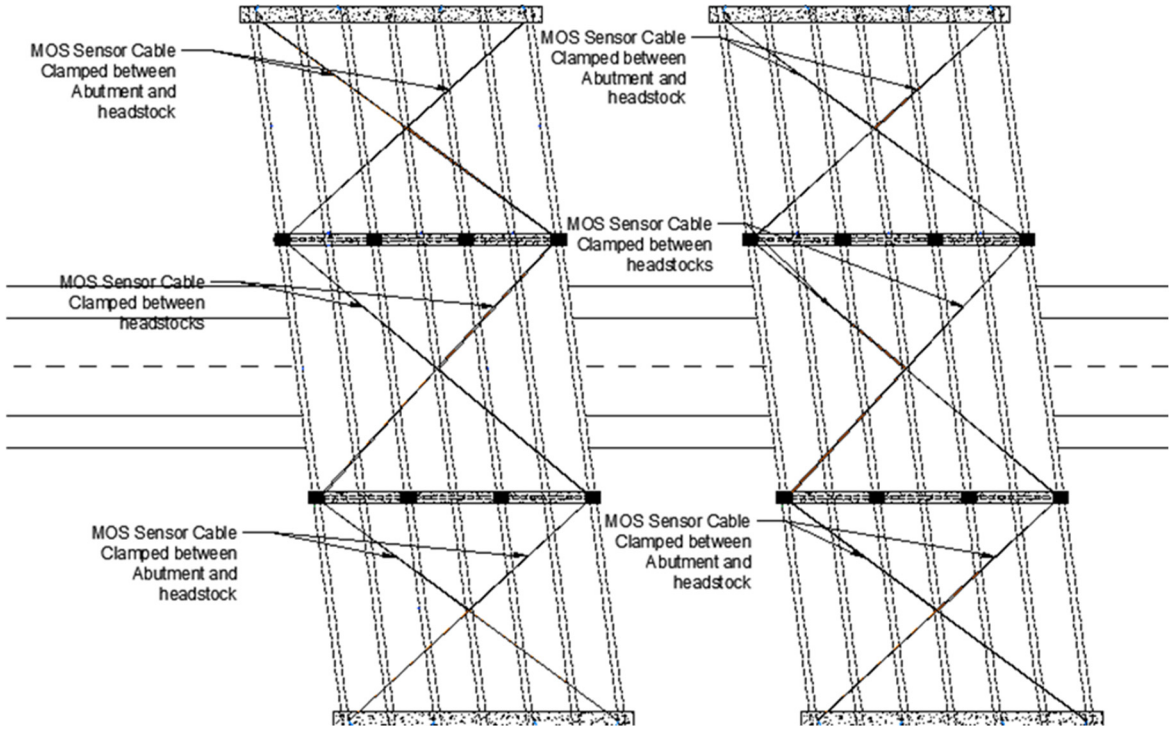


Figure 16: Bridge 2 - FBG Sensor Layout – Abutment Pier Headstocks

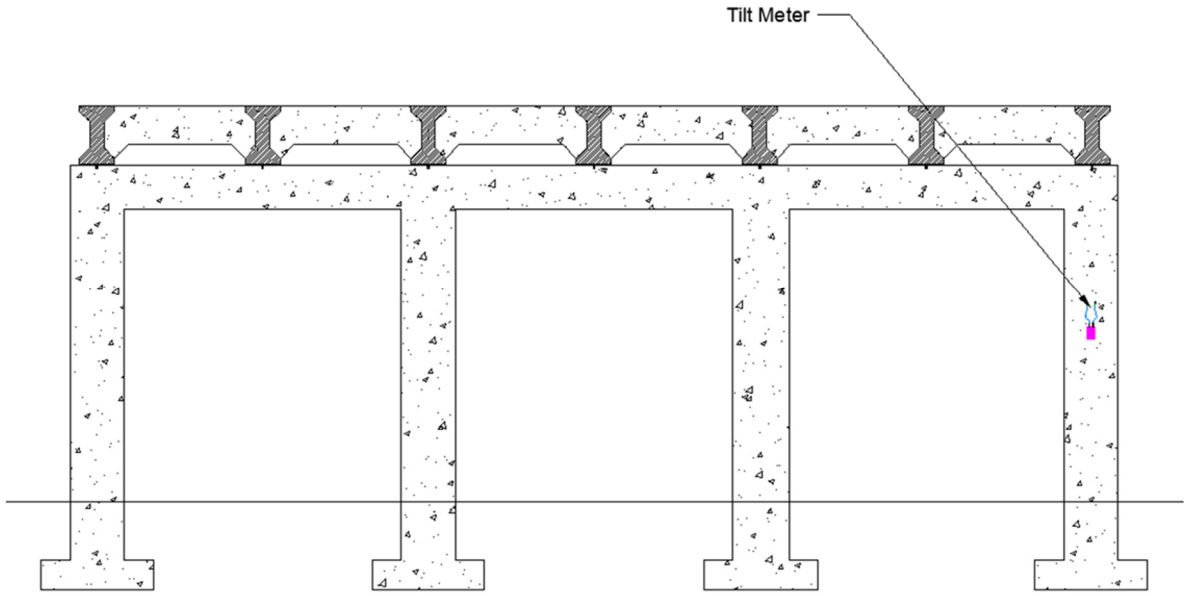


Figure 17: Bridge 2 - FBG Tiltmeter Layout – Pier Columns

7.3.3 Survey Frequency

Re-survey of Bridge 2 targets will occur:

- prior to extraction of Longwall 301; and
- within 3 months of the completion of each longwall (Longwalls 301, 302, 303 and 304).

Monitoring frequency of Bridge 2 will be reviewed if:

- absolute horizontal movement of survey lines (e.g. GNSS Site#3 Bridge 2 and M1 Princes Motorway Northbound Line) indicate more than 30 mm of horizontal movement;
- FBG sensor monitoring detects significant distortion of the structure;
- visual inspection indicates cracking; or
- if otherwise determined in consultation with the Technical Committee.

It is envisaged by the Technical Committee that the frequency of conventional survey monitoring, after 30 mm of absolute movement is measured or significant structure distortion is detected by the FBG sensor system, will be weekly. The frequency may be reduced if the FBG sensor system readings indicate that relative ground movements are developing slowly.

7.3.4 FBG Monitoring Frequency

Prior to and during the early stages of mining of Longwall 301, the FBG readings were taken on one day of each week.

The FBG monitoring frequency will be increased if determined in consultation with the Technical Committee although weekly readings should be sufficient, even if significant relative ground movements are occurring.

7.3.5 Visual Inspections

The most recent visual inspection of Bridge 2 was carried out in December 2018 for end of panel Longwall 302.

Visual inspection of Bridge 2 will be conducted at the completion of Longwalls 301, 302, 303 and 304 or otherwise if determined in consultation with the Technical Committee.

7.4 MONITORING OF CAWLEY ROAD OVERBRIDGE

7.4.1 Relative 3D Survey

The system for relative 3D survey of this bridge using conventional survey equipment was installed prior to the commencement of Longwall 301.

The locations of the bridge monitoring points (targets) are illustrated in Figure 18.

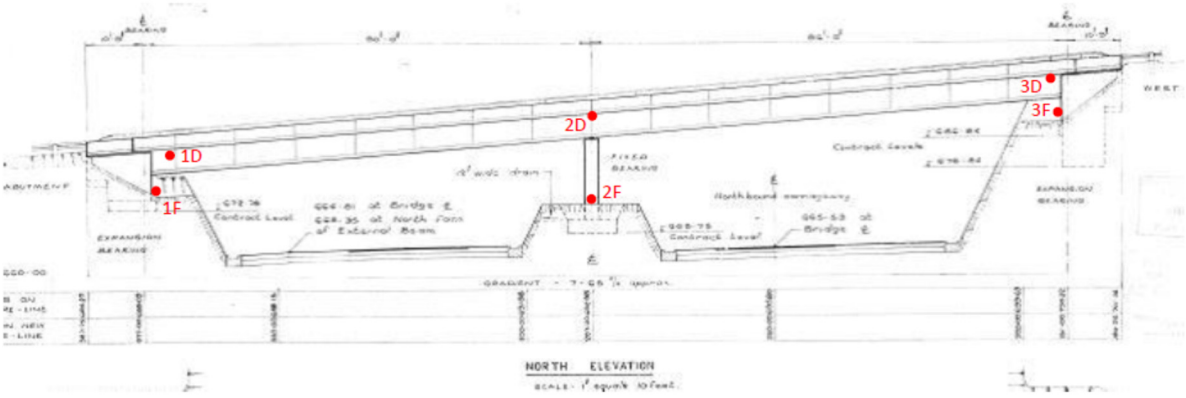


Figure 18: Cawley Road Overbridge – Survey Monitoring Points

7.4.2 Survey Frequency

Survey of Cawley Road Overbridge targets will occur:

- prior to extraction of Longwall 301 (baseline survey); and
- within 3 months of the completion of each longwall (Longwalls 301, 302, 303 and 304).

Monitoring frequency of Cawley Road Overbridge will be reviewed if:

- absolute horizontal movement of survey lines (e.g. GNSS Site #9 or M1 Princes Motorway Northbound Line) indicate more than 30 mm of horizontal movement;
- visual inspection indicates cracking; or
- if otherwise determined in consultation with the Technical Committee.

It is envisaged by the Technical Committee that the frequency of conventional survey monitoring, after 30 mm of absolute movement is measured, will be weekly.

7.4.3 Visual Inspections

A visual inspection was conducted prior to the extraction of Longwall 301. The most recent visual inspection of Cawley Road Overbridge was carried out in December 2018 for end of panel Longwall 302.

Visual inspection of Cawley Road Overbridge will be conducted at the completion of Longwalls 301, 302, 303 and 304 or otherwise if determined in consultation with the Technical Committee.

7.5 ROAD WORKS

The following monitoring will be undertaken during the mining of Longwalls 301-304.

7.5.1 Ground Monitoring

The M1 Princes Motorway Northbound monitoring line will be surveyed within 3 months following the completion of each longwall. The Technical Committee will analyse data from other monitoring lines to assist in assessing the requirement for increased monitoring frequency of the Northbound Line. Otherwise the frequency of ground monitoring lines is as follows:

- M1 Princes Motorway (Northbound Line): prior to Longwall 301, and after the completion of each of Longwall.
- Transmission Line: prior to Longwall 301, and after the completion of each of Longwall (and where available more frequently consistent with the BFMP-TransGrid reporting i.e. when mining is within 400 m of each survey point); and
- Cross line (300 XL Line): prior to Longwall 301, and after the completion of each of Longwall.
- Real time absolute 3D monitoring at GNSS stations being site 3, 4, 5, 6, 7, 8, & 9 located between motorway and Longwall 301.

7.5.2 RMS Road Mounted Monitoring Systems and Visual Monitoring

The pavement condition will be assessed from data obtained using the RMS RoadCrack, Gipsicam and Laser Profilometer pavement assessment systems in accordance with the RMS inspection program. More frequent assessments would be conducted if determined in consultation with the Technical Committee.

A site inspection of the pavement, kerbs and gutters, pits, signs and other road infrastructure will be carried out by the RMS following the completion of each longwall or more frequently if determined in consultation with the Technical Committee.

Regular visual inspections will be conducted during mining by representatives of the RMS as part of the RMS Network Safety Inspections. These inspections are carried out by a dedicated inspector twice weekly and any observed defects that represent a safety hazard will be reported to the Techncial Committee.

7.5.3 Cuttings

It was agreed by the Technical Committee that the risk of impacts to the cuttings and embankments along the M1 Princes Motorway was very low and slopes will be treated only when a change in their condition is noted.

Visual monitoring is undertaken to assess potential movement and or impacts to the cuttings. A site inspection of the cuttings will be conducted following the completion of each longwall, or more frequently if determined in consultation with the Technical Committee. The site inspection will be conducted by representative(s) from the RMS If, following any cutting inspection, there are any observable changes in the cutting face, a further risk assessment of that cutting is to be carried out. Treatment, if required will be based on the revised risk assessment. After completion of the treatment the cutting will be rated in accordance with the RMS Guide to Slope Risk Analysis (RMS, 2014).

Real time survey information is collected from the adjacent Transmission Line GNSS Sites. This survey data along with visual inspections are reviewed by the Technical Committee geotechnical and mining engineering specialists to assess the need for a survey of the M1 Northbound Line or an inspection of the cuttings. The Technical Committee, may as a result of the review, determine that survey of all or part of the M1 Northbound Line be carried out or that inspections be carried on some or all of the cuttings.

Regular visual inspections will be conducted during mining by representatives of the RMS as part of the RMS Network Safety Inspections. These inspections are carried out by a dedicated inspector twice weekly and any observed defects that represent a safety hazard will be reported to the Technical Committee.

7.5.4 Culverts

A site inspection of the culverts will occur (using CCTV) following the completion of each longwall or more frequently if determined in consultation with the Technical Committee. The inspection will include:

- recording of existing cracks;
- recording of other defects and general condition;
- two dimensional image records of the affected structures; and
- condition of the access roads with specific attention to surface cracks.

The site inspection will be conducted by representative(s) from the RMS.

7.6 MONITORING PROGRAM

The monitoring outlined above in this Section will be implemented to monitor the impacts of the Project on the RMS assets. Table 9 summarises the BFMP-RMS monitoring components.

Table 9
BFMP-RMS Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Baseline	Ground	Survey	Adjacent subsidence line points at approximately 20 m spacing	Establish base conditions	Prior to Longwall 301 extraction	Completed
	Bridge 2 (Old Princes Highway Underpass)	FBG	Changes in length of FBG sensors and tilts of FBG tiltmeters	To determine the range of movements due to environmental effects, (diurnal and seasonal).	Program of varying (diurnal and seasonal) sampling rates.	
	Cawley Road Overbridge	Survey (Absolute)	Survey reference pillar	Establish base condition	Prior to Longwall 301 extraction	Completed
		Survey (Relative 3D)	Survey all bridge monitoring points	Establish base condition	Prior to Longwall 301 extraction	Completed
	Other Infrastructure – Transmission Towers	Survey	4 x ground points outside each leg for each tower	Establish base conditions	Prior to Longwall 301 extraction	Completed
			4 x tower leg mounted prisms for each tower	Establish base condition	Prior to Longwall 301 extraction	Completed
			Earth wire peak point for each tower	Establish base condition	Prior to Longwall 301 extraction	Completed
	Cuttings	Condition Report (visual inspection)	Cuttings along the M1 Princes Motorway as described in Table 7 and shown on Figure 5	Establish base condition	Prior to Longwall 301 extraction	Completed
	Culverts	Condition Report		Establish base condition	Prior to Longwall 301 extraction	Completed
	Pavement and Other	Condition Report (visual inspection)	Asphaltic concrete surface	Establish base condition	Prior to Longwall 301 extraction	Completed
			Kerbs, gutters and pits	Establish base condition	Prior to Longwall 301 extraction	Completed
			Signs or other road infrastructure	Establish base condition	Prior to Longwall 301 extraction	Completed

Note: Baseline monitoring of all RMS assets will be carried out as outlined in Section 6.

Table 9 (Continued)
BFMP-RMS Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
During Mining	Ground	Survey	Adjacent subsidence line points at approximately 20 m spacing	Monitor subsidence effects during mining (subsidence, tilt, tensile strain, compressive strain, horizontal movement)	At the completion of each longwall	Once per Longwall 301, 302, 303 & 304
	Bridge 2 (Old Princes Highway Underpass)	Survey (Absolute 3D)	Absolute 3D movement of the survey reference pillar	To measure absolute ground movement at survey reference pillar and hence potential for relative movement of bridge elements	Real-time (continuous) monitoring at GNSS site #3 (Section 7.3.3)	
		Survey (Relative 3D)	Relative 3D movements of all bridge monitoring points	To measure distortion of structure	When active longwall mining is within 600 m of the bridge	Monthly, or Greater frequency or commencing earlier if determined in consultation with the Technical Committee
		FBG	Changes in length of FBG sensors and tilts of FBG tiltmeters	To measure distortion of structure	From the commencement of Longwall 301 extraction for a duration determined in consultation with the Technical Committee	Weekly Greater frequency if determined in consultation with the Technical Committee
		Visual Inspection for impacts on: • Abutments. • Pier frames. • Elastomeric bearings. • Soffits of girders. • Deck expansion joints. • Steel traffic barrier joints. • Other areas of substructure and adjoining areas including concrete paths, stairs, and slope protection.		To identify development of, or changes in existing: • Surface cracks. • Closing or opening of joints. • Distortion or damage to elastomeric bearings.	At the completion of each longwall Greater frequency if determined in consultation with the Technical Committee	Once per Longwall
	Cawley Road Overbridge	Survey (Absolute 3D)	Absolute 3D movement of the survey reference pillar	To measure absolute ground movement at survey reference pillar and hence potential for relative movement of bridge elements	Real-time (continuous) monitoring at GNSS Site #9 (Section 7.4.2)	

Table 9 (Continued)
BFMP-RMS Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
During Mining (Cont.)	Cawley Road Overbridge (Cont.)	Survey (Relative 3D)	Relative 3D movements of all bridge monitoring points	To measure distortion of structure	At the completion of each longwall	Once per Longwall 301, 302, 303 & 304
		Visual inspection for impacts on: • Abutments. • Pier blade wall. • Tetron bearings. • Deck expansion joints. • Steel traffic barrier and safety screen joints.		To identify development of, or changes in existing: • Surface cracks. • Closing or opening of joints. • Distortion or damage to Tetron bearings.	At the completion of each longwall	Once per Longwall
					Greater frequency if determined in consultation with the Technical Committee	
	Other Infrastructure - Towers (TL11-104 to TL11-108)	Survey	Adjacent transmission line real time absolute 3D movement monitors	Monitor subsidence effects during mining (subsidence, tilt, strain)	Real time continuous monitoring at GNSS Sites 4, 5, 6, 7, & 8	
			4 x ground points outside each leg for each tower	Monitor subsidence effects during mining (subsidence, tilt, strain, absolute horizontal translation)	At each tower within 400 m of the active longwall face until subsidence negligible, then at completion of each longwall	Weekly
			4 x tower leg mounted prisms for each tower	Monitor subsidence effects during mining (differential leg movement)	At each tower within 400 m of the active longwall face until subsidence negligible, then at completion of each longwall	Weekly
	Cuttings	Visual inspection for impacts on: • Cuttings along the M1 Princes Motorway as described in Table 7 and shown on Figure 5.		To identify: • Changes in cutting condition, including opening of cracks, spalling. • Changes in groundwater seepage or surface water flows. • Rockfalls. • Changes in RMS risk ranking.	At the completion of each longwall	Once per Longwall
					At a frequency determined in consultation with the Technical Committee after review of Transmission Line strain readings by the geotechnical and mine subsidence specialists (Transmission line is surveyed at weekly intervals within 400 m of the active longwall face) or RMS inspections	
		Network Safety Inspection (RMS)			During the extraction of	Twice Weekly

			Longwalls 301, 302 303 and 304	

Table 9 (Continued)
BFMP-RMS Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
During Mining (Cont.)	Culverts	CCTV inspection for impacts on internal surfaces		To identify changes to the visible surfaces of the culverts including cracking, buckling, shearing, and collapse	At the completion of each longwall	Once per Longwall
					More frequent if determined in consultation with the Technical Committee	
	Pavement and Other	Visual inspection for impacts on: • Asphaltic concrete surface. • Kerbs, gutters and pits. • Signs or other road infrastructure.		To identify development of, or changes in existing: • Asphaltic concrete surface including cracks, buckling and stepping. • Kerbs and gutters including cracking, buckling and joint movement.	At the completion of each longwall	Once per Longwall
					At a frequency determined in consultation with the Technical Committee after review of Transmission Line strain readings by the geotechnical and mine subsidence specialists	
		Network Safety Inspection (RMS)			During the extraction of Longwalls 301, 302, 303 and 304	Twice Weekly
		RoadCrack, Gipsicam and Laser Profilometer pavement assessment systems (RMS)			RMS inspection program	
Post Mining	Bridge 2 (Old Princes Highway Underpass)	Condition Report		Determine level of impact of mining (if any)	Within 3 months of the completion of Longwall 303 (or as otherwise agreed by the Technical Committee)	Once
	Cawley Road Overbridge	Condition Report		Determine level of impact of mining (if any)	Within 3 months of the completion of Longwall 303 (or as otherwise agreed by the Technical Committee)	Once

The frequency of monitoring will be reviewed either:

- in accordance with the Annual Review outlined in Section 12; or
- if triggered as a component of the Contingency Plan as outlined in Section 9.

7.7 SUBSIDENCE PARAMETERS

7.7.1 Ground Monitoring

Subsidence parameters (i.e. subsidence, tilt, tensile strain, and compressive strain) associated with ground movement will be measured in accordance with the Longwall 304 SMP. The ground monitoring locations are illustrated in Figure 6.

In summary, surveys will be conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence parameters (i.e. subsidence, tilt, tensile strain and compressive strain) will be calculated along subsidence lines that have been positioned across the general landscape, including:

- M1 Princes Motorway (Northbound Line);
- Transmission Line; and
- Cross line (300 XL).

With the exception of the direct survey of subsidence parameters along the M1 Princes Motorway, the subsidence parameters obtained from other ground monitoring surveys including the Transmission Line will be used for assessment of potential subsidence movements at the bridges or along the M1 Princes Motorway road pavement.

Survey of the Transmission Line is carried out consistent with the BFMP-TransGrid reporting requirements (i.e. when mining is within 400 m of each survey point). These surveys will be reviewed by the Technical Committee geotechnical and mining engineering specialists to assess the need for a survey of the M1 Northbound Line or an inspection of the cuttings. In addition, automated continuous GPS monitoring of the transmission tower bases is carried out during active mining and data from this monitoring system together with the visual inspections will be considered in the review. The Technical Committee, may as a result of the review, direct that survey of all or part of the M1 Northbound Line be carried out or that inspections be carried on some or all of the cuttings.

7.7.2 Bridge Monitoring

Bridge monitoring parameters are the potential distortional movements within the bridge structure resulting from the extraction of Longwalls 301-304. The monitoring systems to measure these parameters include surveying of targets fixed to key points on the bridges, and FBG sensors (extensometers and tiltmeters) for Bridge 2 only. These are described in 7.2 to 7.4 above.

Metropolitan Coal has installed real-time survey monitoring as an additional management tool that tracks absolute movements on a continuous basis via GPS at both bridges. The real-time data has been validated during the mining of Longwall 301 and 302 to provide information on the absolute movement of the ground nearby each bridge and inform the decision for other higher frequency monitoring.

7.8 SUBSIDENCE IMPACTS

7.8.1 Bridge Impacts

It is generally not possible to assess the impacts of relative ground movements on the bridges directly from the distortions of the bridges measured by the monitoring systems. This is because the ground movements could cause unacceptable stresses well before the effects of those stresses become visible. The pre-existing stresses in bridge elements from permanent loads (self weight etc) combined with those from relative ground movements may not be sufficient to cause an “overstress”. However, the addition of stresses from other transient loads and effects (vehicle loading, braking, wind, temperature, etc.) that could be applied at any time may be sufficient to instantly cause an overstress and so must be taken into account.

The method of assessing the impacts of relative ground movements on bridges is to carry out a structural analysis of the bridge using computer modelling. The distortions of the structure from ground movement, measured using the monitoring systems, are applied in those structural models to determine the component of total stress at each critical location in the structure that is due to relative ground movement. The analysis will determine stress magnitudes at various locations from permanent loads, relative ground movement and future transient effects.

The analysis can therefore determine when the effects of relative ground movement are reaching permissible limit such that the combined stress from all three load types (pre-existing, ground movements and future transient) are combined. It may be necessary to take action to prevent unacceptable impacts on the bridge well before any impact is visible, and this will be determined in consultation with the Technical Committee following its consideration of the structural analysis outcome of relative movements on Bridge 2.

Visual inspections of the bridge structures will be conducted by representative(s) from the RMS and the Technical Committee (e.g. Cardno) to assess any defects that have apparently resulted from the ground movements due to extraction of Longwalls 301-304.

For Bridge 2, inspections will include the following bridge elements and areas:

- visible surfaces of abutments – front and top surfaces of abutment headstocks, inside face of curtain walls where visible and faces of blade walls at the junction with the headstock (where they are exposed);
- visible surfaces of pier frames – all faces of each column (above ground) and four sides of headstock;
- elastomeric bearings at the abutments and piers;
- soffits of girders around the bearings at piers (where excessive force from dowels would result in cracking); and
- deck expansion joints and steel traffic barrier joints at the abutments.

Other areas of the substructure should also be inspected generally with particular attention to locations where the substructure abuts and is hard against rigid pavement, concrete stairs and slope protection, etc.

For Cawley Road Overbridge, inspections will include the following bridge elements and areas:

- visible surfaces of abutments;
- visible surfaces of pier blade wall;

- Tetron bearings at the abutments; and
- deck expansion joints and steel traffic barrier joints at the abutments.

7.8.2 Pavement Impacts

In addition to monitoring of subsidence parameters for the M1 Princes Motorway road pavement, subsidence impacts will be assessed along the pavement using the RMS RoadCrack, Gipsicam and Laser Profilometer pavement assessment systems.

Visual inspections of the road pavement, kerbs and gutters, pits, signs and other road infrastructure will be carried out by representative(s) from the RMS to assess changes from the baseline condition as a result of the extraction of Longwalls 301-304. Twice weekly drive through visual inspections will also be conducted as part of the RMS Network Safety Inspections with particular focus on impacts in the vicinity of the faults.

Subsidence impacts will be monitored using the above methods for both carriageways of the pavement extending from a distance south of Bridge 2 (as determined in consultation with the Technical Committee) to Cawley Road Overbridge.

7.8.3 Impacts to Cuttings

Visual monitoring would be undertaken to assess potential movement and/or impacts to the cuttings resulting from the extraction of Longwalls 301-304. Twice weekly drive through visual inspections will also be conducted as part of the RMS Network Safety Inspections.

If, following any cutting inspection, there are any observable changes in the cutting face, a further risk assessment of that cutting is to be carried out. Treatment, if required will be based on the revised risk assessment. After completion of the treatment the cutting will be rated in accordance with the RMS Guide to Slope Risk Analysis (RMS, 2014).

7.8.4 Impacts to Culverts

Visual inspection of the culverts will be carried out using CCTV to provide an assessment of the condition of the culverts. The inspection will be carried out by representative(s) from the RMS. The inspection will include:

- recording of existing cracks;
- recording of other defects and general condition;
- video records of the affected structures; and
- condition of the access roads with specific attention to surface cracks.

7.9 ENVIRONMENTAL CONSEQUENCES

Metropolitan Coal and RMS will compare the results of the subsidence impact monitoring against the built features performance indicators. In the event that the observed subsidence impacts exceed the performance indicators, Metropolitan Coal and RMS will assess the consequences of the exceedance in accordance with the management measures outlined in Section 8. In the event that the performance measures are exceeded or are considered likely to be exceeded in the absence of contingent actions, then the Contingency Plan described in Section 9 will be implemented.

8 MANAGEMENT MEASURES

8.1 GENERAL

A number of general management measures in relation to RMS assets are applicable. These include:

- review of scope and frequency of monitoring;
- site inspections;
- review by relevant specialists;
- initiate traffic management procedures;
- review of the potential factors contributing to the exceedance of the performance trigger including review of subsidence measurements and predictions; and
- review effectiveness of management measures.

8.2 BRIDGES

Potential management measures that can be implemented for Bridge 2 and Cawley Road Overbridge include repair of cracked elements where the crack width is within the acceptable limit. This can be carried out after ground movements due to mining have ceased as their presence during mining does not affect to safe operation of the bridge.

At Cawley Road Overbridge, replacement of guided sliding bearings at abutments could also be carried out.

8.3 ROAD PAVEMENTS

A number of potential management measures in relation to the M1 Princes Motorway pavement are considered to be applicable. These include:

- mill and replace pavement layers;
- slotting; and
- crack sealing.

During the risk assessment, it was also noted that the planned re-surfacing of the carriageway by RMS to remediate general road use wear and tear may be able to be scheduled after Longwall 303 has been mined (i.e. early 2019). This may provide an opportunity to remediate the road if any pavement damage was caused by the mining activities, as well as general road use wear and tear. The planned re-surfacing timing however may be subject to change and will be determined by the RMS.

8.4 CUTTINGS

A number of potential management measures in relation to cuttings are considered to be applicable. These include:

- rock bolting;
- scaling;
- shotcreting;
- installation of rockfall mesh;

- installation of barriers; and
- trimming of the cut face.

8.5 CULVERTS

A number of potential management measures in relation to culverts are considered to be applicable. These include:

- point repairs;
- lining;
- grouting; and
- culvert replacement.

9 CONTINGENCY PLAN

In the event that the observed subsidence parameters or impacts exceed or are considered likely to exceed the performance measures detailed in Section 5 of this BFMP-RMS, Metropolitan Coal will implement the following Contingency Plan (Appendix 7):

- The observation will be reported to the Manager - Technical Services within 24 hours.
- The observation will be recorded in the Built Features Management Plan – Subsidence Impact Register (Appendix 6) consistent with the monitoring program described in Section 7 of this BFMP-RMS.
- Metropolitan Coal will report any exceedance of the performance measure to the DP&E and the RMS as soon as practicable after Metropolitan Coal becomes aware of the exceedance.
- Metropolitan Coal and the RMS will assess public safety and where appropriate implement safety measures in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan and the NSW *Roads Act, 2003*.
- Metropolitan Coal will conduct an investigation to evaluate the potential contributing factors. The investigation will:
  - include the re-survey of relevant subsidence monitoring lines;
  - compare and critically analyse measured versus predicted subsidence parameters;
  - review measured subsidence parameters against the observed impact; and
  - review the SMP and update the program where appropriate.
- Metropolitan Coal will identify an appropriate course of action with respect to the identified impact(s), in consultation with specialists, relevant agencies, and the RMS. For example:
  - proposed contingency measures;
  - a program to review the effectiveness of the contingency measures; and
  - consideration of modification to the mine layout under circumstances where unacceptable impacts to the bridges or pavements would otherwise be unmanageable.
- Contingency measures will be developed in consideration of the specific circumstances of the issue and the assessment of consequences. Contingency measures include those described in Section 8 and Section 9.1.

- Metropolitan Coal will submit the proposed course of action to the DP&E for approval.
- Metropolitan Coal will implement the approved course of action to the satisfaction of the DP&E.

In accordance with Condition 6, Schedule 6 of the Project Approval, Metropolitan Coal will provide a suitable offset to compensate for the impact to the satisfaction of the Director-General (now Secretary) of DP&E if either the contingency measures implemented by Metropolitan Coal have failed to remediate the impact or the Director-General (now Secretary) determines that it is not reasonable or feasible to remediate the impact.

9.1 CONTINGENCY MEASURES

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of environmental consequences).

Contingency measures that could be considered in the event that the performance measure for the relevant asset is exceeded (e.g. damaged beyond repair) are summarised in Table 10. The decision trees for the contingency measures are shown in Appendix 7.

In the remote event traffic diversions are required due to subsidence impacts, an alternate travel route along the Old Princes Highway may be available (subject to consultation and agreement with Wollongong City Council). This route may therefore be available for the period required to effect such contingency measures summarised in Table 10.

Table 10
Contingency Measures – RMS Assets

Environmental Consequence	Contingency Measures	
	Measure	**Description**
General	-	• Reconfigure mining geometry. • Reduce rate of extraction.
Impact on:		
Bridges	Replace bridge.	• Complete replacement of the bridge with a new bridge structure. • Erect temporary bridge. • Staged replacement.
	Stabilise bridge.	• Erect temporary bridge props/supports. • Contraflow arrangements using one of the two bridges.
M1 Princes Motorway road pavement	Major repairs.	• Major reconstruction of a section of the motorway.
Cuts and Fills	Stabilisation measures.	• Reconstruct the cutting or fill.
Culverts	Replacement.	• Reconstruct the culvert.

10 TARP – MANAGEMENT TOOL

The framework for the various components of the BFMP-RMS are summarised in the BFMP-RMS Trigger Action Response Plans (TARPs) shown in Tables 11 to 15. The BFMP-RMS TARPs illustrate how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

The TARP comprises:

- baseline conditions;
- predicted subsidence impacts;
- trigger levels from monitoring to assess performance; and
- triggers that flag implementation of contingency measures.

The TARP system provides a simple and transparent snapshot of the monitoring of environmental performance and the implementation of management and/or contingency measures.

Table 11
Trigger Action Response Plan – Bridge 2 (Old Princes Highway Underpass)

<table>
<tr><td colspan="4">RMS – Bridge 2 (Old Princes Highway Underpass)</td></tr>
<tr><td rowspan="6">RMS – Bridge 2 (Old Princes Highway Underpass)</td><td colspan="3">Risk: Subsidence effect on bridge structure resulting in impact to structural integrity.</td></tr>
<tr><td>TRIGGER LEVEL</td><td colspan="2">RESPONSE</td></tr>
<tr><td colspan="3">Level 1 - Normal
Expected subsidence conditions</td></tr>
<tr><td>Subsidence
• less than 20 mm
Absolute Horizontal Movements
• less than 95 mm at the base*
Incremental Relative Movement (FBG)
• opening less than 8.0 mm
• closing less than 6.0 mm</td><td colspan="2"><u>Normal Operations</u>
• Bridge is safe and serviceable.
• Negligible impact to bridge structure.
• Continue monitoring activities as planned.
<u>Metropolitan Coal</u>
* Weekly monitoring to commence upon greater than 30 mm absolute horizontal movement or FBG recording greater than 2.0 mm.</td></tr>
<tr><td colspan="3">Level 2 - Monitor
Subsidence more than predicted (e.g. beyond survey tolerance) and up to 1 in ~100 probability, but bridge condition normal</td></tr>
<tr><td>Subsidence
• between 20 and 30 mm
Absolute Horizontal Movements
• between 95 and 105 mm at the base
Incremental Relative Movement (FBG)
• opening between 8.0 and 14.0 mm
• closing between 6.0 and 13.0 mm
Structural cracks less than 0.1 mm</td><td colspan="2"><u>Conditions: Continue operations but report on subsidence anomaly</u>
• Bridge is safe and serviceable.
• Impact on bridge structure is within tolerable limits or no credible consequences.
<u>Metropolitan Coal (actions as required)</u>
• Resurvey subsidence line, ground points and FBG to confirm results, and that the results are consistent with other subsidence lines.
• Inform and provide the report on subsidence results to RMS, NSW Principal Subsidence Engineer and Subsidence Advisory NSW.
<u>RMS (Technical Committee)</u>
• Technical Committee subsidence specialists to review monitoring data and assess results for trends, and forecast when the Level 3 trigger might be exceeded.
• Technical Committee to consider whether:
o to increase the frequency of survey and site inspections; and
o any mitigation measures or additional management measures are required to avoid exceeding the Level 3 trigger.</td><td><u>Timing / Frequency</u>
• Within 3 days.
• Within 7 days.
<u>Timing / Frequency</u>
• Within 7 days.
• Within 7 days.</td></tr>
</table>

Table 11 (Continued)
Trigger Action Response Plan – Bridge 2 (Old Princes Highway Underpass)

<table>
<tr><td colspan="4">RMS – Bridge 2 (Old Princes Highway Underpass)</td></tr>
<tr><td rowspan="6">RMS – Bridge 2 (Old Princes Highway Underpass)</td><td colspan="3">Risk: Subsidence effect on bridge structure resulting in impact to structural integrity.</td></tr>
<tr><td>TRIGGER LEVEL</td><td colspan="2">RESPONSE</td></tr>
<tr><td colspan="3">Level 3 - Cautionary
Anomalous differential bridge movement or subsidence beyond +15% of predicted or exceedance of nominated 1 in ~100 probability</td></tr>
<tr><td>Subsidence
• greater than 30 mm
Absolute Horizontal Movements
• greater than 105 mm at the base
Observable subsidence ground deformations at the bridge
Incremental Relative Movement (FBG)
• opening between 14.0 and 44.0 mm
• closing between 13.0 and 44.0 mm
Structural cracks between 0.1 mm and 1.0 mm width</td><td colspan="2"><u>Conditions: Investigate & Resolve</u>
• Bridge is safe and serviceable.
• Indication of impact to bridge structure including structural cracks between 0.1 mm and 1.0 mm width.
• Works to affect Old Princess Highway, not the M1 Motorway.</td></tr>
<tr><td colspan="2"><u>Metropolitan Coal (actions as required)</u>
• Notify RMS, NSW Principal Subsidence Engineer, Subsidence Advisory NSW, and the Technical Committee that survey results show the trigger was exceeded and provide a report on the subsidence results.
• Provide a report to the NSW Principal Subsidence Engineer on how the Level 3 situation is being managed to keep the bridge safe and serviceable.</td><td><u>Timing / Frequency</u>
• Within 24 hours.
• Within 2 weeks.</td></tr>
<tr><td colspan="2"><u>RMS (Works Supervisor)</u>
• Inspect and assess condition of bridge at trigger point and general area, determine if any remedial action required, and advise Technical Committee.</td><td><u>Timing / Frequency</u>
• Within 4 hours of notification.</td></tr>
<tr><td colspan="2"><u>RMS (Technical Committee)</u>
• Technical Committee subsidence specialists to review monitoring data and assess results for trends, and forecast when the Level 4 trigger might be reached.
• Technical Committee to consider whether to:
o increase survey and/or inspection frequencies;
o take any mitigation/additional management measures, including erecting temporary bridge props/supports or bringing forward the end-of-panel position, to avoid reaching the Level 4 trigger;
o employ a dedicated Inspector on site on full time basis; and/or
o suggest the need for a speed restriction or traffic diversions to RMS,
and implement decisions following RMS and Metropolitan Coal concurrence.</td><td><u>Timing / Frequency</u>
• Within 3 days.
• Within 5 days.</td></tr>
</table>

Table 11 (Continued)
Trigger Action Response Plan – Bridge 2 (Old Princes Highway Underpass)

<table>
<tr><td colspan="4">RMS – Bridge 2 (Old Princes Highway Underpass)</td></tr>
<tr><td rowspan="8">RMS – Bridge 2 (Old Princes Highway Underpass)</td><td colspan="3">Risk: Subsidence effect on bridge structure resulting in impact to structural integrity.</td></tr>
<tr><td>TRIGGER LEVEL</td><td colspan="2">RESPONSE</td></tr>
<tr><td colspan="3">Level 4 – Restoration
Exceedance of nominated 1 in ~2000 probability or fault occurs</td></tr>
<tr><td rowspan="5">Fault Occurs
Incremental Relative Movement (FBG)
• opening greater than 44.0 mm
• closing greater than 44.0 mm
Structural cracks greater than 1.0 mm width</td><td colspan="2"><u>Implement Contingency Plan</u>
• As per BFMP Section 9 and Appendix 7.</td></tr>
<tr><td><u>Metropolitan Coal (actions under the circumstances)</u>
• Notify RMS, NSW Principal Subsidence Engineer, Subsidence Advisory NSW, and the Technical Committee of the Level 4 situation.</td><td><u>Timing / Frequency</u>
• Within 2 hours.</td></tr>
<tr><td><u>RMS (Works Supervisor)</u>
• Notify RMS Traffic Commander via Transport Management Centre to immediately apply speed restriction. Phone 131 700
• Inspect and assess condition of bridge at trigger point and general area, initiate any remedial action as required, and advise Technical Committee.</td><td><u>Timing / Frequency</u>
• Immediately upon notification. Phone 131 700 Transport Management Centre
• Immediate callout and arrive within 2 hours.</td></tr>
<tr><td><u>RMS (Traffic Commander) and NSW Police</u>
• RMS Traffic Commander and NSW Police apply and enforce speed restriction, and determine if a detour is necessary.</td><td><u>Timing / Frequency</u>
• Immediate callout and arrive within 2 hours.</td></tr>
<tr><td><u>RMS (Technical Committee)</u>
• Technical Committee to review monitoring data and consider whether to:
o increase survey and/or inspection frequencies;
o take any additional management measures, including erecting temporary bridge props/supports or bringing forward the end-of-panel position; and/or
o suggest the need for mining to be temporarily halted (if unacceptable to RMS);
and implement decisions following RMS and Metropolitan Coal concurrence.</td><td><u>Timing / Frequency</u>
• Within 3 days.</td></tr>
</table>

Table 12
Trigger Action Response Plan – Cawley Road Overpass

<table>
<tr><td colspan="4">RMS – Cawley Road Overpass</td></tr>
<tr><td rowspan="11">RMS – Cawley Road Overpass</td><td colspan="3">Risk: Subsidence effect on bridge structure resulting in impact to structural integrity.</td></tr>
<tr><td>TRIGGER LEVEL</td><td colspan="2">RESPONSE</td></tr>
<tr><td colspan="3">Level 1 - Normal
Expected subsidence conditions</td></tr>
<tr><td>Subsidence
• less than 20 mm
Absolute Horizontal Movements
• less than 20 mm at the base
Incremental Relative Movement
• opening less than 5.0 mm
• closing less than 5.0 mm</td><td colspan="2"><u>Normal Operations</u>
• Bridge is safe and serviceable.
• Negligible impact to bridge structure.
• Continue monitoring activities as planned.</td></tr>
<tr><td colspan="3">Level 2 - Monitor
Subsidence more than predicted (e.g. beyond survey tolerance) or 1 in ~100 probability exceedance, but bridge condition normal</td></tr>
<tr><td rowspan="3">Subsidence
• between 20 and 30 mm
Absolute Horizontal Movements
• between 20 and 30 mm at the base
Incremental Relative Movement
• opening between 5.0 and 7.0 mm
• closing between 5.0 and 9.0 mm
Structural cracks less than 0.1 mm</td><td colspan="2"><u>Conditions: Continue operations but report on subsidence anomaly</u>
• Bridge is safe and serviceable.
• Impact on bridge structure is within tolerable limits.</td></tr>
<tr><td><u>Metropolitan Coal (actions as required)</u>
• Resurvey bridge points to confirm results.
• Inform and provide the report on subsidence results to RMS, NSW Principal Subsidence Engineer and Subsidence Advisory NSW.</td><td><u>Timing / Frequency</u>
• Within 3 days.
• Within 7 days.</td></tr>
<tr><td><u>RMS (Technical Committee)</u>
• Technical Committee subsidence specialists to review monitoring data and assess results for trends, and forecast when the Level 3 trigger might be exceeded.
• Technical Committee to consider whether:
o to increase the frequency of survey and site inspections; and
o any mitigation measures or additional management measures are required to avoid exceeding the Level 3 trigger.</td><td><u>Timing / Frequency</u>
• Within 7 days.
• Within 7 days.</td></tr>
</table>

Table 12 (Continued)
Trigger Action Response Plan – Cawley Road Overpass

<table>
<tr><td colspan="4">RMS – Cawley Road Overpass</td></tr>
<tr><td rowspan="8">RMS – Cawley Road Overpass</td><td colspan="3">Risk: Subsidence effect on bridge structure resulting in impact to structural integrity.</td></tr>
<tr><td>TRIGGER LEVEL</td><td colspan="2">RESPONSE</td></tr>
<tr><td colspan="3">Level 3 - Cautionary
Anomalous differential bridge movement or subsidence beyond +15% of predicted or exceedance of nominated 1 in ~100 probability</td></tr>
<tr><td rowspan="4">Subsidence
• greater than 30 mm
Absolute Horizontal Movements
• greater than 30 mm at the base
Observable subsidence ground deformations at the bridge
Incremental Relative Movement
• opening between 7.0 and 14.0 mm
• closing between 9.0 and 19.0 mm
If M1 Motorway absolute horizontal movement greater than 30 mm within 400 m of bridge
Structural cracks between 0.1 mm and 1.0 mm width</td><td colspan="2"><u>Conditions: Investigate & Resolve</u>
• Bridge is safe and serviceable.
• Indication of impact to bridge structure including structural cracks between 0.1 mm and 1.0 mm width.</td></tr>
<tr><td><u>Metropolitan Coal (actions as required)</u>
• Notify RMS, NSW Principal Subsidence Engineer, Subsidence Advisory NSW, and the Technical Committee that survey results show the trigger was exceeded and provide a report on the subsidence results.
• Provide a report to the NSW Principal Subsidence Engineer on how the Level 3 situation is being managed to keep the bridge safe and serviceable.</td><td><u>Timing / Frequency</u>
• Within 24 hours.
• Within 2 weeks.</td></tr>
<tr><td><u>RMS (Works Supervisor)</u>
• Inspect and assess condition of bridge at trigger point and general area, determine if any remedial action required, and advise Technical Committee.</td><td><u>Timing / Frequency</u>
• Within 4 hours of notification.</td></tr>
<tr><td><u>RMS (Technical Committee)</u>
• Technical Committee subsidence specialists to review monitoring data and assess results for trends, and forecast when the Level 4 trigger might be reached.
• Technical Committee to consider whether to:
o increase survey and/or inspection frequencies;
o take any mitigation/additional management measures, including erecting temporary bridge props/supports or bringing forward the end-of-panel position, to avoid reaching the Level 4 trigger;
o employ a dedicated Inspector on site on full time basis; and/or
o suggest the need for a speed restriction or traffic diversions to RMS,
and implement decisions following RMS and Metropolitan Coal concurrence.</td><td><u>Timing / Frequency</u>
• Within 3 days.
• Within 5 days.</td></tr>
</table>

Table 12 (Continued)
Trigger Action Response Plan – Cawley Road Overpass

<table>
<tr><td colspan="4">RMS – Cawley Road Overpass</td></tr>
<tr><td rowspan="8">RMS – Cawley Road Overpass</td><td colspan="3">Risk: Subsidence effect on bridge structure resulting in impact to structural integrity.</td></tr>
<tr><td>TRIGGER LEVEL</td><td colspan="2">RESPONSE</td></tr>
<tr><td colspan="3">Level 4 – Restoration
Exceedance of nominated 1 in ~2000 probability or fault occurs</td></tr>
<tr><td rowspan="5">Fault Occurs
Incremental Relative Movement
• opening greater than 14.0 mm
• closing greater than 19.0 mm
Structural cracks greater than 1.0 mm width</td><td colspan="2"><u>Implement Contingency Plan</u>
• As per BFMP Section 9 and Appendix 7.</td></tr>
<tr><td><u>Metropolitan Coal (actions under the circumstances)</u>
• Notify RMS, NSW Principal Subsidence Engineer, Subsidence Advisory NSW, and the Technical Committee of the Level 4 situation.</td><td><u>Timing / Frequency</u>
• Within 2 hours.</td></tr>
<tr><td><u>RMS (Works Supervisor)</u>
• Notify RMS Traffic Commander via Transport Management Centre to immediately apply speed restriction.
• Inspect and assess condition of bridge at trigger point and general area, initiate any remedial action as required, and advise Technical Committee.</td><td><u>Timing / Frequency</u>
• Immediately upon notification.
• Immediate callout and arrive within 2 hours.</td></tr>
<tr><td><u>RMS (Traffic Commander) and NSW Police</u>
• RMS Traffic Commander and NSW Police apply and enforce speed restriction, and determine if a detour is necessary.</td><td><u>Timing / Frequency</u>
• Immediate callout and arrive within 2 hours.</td></tr>
<tr><td><u>RMS (Technical Committee)</u>
• Technical Committee to review monitoring data and consider whether to:
o increase survey and/or inspection frequencies;
o take any additional management measures, including erecting temporary bridge props/supports or bringing forward the end-of-panel position; and/or
o suggest the need for mining to be temporarily halted (if unacceptable to RMS);
and implement decisions following RMS and Metropolitan Coal concurrence.</td><td><u>Timing / Frequency</u>
• Within 3 days.</td></tr>
</table>

Table 13
Trigger Action Response Plan – Pavement

RMS – Pavements			
RMS – Pavements	*Risk: Subsidence effect on road pavement resulting in impact to structural integrity and serviceability.*		
	TRIGGER LEVEL	**RESPONSE**	
	Level 1 - Normal **Expected subsidence conditions**		
	Subsidence • less than 50 mm Absolute Horizontal Movements • less than 115 mm Strain (Tensile or Compressive) • less than 0.4 mm/m	**Normal Operations** • Road pavement is safe and serviceable. • Negligible impact to road pavements. • Continue monitoring activities as planned.	
	Level 2 - Monitor **Subsidence more than predicted (+15%), but road condition normal**		
	Subsidence • between 50 and 60 mm Absolute Horizontal Movements • between 115 and 130 mm Strain • between 0.4 and 0.5 mm/m	**Conditions: Continue operations but report on subsidence anomaly** • Road pavement is safe and serviceable. • Impact on road pavement is within tolerable limits.	
		Metropolitan Coal (actions as required) • Resurvey subsidence line and ground points to confirm results, and that the results are consistent with other subsidence lines. • Inform and provide the report on subsidence results to RMS, NSW Principal Subsidence Engineer and Subsidence Advisory NSW.	**Timing / Frequency** • Within 3 days. • Within 7 days.
		RMS (Technical Committee) • Technical Committee subsidence specialists to review monitoring data and assess results for trends, and forecast when the Level 3 trigger might be exceeded. • Technical Committee to consider whether: o to increase the frequency of survey and site inspections; and/or o any mitigation measures or additional management measures are required to avoid exceeding the Level 3 trigger.	**Timing / Frequency** • Within 7 days. • Within 7 days.

Table 13 (Continued)
Trigger Action Response Plan – Pavement

<table>
<tr><td colspan="4">RMS – Pavements</td></tr>
<tr><td rowspan="6">RMS – Pavements</td><td colspan="3">Risk: Subsidence effect on road pavement resulting in impact to structural integrity and serviceability.</td></tr>
<tr><td>TRIGGER LEVEL</td><td colspan="2">RESPONSE</td></tr>
<tr><td colspan="3">Level 3 - Cautionary
Anomalous road pavement defects or subsidence beyond +15% of predicted</td></tr>
<tr><td>Subsidence
• greater than 60 mm
Absolute Horizontal Movements
• greater than 130 mm
Strain
• greater than 0.5 mm/m
Observable subsidence ground deformations in/near pavement
Pavement cracking
Deterioration in ride quality
Defects in minor structures such as kerbs and gutters, pits, etc</td><td colspan="2"><u>Conditions: Investigate & Resolve</u>
• Road pavement is safe and serviceable.
• Indication of impact to road pavements including observable subsidence ground deformations in/near pavement, pavement cracking, deterioration in ride quality, and defects in minor structures such as kerb & gutter, pits, etc.</td></tr>
<tr><td colspan="3">
<table>
<tr><td><u>Metropolitan Coal (actions as required)</u></td><td><u>Timing / Frequency</u></td></tr>
<tr><td>• Notify RMS, NSW Principal Subsidence Engineer, Subsidence Advisory NSW, and the Technical Committee that survey results show the trigger was exceeded and provide a report on the subsidence results.
• Provide a report to the NSW Principal Subsidence Engineer on how the Level 3 situation is being managed to keep the affected section of M1 safe and serviceable.</td><td>• Within 24 hours.
• Within 2 weeks.</td></tr>
<tr><td><u>RMS (Works Supervisor)</u></td><td><u>Timing / Frequency</u></td></tr>
<tr><td>• Inspect and assess condition of pavement at trigger point and general area, determine if any remedial action required, and advise Technical Committee.</td><td>• Within 4 hours of notification.</td></tr>
<tr><td><u>RMS (Technical Committee)</u></td><td><u>Timing / Frequency</u></td></tr>
<tr><td>• Technical Committee subsidence specialists to review monitoring data and assess results for trends, and forecast when the Level 4 trigger might be reached.
• Technical Committee to consider whether to:
o increase survey and/or inspection frequencies;
o take any mitigation/additional management measures, including bringing forward the end-of-panel position, to avoid reaching the Level 4 trigger;
o employ a dedicated Inspector on site on full time basis; and/or
o suggest the need for a speed restriction to RMS,
and implement decisions following RMS and Metropolitan Coal concurrence.</td><td>• Within 3 days.
• Within 5 days.</td></tr>
</table>
</td></tr>
</table>

Table 13 (Continued)
Trigger Action Response Plan – Pavement

RMS – Pavements			
RMS – Pavements	*Risk: Subsidence effect on road pavement resulting in impact to structural integrity and serviceability.*		
	TRIGGER LEVEL	**RESPONSE**	
	Level 4 – Restoration **Fault occurs**		
	Fault Occurs	**Implement Contingency Plan** • As per BFMP Section 9 and Appendix 7.	
		Metropolitan Coal (actions under the circumstances) • Notify RMS, NSW Principal Subsidence Engineer, Subsidence Advisory NSW, and the Technical Committee of the Level 4 situation.	**Timing / Frequency** • Within 2 hours.
		RMS (Works Supervisor) • Notify RMS Traffic Commander via Transport Management Centre to immediately apply speed restriction. • Inspect and assess condition of pavement at trigger point and general area, initiate any remedial action as required, and advise Technical Committee.	**Timing / Frequency** • Immediately upon notification. • Immediate callout and arrive within 2 hours.
		RMS (Traffic Commander) and NSW Police • RMS Traffic Commander and NSW Police apply and enforce speed restriction, and determine if a detour is necessary.	**Timing / Frequency** • Immediate callout and arrive within 2 hours.
		RMS (Technical Committee) • Technical Committee to review monitoring data and consider whether to: o increase survey and/or inspection frequencies; o mill, fill and/or cut slots; o take any additional management measures, including bringing forward the end-of-panel position; and/or o suggest the need for mining to be temporarily halted (if unacceptable to RMS); and implement decisions following RMS and Metropolitan Coal concurrence.	**Timing / Frequency** • Within 3 days.

Table 14
Trigger Action Response Plan – Cuttings

RMS – Cuttings			
RMS – Cuttings	*Risk: Subsidence effect on cuttings resulting in impact to stability.*		
	TRIGGER LEVEL	**RESPONSE**	
	Level 1 - Normal **Expected subsidence conditions**		
	Subsidence • less than 50 mm Absolute Horizontal Movements • less than 115 mm Strain (Tensile or Compressive) • less than 0.4 mm/m	**Normal Operations** • Cuttings are safe and serviceable. • Negligible impact to cuttings. • Continue monitoring activities as planned.	
	Level 2 - Monitor **Subsidence more than predicted (+15%), but cutting condition normal**		
	Subsidence • between 50 and 60 mm Absolute Horizontal Movements • between 115 and 130 mm Strain • between 0.4 and 0.5 mm/m	**Conditions: Continue operations but report on subsidence anomaly** • Cuttings are safe and serviceable. • Impact on cuttings is within tolerable limits.	
		Metropolitan Coal (actions as required) • Resurvey subsidence line and ground points to confirm results, and that the results are consistent with other subsidence lines. • Inform and provide the report on subsidence results to RMS, NSW Principal Subsidence Engineer and Subsidence Advisory NSW.	**Timing / Frequency** • Within 3 days. • Within 7 days.
		RMS (Technical Committee) • Technical Committee subsidence specialists to review monitoring data and assess results for trends, and forecast when the Level 3 trigger might be exceeded. • Technical Committee to consider whether: o to increase the frequency of survey and site inspections; and o any mitigation measures or additional management measures are required to avoid exceeding the Level 3 trigger.	**Timing / Frequency** • Within 7 days. • Within 7 days.

Table 14 (Continued)
Trigger Action Response Plan – Cuttings

<table>
<tr><td colspan="4">RMS – Cuttings</td></tr>
<tr><td rowspan="8">RMS – Cuttings</td><td colspan="3">Risk: Subsidence effect on cuttings resulting in impact to stability.</td></tr>
<tr><td>TRIGGER LEVEL</td><td colspan="2">RESPONSE</td></tr>
<tr><td colspan="3">Level 3 - Cautionary
Anomalous cutting impact/movement or subsidence beyond +15% of predicted</td></tr>
<tr><td>Subsidence
• greater than 60 mm
Absolute Horizontal Movements
• greater than 130 mm
Strain
• greater than 0.5 mm/m
Observable subsidence ground deformations in/near cutting
Rock fall
Cracking or visual deterioration at the rock face
Visual displacement at joints</td><td colspan="2"><u>Conditions: Investigate & Resolve</u>
• Cuttings are safe and serviceable.
• Indication of impact to cuttings including rock fall, cracking or visual deterioration at the rock face, or visual displacement at joints.</td></tr>
<tr><td><u>Metropolitan Coal (actions as required)</u>
• Notify RMS, NSW Principal Subsidence Engineer, Subsidence Advisory NSW, and the Technical Committee that survey results show the trigger was exceeded and provide a report on the subsidence results.
• Provide a report to the NSW Principal Subsidence Engineer on how the Level 3 situation is being managed to keep the affected section of M1 safe and serviceable.</td><td><u>Timing / Frequency</u>
• Within 24 hours.
• Within 2 weeks.</td></tr>
<tr><td><u>RMS (Works Supervisor)</u>
• Inspect and assess condition of cutting at trigger point and general area, determine if any remedial action required, and advise Technical Committee.</td><td><u>Timing / Frequency</u>
• Within 4 hours of notification.</td></tr>
<tr><td><u>RMS (Technical Committee)</u>
• Technical Committee subsidence specialists to review monitoring data and assess results for trends, and forecast when the Level 4 trigger might be reached.
• Technical Committee to consider whether to:
o increase survey and/or inspection frequencies;
o take any mitigation/additional management measures (e.g. rock bolting; scaling; shotcreting; installation of rockfall mesh; installation of barriers; and trimming of the cut face), including bringing forward the end-of-panel position, to avoid reaching the Level 4 trigger;
o employ a dedicated Inspector on site on full time basis; and/or
o suggest the need for a speed restriction to RMS,
and implement decisions following RMS and Metropolitan Coal concurrence.</td><td><u>Timing / Frequency</u>
• Within 3 days.
• Within 5 days.</td></tr>
</table>

Table 14 (Continued)
Trigger Action Response Plan – Cuttings

RMS – Cuttings			
RMS – Cuttings	*Risk: Subsidence effect on cuttings resulting in impact to stability.*		
	TRIGGER LEVEL	**RESPONSE**	
	Level 4 – Restoration **Fault occurs**		
	Fault Occurs	**Implement Contingency Plan** • As per BFMP Section 9 and Appendix 7.	
		Metropolitan Coal (actions under the circumstances) • Notify RMS, NSW Principal Subsidence Engineer, Subsidence Advisory NSW, and the Technical Committee of the Level 4 situation.	**Timing / Frequency** • Within 2 hours.
		RMS (Works Supervisor) • Notify RMS Traffic Commander via Transport Management Centre to immediately apply speed restriction. • Inspect and assess condition of cutting at trigger point and general area, initiate any remedial action as required, and advise Technical Committee.	**Timing / Frequency** • Immediately upon notification. • Immediate callout and arrive within 2 hours.
		RMS (Traffic Commander) and NSW Police • RMS Traffic Commander and NSW Police apply and enforce speed restriction, and determine if a detour is necessary.	**Timing / Frequency** • Immediate callout and arrive within 2 hours.
		RMS (Technical Committee) • Technical Committee to review monitoring data and consider whether to: o increase survey and/or inspection frequencies; o take any additional management measures (e.g. rock bolting; scaling; shotcreting; installation of rockfall mesh; installation of barriers; and trimming of the cut face), including bringing forward the end-of-panel position; and/or o suggest the need for mining to be temporarily halted (if unacceptable to RMS); and implement decisions following RMS and Metropolitan Coal concurrence.	**Timing / Frequency** • Within 3 days.

Table 15
Trigger Action Response Plan – Culverts

RMS – Culverts			
RMS – Culverts	*Risk: Subsidence effect on culvert structure resulting in impact to structural integrity.*		
	TRIGGER LEVEL	**RESPONSE**	
	Level 1 - Normal **Expected subsidence conditions**		
	Subsidence • less than 50 mm Absolute Horizontal Movements • less than 115 mm Strain (Tensile or Compressive) • less than 0.4 mm/m	**Normal Operations** • Culvert is safe and serviceable. • Negligible impact to culvert structure. • Continue monitoring activities as planned.	
	Level 2 - Monitor **Subsidence more than predicted (+15%), but culvert condition normal**		
	Subsidence • between 50 and 60 mm Absolute Horizontal Movements • between 115 and 130 mm Strain • between 0.4 and 0.7 mm/m	**Conditions: Continue operations but report on subsidence anomaly** • Culvert is safe and serviceable. • Impact on culvert structure is within tolerable limits.	
		Metropolitan Coal (actions as required) • Resurvey subsidence line and ground points to confirm results, and that the results are consistent with other subsidence lines. • Inform and provide the report on subsidence results to RMS, NSW Principal Subsidence Engineer and Subsidence Advisory NSW.	**Timing / Frequency** • Within 3 days. • Within 7 days.
		RMS • Technical Committee subsidence specialists to review monitoring data and assess results for trends, and forecast when the Level 3 trigger might be exceeded. • Technical Committee to consider whether: o to increase the frequency of survey and site inspections; and o any mitigation measures or additional management measures are required to avoid exceeding the Level 3 trigger.	**Timing / Frequency** • Within 7 days. • Within 7 days.

Table 15 (Continued)
Trigger Action Response Plan – Culverts

<table>
<tr><td colspan="4">RMS – Culverts</td></tr>
<tr><td rowspan="8">RMS – Culverts</td><td colspan="3">Risk: Subsidence effect on culvert structure resulting in impact to structural integrity.</td></tr>
<tr><td>TRIGGER LEVEL</td><td colspan="2">RESPONSE</td></tr>
<tr><td colspan="3">Level 3 - Cautionary
Anomalous culvert impact/movement or subsidence beyond +15% of predicted</td></tr>
<tr><td>Subsidence
• greater than 60 mm
Absolute Horizontal Movements
• greater than 130 mm
Strain
• greater than 0.7 mm/m
Observable subsidence ground deformations in/near culverts
Cracking in culverts
Visual displacement at joints
Ponding</td><td colspan="2"><u>Conditions: Investigate & Resolve</u>
• Culvert is safe and serviceable.
• Indication of impact to culvert structure including cracking in culverts, visual displacement at joints or ponding.</td></tr>
<tr><td></td><td><u>Metropolitan Coal (actions as required)</u>
• Notify RMS, NSW Principal Subsidence Engineer, Subsidence Advisory NSW, and the Technical Committee that survey results show the trigger was exceeded and provide a report on the subsidence results.
• Provide a report to the NSW Principal Subsidence Engineer on how the Level 3 situation is being managed to keep the affected culvert section safe and serviceable.</td><td><u>Timing / Frequency</u>
• Within 24 hours.
• Within 2 weeks.</td></tr>
<tr><td></td><td><u>RMS (Works Supervisor)</u>
• Inspect and assess condition of culvert at trigger point and general area, determine if any remedial action required, and advise Technical Committee.</td><td><u>Timing / Frequency</u>
• Within 4 hours of notification.</td></tr>
<tr><td></td><td><u>RMS (Technical Committee)</u>
• Technical Committee subsidence specialists to review monitoring data and assess results for trends, and forecast when the Level 4 trigger might be reached.
• Technical Committee to consider whether to:
o increase survey and/or inspection frequencies;
o take any mitigation/additional management measures (e.g. point repairs; lining; grouting; or culvert replacement), including bringing forward the end-of-panel position, to avoid reaching the Level 4 trigger;
o employ a dedicated Inspector on site on full time basis; and/or
o suggest the need for a speed restriction to RMS,
and implement decisions following RMS and Metropolitan Coal concurrence.</td><td><u>Timing / Frequency</u>
• Within 3 days.
• Within 5 days.</td></tr>
</table>

Table 15 (Continued)
Trigger Action Response Plan – Culverts

RMS – Culverts			
RMS – Culverts	*Risk: Subsidence effect on culvert structure resulting in impact to structural integrity.*		
	TRIGGER LEVEL	**RESPONSE**	
	Level 4 – Restoration **Fault occurs**		
	Fault Occurs	**Implement Contingency Plan** • As per BFMP Section 9 and Appendix 7.	
		Metropolitan Coal (actions under the circumstances) • Notify RMS, NSW Principal Subsidence Engineer, Subsidence Advisory NSW, and the Technical Committee of the Level 4 situation.	**Timing / Frequency** • Within 2 hours.
		RMS (Works Supervisor) • Notify RMS Traffic Commander via Transport Management Centre to immediately apply speed restriction. • Inspect and assess condition of culvert at trigger point and general area, initiate any remedial action as required, and advise Technical Committee.	**Timing / Frequency** • Immediately upon notification. • Immediate callout and arrive within 2 hours.
		RMS (Traffic Commander) and NSW Police • RMS Traffic Commander and NSW Police apply and enforce speed restriction, and determine if a detour is necessary.	**Timing / Frequency** • Immediate callout and arrive within 2 hours.
		RMS (Technical Committee) • Technical Committee to review monitoring data and consider whether to: o increase survey and/or inspection frequencies; o take any additional management measures (e.g. point repairs; lining; grouting; or culvert replacement), including bringing forward the end-of-panel position; and/or o suggest the need for mining to be temporarily halted (if unacceptable to RMS); and implement decisions following RMS and Metropolitan Coal concurrence.	**Timing / Frequency** • Within 3 days.

11 FUTURE EXTRACTION PLANS

In accordance with Condition 7, Schedule 3 of the Project Approval, Metropolitan Coal will collect baseline data for the next Extraction Plan (i.e. Longwalls 305-310). The collection of baseline data will be consistent with the baseline data collected for Longwalls 301-304.

However for the M1 Princes Motorway and associated bridges, the baseline (and post-mining) data collected for Longwalls 301-304 will be used as baseline for Longwalls 305 onward as longwall mining progressively moves further away from the RMS assets.

In addition to the baseline data collection, consideration of the environmental performance and management measures in accordance with the review(s) conducted as part of this BFMP-RMS will inform the appropriate type and frequency of monitoring of the assets relevant to the next Extraction Plan.

12 ANNUAL REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

In accordance with Condition 3, Schedule 7 of the Project Approval, Metropolitan Coal will conduct an Annual Review of the environmental performance of the Project by the end of March each year.

The Annual Review will:

- describe the works carried out in the past year, and the works proposed to be carried out over the next year;
- include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the EA, Preferred Project Report and Extraction Plan;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

As described in Section 2, this BFMP-RMS will be reviewed within three months of the submission of an Annual Review, and revised where appropriate.

13 INCIDENTS

An incident is defined as a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval.

The reporting of incidents will be conducted in accordance with Condition 6, Schedule 7 of the Project Approval. Metropolitan Coal will notify the Director-General (now Secretary) of DP&E and any other relevant agencies of any incident associated with the Project as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of DP&E and any relevant agencies with a detailed report on the incident.

The RMS will be notified within 24 hours of any access limitations or restrictions.

14 COMPLAINTS

A protocol for the managing and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

The Environment & Community Superintendent is responsible for maintaining a system for recording complaints.

Metropolitan Coal will maintain public signage advertising the telephone number on which environmental complaints can be made. The Environment & Community Superintendent is responsible for ensuring that the currency and effectiveness of the service is maintained. Notifications of complaints received are to be provided as quickly as practicable to the Environment & Community Superintendent.

Complaints and enquiries do not have to be received via the telephone line and may be received in any other form. Any complaint or enquiry relating to environmental management or performance is to be relayed to the Environment & Community Superintendent as soon as practicable. All employees are responsible for ensuring the prompt relaying of complaints. All complaints will be recorded in a complaints register.

For each complaint, the following information will be recorded in the complaints register:

- date and time of complaint;
- method by which the complaint was made;
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- nature of the complaint;
- the action(s) taken by Metropolitan Coal in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken by Metropolitan Coal, the reason why no action was taken.

The Environment & Community Superintendent is responsible for ensuring that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary.

In accordance with Condition 10, Schedule 7 of the Project Approval, the complaints register will be made publicly available on the website and updated on a monthly basis. A summary of complaints received and actions taken will be presented to the Community Consultative Committee as part of the operational performance review.

15 NON-COMPLIANCES WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with Metropolitan Coal, and will be developed through promotion of Metropolitan Coal ownership under the direction of the General Manager.

The Manager - Technical Services and/or Environment & Community Superintendent will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 13, Metropolitan Coal will notify the Director-General (now Secretary) of the DP&E and any other relevant agencies of any incident associated with Metropolitan Coal as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of the DP&E and any relevant agencies with a detailed report on the incident.

A review of Metropolitan Coal's compliance with all conditions of the Project Approval, mining leases and all other approvals and licenses will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the Peabody website.

Additionally, in accordance with Condition 8, Schedule 7 of the Project Approval, an independent environmental audit was undertaken by the end of December 2011, and is undertaken a minimum of once every three years thereafter. A copy of the audit report will be submitted to the Director-General (now Secretary) of the DP&E and made publicly available on the Peabody website. The independent audit will be undertaken by an appropriately qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General (now Secretary) of the DP&E.

16 REFERENCES

Arup (2016) Metropolitan Colliery Longwall Mining – LW301-303 Risk Assessment as Applied to RMS Assets.

Arup (2019) Metropolitan Colliery Longwall Mining – LW304-306 Risk Assessment as Applied to RMS Assets.

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Cardno (2015a) *Investigation of Potential Effects on Underpass 2 over Princes Highway of Ground Movement Due to Mining.* May 2015.

Cardno (2015b) *Supplementary Report on Investigation of Potential Effects on Underpass 2 over Princes Highway of Ground Movement Due to Mining.* July 2015.

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Department of Planning & Environment and Division of Resources and Energy (2014) *Guidelines for the Preparation of Extraction Plans*. Draft.

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Mine Subsidence Engineering Consultants (2008) *Metropolitan Colliery Longwalls 20-44 Subsidence Assessment Report (MSEC Report MSEC285 Revision C, August 2008*), Appendix A in Helensburgh Coal Pty Ltd (2008) *Metropolitan Coal Project Environmental Assessment.*

Mine Subsidence Engineering Consultants (2016) *Metropolitan Colliery – Proposed Longwalls 301 to 303 – Subsidence Predictions and Impact Assessments for the Roads and Maritime Services Infrastructure*, 6 September 2016.

Mine Subsidence Engineering Consultants (2019) *Metropolitan Colliery – Proposed Longwall 304 – Subsidence Predictions and Impact Assessments for the Roads and Maritime Services Infrastructure.*

Roads and Maritime Services (2014) *Guide to Slope Risk Analysis Version 4.*

APPENDIX 1

MSEC (2016) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 301 TO 303 - SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE ROADS AND MARITIME SERVICES INFRASTRUCTURE, DATED 6 SEPTEMBER 2016

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

6th September 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-08

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Roads and Maritime Services Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Roads and Maritime Services (RMS) infrastructure resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery.

The locations of the RMS infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC844-08. The M1 Princes Motorway is located to the east of Longwalls 301 to 303. The distance of the M1 Princes Motorway from Longwalls 301 to 303 varies from 210 metres near the finishing (southern) end of Longwall 301 to 335 metres near the commencing (northern) end of Longwall 301.

A series of cuttings and embankments up to a maximum height of approximately 20 metres are shown in the attached Drawing No. MSEC844-08. A summary of the rock cuttings is provided in Table 1.

Table 1 Summary of RMS Rock Cuttings

RMS Slope Number	RMS Assessed Risk Level (ARL)	Length (m)	Maximum Slope Height (m)	Average Slope Angle (degrees)
13563	2	202	17	65
13562	2	531	18	70
13561	2	599	13	62
13560	2	231	8	70
10425	2	188	9	66
10426	2	503	15	55
10427	2	452	14	55
10428	2	192	9	65

A bridge is located at the crossing of the M1 Princes Motorway with the Old Princes Highway (Bridge 2), and is located approximately 330 metres from Longwall 301. The next nearest bridge is Cawley Road Overpass, which is located approximately 1.43 kilometres to the north east of Longwall 303.

A series of culverts cross the M1 Princes Motorway, as shown on Drawing No. MSEC844-08. The culverts comprise pipes of varying diameters from 375 mm to 1800 mm. The pipe materials comprise asbestos cement (pipes up to

600 mm diameter) and steel reinforced concrete (pipes up to 1800 mm diameter). In addition to the culverts, there are also a number of other drainage structures, such as kerbs, gutters, pits and drainage pipes. The largest culvert comprises two 1800mm pipes located to the north east of the longwalls at Cawley's Creek.

The predictions and impact assessments for the RMS infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the RMS Infrastructure

A summary of the maximum predicted values of total subsidence, tilt and curvature for the M1 Princes Motorway, resulting from the extraction of Longwalls 301 to 303, is provided in Table 2. The values are the maxima anywhere along the section of the motorway located within the Study Area.

Table 2 Predicted Total Subsidence, Tilt and Curvature for the M1 Princes Motorway Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	< 20	< 0.5	< 0.01	< 0.01
After LW302	50	< 0.5	< 0.01	< 0.01
After LW303	50	< 0.5	< 0.01	< 0.01

The maximum predicted conventional tilt and curvature are negligible and less than typical limits of survey accuracy (i.e. 0.5 mm/m for tilt and 0.01 km^{-1} for curvature).

Princes Motorway will potentially experience low level far-field horizontal movement. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield.

The observed incremental far-field horizontal movements, resulting from the extraction of longwalls in the Southern Coalfield, are provided in Figure 1. The data are based on survey marks located outside of the mining area (i.e. above solid coal).

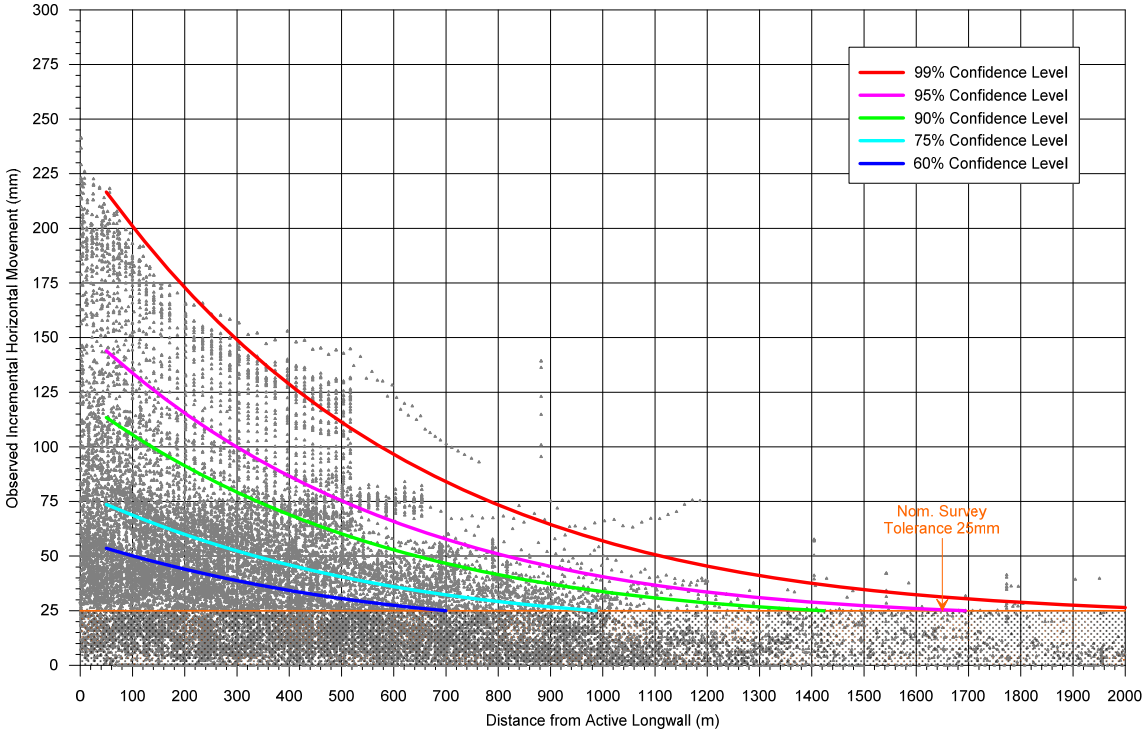

Figure 1 Observed Incremental Far-field Horizontal Movements from the Southern Coalfield (Solid Coal)

The absolute horizontal movements measured at distances greater than 210 metres from mining are in the order of 115 mm based on the 95 % confidence level. These low level movements comprise a large proportion of survey tolerance. Far-field horizontal movements tend to be bodily movements orientated towards the mining area. The strains associated with these low level horizontal movement are not expected to be measurable.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the RMS infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The M1 Princes Motorway is located at distances of 200 metres or greater from the longwalls. The database of measured strains has therefore been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located outside and within 100 metres to 250 metres of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

A histogram of the maximum observed tensile and compressive strains measured in survey bays located above solid coal, for monitoring lines in the Southern Coalfield, is provided in Figure 2. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

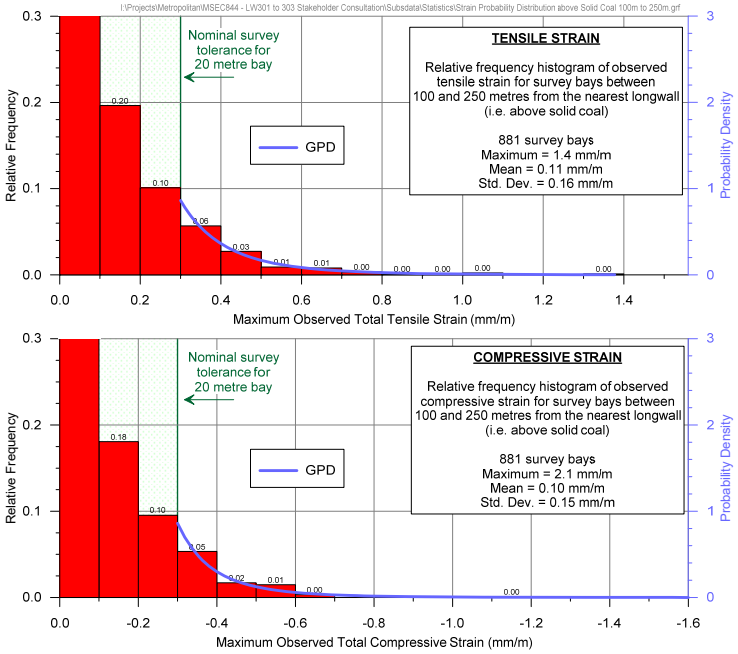

Figure 2 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Solid Coal (100 to 250 metres)

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above solid coal, based on the fitted GPDs, is provided in Table 3.

Table 3 Probabilities of Exceedance for Strain for Survey Bays Located above Solid Coal

Strain (mm/m)		Probability of Exceedance
Compression	-2.0	1 in 9,840
	-1.5	1 in 3000
	-1.0	1 in 635
	-0.5	1 in 55
	-0.3	1 in 10
Tension	+0.3	1 in 9
	+0.5	1 in 36
	+1.0	1 in 410
	+1.5	1 in 2,200
	+2.0	1 in 8,000

The 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal (100 to 250 metres) experienced at any time during mining are 0.4 mm/m tensile and compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.7 mm/m tensile and 0.6 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures and the streams are shown in Drawing No. MSEC844-08.

There are no identified geological structures above the longwalls. The M1 Princes Motorway crosses the Metropolitan Fault approximately 500 metres to the north east of Longwall 301 and several faults to the south east of Longwalls 301 and 302 intersecting the M1 Princes Motorway at approximately 340 metres. The absolute horizontal movements measured at distances of 500 metres and 340 metres from mining are in the order of 75 mm and 95 mm respectively based on the 95 % confidence level. It is noted that these faults are identified at seam level and surface expression of faults may occur at different locations, or faults may not have continuity to the ground surface.

A drainage line crosses the M1 Princes Motorway approximately 210 metres east of the finishing end of Longwall 301, as shown on Drawing No. MSEC844-08. Predicted valley closure across the culvert at the location of the M1 Princes Motorway is less than 20 mm.

A second drainage line is located to the north of the longwalls at Cawley's Creek. Due to the shortened commencing end of the longwalls, the culvert is located approximately 1060 metres from the nearest longwall (Longwall 301). At this distance, the culvert is not predicted to experience valley related movements due to the extraction of the Longwalls 301 to 303.

Valley closure is not expected to occur in the cuttings along the M1 Princes Motorway, however, minor closure movements could be observed due to potential horizontal movements.

Impact Assessments for the M1 Princes Motorway

The predicted conventional vertical subsidence for the M1 Prince Motorway resulting from the extraction of Longwalls 301 to 303 are very small and the predicted tilts and curvatures are less than the expected limits of survey tolerance. Adverse impacts to the M1 Princes Motorway, including the road pavement, slopes, culverts, barriers and furniture, resulting from conventional subsidence movements is considered unlikely.

The M1 Princes Motorway will potentially experience far-field horizontal movements resulting from the extraction of the Longwalls 301 to 303 of up to 115 mm, based on the 95% confidence level.

There are no major geological features to the east of the longwalls near the M1 Princes Motorway. The mapped geological features are shown on Drawing No. MSEC846-08. The Metropolitan Fault intersects the M1 Princes Motorway at approximately 500 metres to the north east of Longwall 301. There are mapped faults to the south east of Longwalls 301 and 302, intersecting the M1 Princes Motorway at approximately 340 metres from the longwalls. A dyke with a surface exposure is also present to the east of Longwall 301 at approximately 380 metres from Longwall 301. There is the potential for far-field horizontal movements to result in the minor differential movement near the faults and potential shearing and/or stepping in the road pavement. The faults have been mapped at seam level and surface expressions have not been identified. The mapped dyke has been identified in the motorway cuttings. There is also the potential for far-field horizontal movements to result in differential movement at the interface of cut and fill areas along the motorway corridor.

The M1 Princes Motorway crosses a valley and an associated drainage culvert to the east of the Longwall 301 finishing end. The predicted valley closure due to Longwalls 301 to 303 is less than 20 mm. A second valley and culvert are located at Cawley's Creek, approximately 930 metres from Longwall 303. Adverse impacts to the culverts resulting from conventional subsidence and valley related movements is considered unlikely.

It is recommended that monitoring and management strategies are developed, in consultation with RMS, to manage the potential impacts on the M1 Princes Motorway. It is expected that the motorway can be maintained in safe and serviceable conditions with the implementation of the appropriate monitoring and management strategies.

Impact Assessments for the Bridges

An assessment of Bridge 2 (RMS reference BN616-southbound and BN617-northbound) has been undertaken by the RMS technical committee, which was formed prior to the commencement of the extraction of Longwall 20 to assess and monitor potential impacts to RMS assets due to the extraction of longwalls at Metropolitan Colliery. A letter report MSEC696-02 dated 30th June 2014 was prepared based on a preliminary layout of Longwalls 301 to 317. The distance of the bridge from the longwalls is unchanged at 330 metres hence the impact assessments are the same as previously reported. A summary of the subsidence predictions and impact assessments for Bridge 2 is provided below.

- At a distance of approximately 330 metres, the predicted subsidence parameters are less than survey tolerance, which is typically 20mm for subsidence, 0.5mm/m for tilt and 0.01km^{-1} for curvature. The predicted conventional subsidence parameters indicate that with high accuracy survey, minor subsidence, tilt and hogging curvature may be observed, but sagging curvature is unlikely to be observed.
- The absolute horizontal movements measured at distances greater than 330 metres are in the order of 95 mm based on the 95% confidence level. An absolute horizontal movement of 105 mm based on the 95% confidence level was provided in the MSEC696-02 report. The updated data set as presented in Figure 1 results in a slightly lower value of observed horizontal movement, however the difference of 10 mm does not change the impact assessments for the bridge.
- It is difficult to predict differential horizontal movements since the potential values of relative movement are typically very small and much of the scatter in the observed data is the result of survey accuracy. Also, a spacing between pegs of 20 metres is commonly used along monitoring lines, and this distance is larger than the typical column and blade wall spacing for Bridge 2.
- Differential horizontal movement was assessed by analysing the far-field horizontal movement data discussed above. The data set was analysed to determine incremental relative opening and closing and incremental mid ordinate deviation.
- The incremental relative opening and closing and mid ordinate deviation for various probabilities at a distance of approximately 330 metres from an active longwall are summarised in Table 4 and Table 5.

Table 4 Incremental Relative Opening, Closing and Mid-Ordinate Deviation at Approximately 330 metres Distance from Active Longwall

	1 in 20 probability (95% confidence level)	1 in 100 probability (99% confidence level)	1 in 2000 probability (99.95% confidence level)
Opening	8 mm	14 mm	44 mm
Closing	6 mm	13 mm	44 mm
Mid-Ordinate Deviation	9 mm	15 mm	32 mm

Table 5 Incremental Relative Opening, Closing and Mid-Ordinate Deviation due to First Panel Extraction Only

	1 in 20 probability (95% confidence level)	1 in 100 probability (99% confidence level)	1 in 2000 probability (99.95% confidence level)
Opening	5 mm	10 mm	25 mm
Closing	4 mm	9 mm	32 mm
Mid Ordinate Deviation	5 mm	8 mm	14 mm

- The differential movements presented in Table 4 and Table 5 should be applied to the bridge elements in both the longitudinal and transverse direction of the bridge. The application of the differential movements to short bridge element spacing (e.g. columns approximately 5m apart), was discussed by the technical committee and it was agreed that the movements should be applied directly to shorter element spacing.
- The differential longitudinal movement, opening (+ve) and closing (-ve) should be applied to the longitudinal and transverse direction as an opening and closing movement, between piers, and between columns. The mid-ordinate deviation should be applied to an out of plane movement of one pier relative to adjacent piers, which are spaced at 13.5 metres at abutments and 18.3 metres in the centre, as well as between columns which are approximately 5 metres apart.
- Faults have been identified at seam level to the west and to the east of Bridge 2. The nearest faults, Main West and Powel are approximately 235 metres horizontal distance from Bridge 2. There are no mapped surface expressions of the faults. The projected alignments of these faults do not intersect the location of Bridge 2. There is a low likelihood of the identified structures directly impacting Bridge 2, however other potential unidentified structures may be present at or near the bridge location.

A decision was made by the RMS technical committee to monitor potential movements of Bridge 2 using a high accuracy fibre optic monitoring system, along with conventional surveying methods. The monitoring system is being established to record baseline readings during the extraction of Longwalls 26 and 27, prior to the commencement of Longwall 301.

Cawley Road Overpass is located at 1.43 kilometres from Longwall 301 at its nearest point. At this distance, observed far-field movements as shown in Figure 1 are close to nominal survey tolerance and observed differential movement data is predominantly within survey tolerance. Differential horizontal movement was assessed by analysing the far-field horizontal movement data. The data set was analysed to determine incremental relative opening and closing and incremental mid ordinate deviation at a distance of approximately 1.43 kilometres from an active longwall.

The incremental relative opening and closing and mid ordinate deviation for various probabilities at a distance of approximately 1.43 kilometres from an active longwall are summarised in Table 6.

Table 6 Incremental Relative Opening, Closing and Mid-Ordinate Deviation at Approximately 1.43 kilometres Distance from Active Longwall

	1 in 20 probability (95% confidence level)	1 in 100 probability (99% confidence level)	1 in 2000 probability (99.95% confidence level)
Opening	4 mm	7 mm	14 mm
Closing	5 mm	9 mm	19 mm
Mid-Ordinate Deviation	7 mm	10 mm	18 mm

At this distance, adverse impact to Cawley Road Overpass resulting from the extraction of Longwalls 301 to 303 is considered unlikely, however an assessment of the structure should be undertaken to assess the sensitivity of the structure to potential differential movements a result of Longwalls 301 to 303.

Summary

The M1 Princes Motorway is located greater than 210 metres to the east of Longwalls 301 to 303. The previous experience from the Southern Coalfield has found that the potential impacts on bitumen seal and asphaltic pavements can be managed with the implementation of suitable monitoring and management strategies.

It is recommended that monitoring and management strategies are developed, in consultation with RMS, to manage the potential impacts on the M1 Princes Motorway. It is expected that the motorway can be maintained in safe and serviceable conditions with the implementation of the appropriate monitoring and management strategies.

Bridge 2 is located approximately 330 metres from Longwall 301. A program of high accuracy monitoring of this bridge has been implemented by the RMS technical committee and will be outlined in the Built Features Management Plan for Longwalls 301 to 303. The culverts and Cawley Road Overpass are located outside the predicted 20 mm subsidence contour. Whilst these features could experience low level far-field horizontal movements, they are not expected to experience measurable strains or differential horizontal movements. Assessment of these structures should be undertaken by the RMS technical committee to assess the sensitivity of these structures to potential differential movements a result of Longwalls 301 to 303.

Yours sincerely

Peter DeBono

Mine Subsidence Engineering Consultants

Attachments:

Drawing No. MSEC844-08 – Longwalls 301 to 303 – RMS Infrastructure

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COAL

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
RMS

DATE:	SCALE:	DRAWING No:	Rev No
23 Aug 2016	1:12500	MSEC844-08	A

313 000 314 000 312 000
6 218 000 6 217 000 6 216 000 6 215 000

Grid to MGA co-ordinates

CAWLEY ROAD OVERPASS
METROPOLITAN FAULT
CAWLEYS CK
CUTTING 13563
CUTTING 10425
EMBANKMENT
1430m
STUDY AREA
WORONORA RESERVOIR
20
20mm SUBSIDENCE CONTOUR
OLD PRINCES HIGHWAY
LW303
LW302
LW301
CUTTING 13562
CUTTING 10426
M1 PRINCES MOTORWAY
CUTTING 13561
CUTTING 10427
DYKE
CUTTING 13560
EMBANKMENT
CUTTING 10428
EMBANKMENT
WILSONS CK
330m
PRINCES HIGHWAY UNDERPASS (BRIDGE 2)
CUTTING 13559
FAULT
MAIN WEST FAULT
POWELL FAULT

LEGEND
- RMS INFRATRUCTURE- M1 PRINCES MOTORWAY
- BRIDGES
- CUTTINGS
- EMBANKMENTS
- CULVERTS
- GEOLOGICAL FAULTS AT SEAM LEVEL

APPENDIX 2

MSEC (2019) METROPOLITAN COLLIERY – PROPOSED LONGWALL 304 - SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE ROADS AND MARITIME SERVICES INFRASTRUCTURE

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

12th February 2019

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC1013-08

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 304 - Subsidence Predictions and Impact Assessments for the Roads and Maritime Services Infrastructure

Metropolitan Coal is a wholly owned subsidiary of Peabody Energy Pty Limited (Peabody) and operates Metropolitan Colliery (the Colliery), which is located in the Southern Coalfield of New South Wales. Metropolitan Coal has extracted Longwalls 1 to 27, 301 and 302 at the Colliery and, at the time of this report, was extracting Longwall 303. The Roads and Maritime Services (RMS) infrastructure has been managed during the extraction of Longwalls 301 to 303 by a Technical Committee and in accordance with the Built Features Management Plan for RMS (LW301-303 BFMP_RMS-R01-H.

In October 2018, Metropolitan Coal submitted an application to the DP&E to amend the first workings layout of Longwalls 304-306. The amended longwall layout included:

- uniform void panel width of 163 m and uniform solid tailgate pillar width of 45 m for Longwall 304 with a void panel length of 1,438 m;
- uniform void panel width of 138 m and uniform solid tailgate pillar width of 45 m for Longwall 305; and
- uniform void panel width of 138 m and uniform solid tailgate pillar width of 70 m for Longwalls 306.

DP&E's approval of the first workings application (granted in November 2018) requires Metropolitan Coal to commit to an appropriate setback of Longwall 304 from the Eastern Tributary and a detailed cumulative subsidence assessment including Longwalls 304 to 308 for the Eastern Tributary.

MSEC prepared report MSEC1009 to support the Longwall 304 Extraction Plan. The predictions and impact assessments provided the report are based on the Extraction Plan Layout, defined as:

- the approved Longwalls 301 to 303 layout incorporating a proposed additional 182 m of secondary extraction of Longwall 303 (i.e. a longwall length of 1,325 m); and
- uniform void panel width of 163 m and uniform solid tailgate pillar widths of 45 m for Longwall 304 with a void panel length of 1,285 m.

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Roads and Maritime Services (RMS) infrastructure resulting from the extraction of the proposed Longwalls 304 at Metropolitan Colliery.

The locations of the RMS infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC1013-08. The M1 Princes Motorway is located to the east of Longwall 304. The distance of the M1 Princes Motorway from Longwalls 304 varies from 850 m near the finishing (southern) end to 930 m near the commencing (northern) end of Longwall 304. Longwalls 301 to 303 are located closer to the M1 Princes Motorway

with 210 metres distance to the finishing (southern) end of Longwall 301 and 335 metres distance to the commencing (northern) end of Longwall 301.

A series of cuttings and embankments up to a maximum height of approximately 20 metres are shown in the attached Drawing No. MSEC1013-08. A summary of the rock cuttings is provided in Table 1.

Table 1 Summary of RMS Rock Cuttings

RMS Slope Number	RMS Assessed Risk Level (ARL)	Length (m)	Maximum Slope Height (m)	Average Slope Angle (degrees)
13563	2	202	17	65
13562	3	531	18	70
13561	4	599	13	62
13560	3	231	8	70
10425	3	188	9	66
10426	4	503	15	55
10427	4	452	14	55
10428	4	192	9	65

A bridge is located at the crossing of the M1 Princes Motorway with the Old Princes Highway (Bridge 2), and is located approximately 890 metres from Longwall 304. The next nearest bridge is Cawley Road Overpass, which is located approximately 1.67 kilometres to the commencing end of Longwall 304.

A series of culverts cross the M1 Princes Motorway, as shown on Drawing No. MSEC1013-08. The culverts comprise pipes of varying diameters from 375 mm to 1800 mm. The pipe materials comprise asbestos cement (pipes up to 600 mm diameter) and steel reinforced concrete (pipes up to 1800 mm diameter). In addition to the culverts, there are also a number of other drainage structures, such as kerbs, gutters, pits and drainage pipes. The largest culvert comprises two 1800mm pipes located to the north east of the longwalls at Cawley's Creek.

The predictions and impact assessments for the RMS infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the RMS Infrastructure

The Study Area for Longwall 304 is defined as the surface area that is likely to be affected by the proposed mining of these longwalls (i.e. from conventional subsidence) and is based on the further extents of a 35° angle of draw line from the proposed extents of the longwalls and the predicted 20 mm subsidence contour resulting from the extraction of Longwall 304. The study area and the predicted 20mm subsidence contour for the extraction of Longwall 304 is are shown in Drawing No. MSEC1013-08.

At over 850m from Longwall 304, the RMS assets are located outside the Study Area and are not expected to experience measurable conventional vertical subsidence, tilts, curvatures or strains (i.e. no greater than survey accuracy). The RMS assets could however experience low level far-field horizontal movement.

The observed incremental far-field horizontal movements, resulting from the extraction of longwalls in the Southern Coalfield, are provided in Figure 1. The data are based on survey marks located in areas influenced by previously extracted longwall panels.

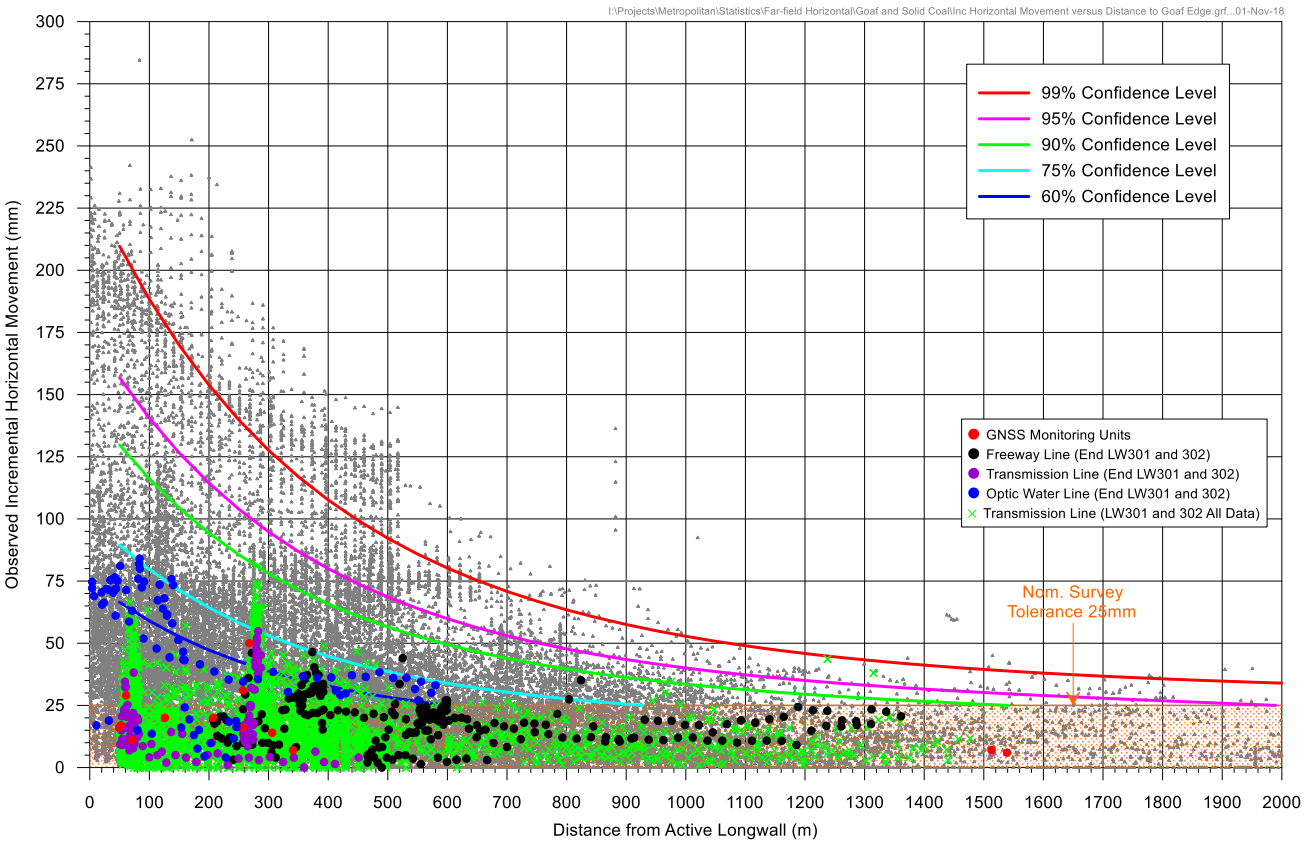


Figure 1 Observed Incremental Far-field Horizontal Movements from the Southern Coalfield

The observed horizontal movements during the extraction of Longwalls 301 and 302 are also plotted in Figure 1. The absolute horizontal movements measured at distances greater than 850 metres from mining are in the order of 45 mm based on the 95 % confidence level. These low level movements comprise a large proportion of survey tolerance. Far-field horizontal movements tend to be bodily movements orientated towards the mining area. The strains associated with these low level horizontal movement are not expected to be measurable.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures at seam level and the major streams are shown in Drawing No. MSEC982-08. There are no identified geological structures within the Study Area that extend beneath the M1 Princes Motorway. The M1 Princes Motorway crosses the Metropolitan Fault approximately 960m from Longwall 304 and faults to the south east of Longwalls 304 are approximately 850m at the location of the M1 Princes Motorway. It is noted that these faults are identified at seam level and surface expression of faults may occur at different locations, or faults may not have continuity to the ground surface.

A small drainage line crosses the M1 Princes Motorway approximately 850m east of the finishing end of Longwall 304. A second drainage line is located to the north of the longwalls at Cawley's Creek and is 1.3km from LW304). At these distance, the culverts are not predicted to experience valley related movements greater than survey accuracy, due to the extraction of Longwall 304.

Valley closure is not expected to occur in the cuttings along the M1 Princes Motorway, however, minor closure movements could be observed due to differential horizontal movements.

Impact Assessments for the RMS Infrastructure

The M1 Princes Motorway is located more than 850m from Longwall 304 and is outside the Study Area boundary for this longwall.

The motorway (including bridges and associated features) is not expected to experience measurable conventional vertical subsidence, tilt, curvature and strain. The M1 Princes Motorway could experience far-field horizontal movements resulting from the extraction of the Longwall 304 of up to 45 mm, based on the 95% confidence level for observed far-field horizontal movement data for the Southern Coalfield.

Adverse impacts to the M1 Princes Motorway, including the road pavement, slopes, culverts, barriers and furniture, resulting from conventional subsidence movements is considered unlikely to occur due to the extraction of Longwall 304.

Bridge 2 (RMS reference BN616-southbound and BN617-northbound) is located approximately 880 m to the south east of Longwall 304 as shown in Drawing No. MSEC1013-08. The next nearest bridge is Cawleys Rd overpass (RMS reference BN615), located approximately 1.67 km from Longwall 304.

The potential for differential horizontal movement at the bridges was assessed by analysing the far-field horizontal movement data. The data set was analysed to determine incremental relative opening and closing and incremental mid ordinate deviation.

Relative opening and closing movement is calculated as the change in the distance between two survey marks (either positive opening, or negative closing) over two survey epochs.

A plot of the calculated incremental relative opening and closing movement for the current database of observed far-field horizontal movements that were used for this assessment is provided in Figure 2. The incremental relative opening and closing movement was calculated for pegs with a spacing of 20 m ±10 m.

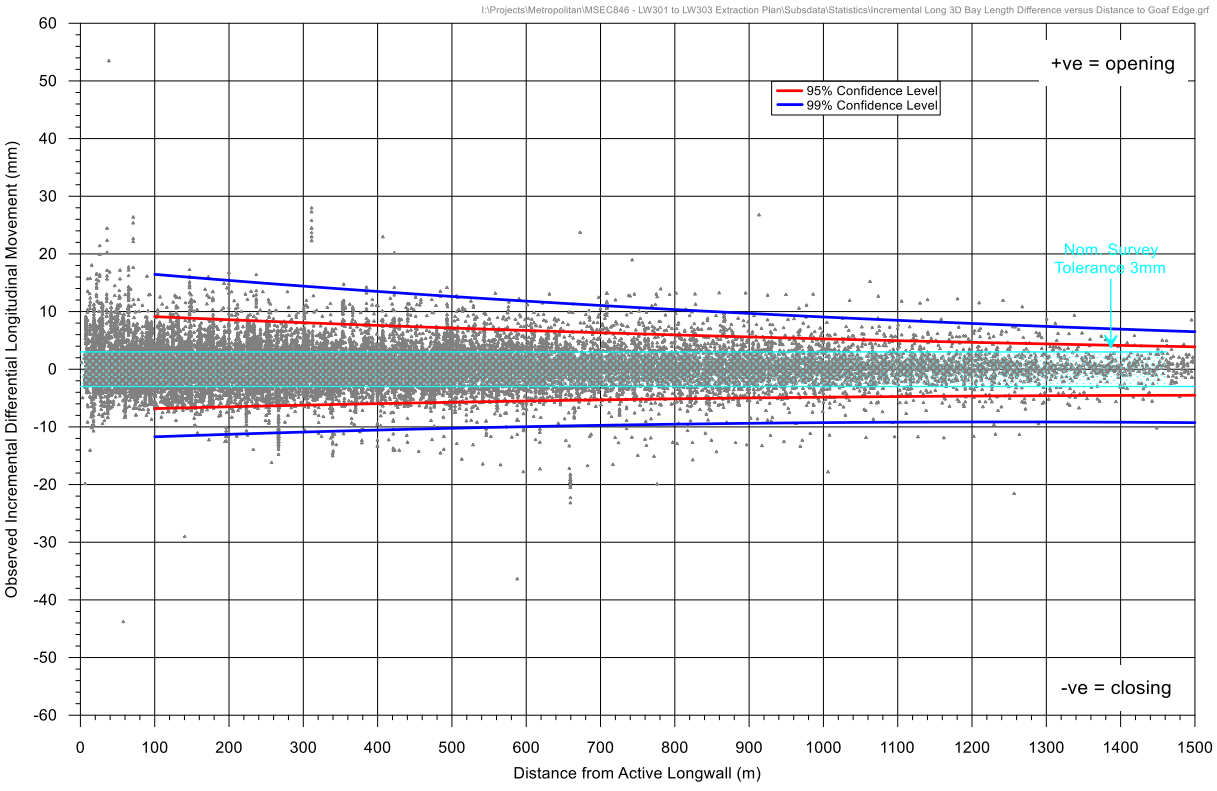


Figure 2 Incremental Differential Horizontal Movements versus Distance from Active Longwall for Marks Spaced at 20 m ±10 m

Mid ordinate deviation provides a measure of out of plane movement or horizontal bending by calculating the mid ordinate deviation between three survey pegs. The mid ordinate deviation is the change in perpendicular horizontal distance from a point to a chord formed by points on either side. A schematic sketch of the mid ordinate deviation is provided in Figure 3

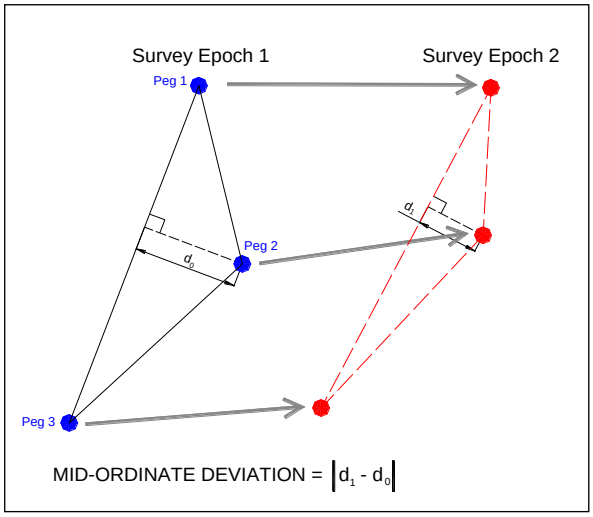


Figure 3 Schematic Representation of Mid Ordinate Deviation

A plot of the calculated incremental mid-ordinate deviation for the current database of observed far-field horizontal movements that were used for this assessment is provided in Figure 4. The mid-ordinate deviation was calculated for pegs with a spacing of 20 m ±10 m, or an approximate spacing of 40 m over the three pegs.

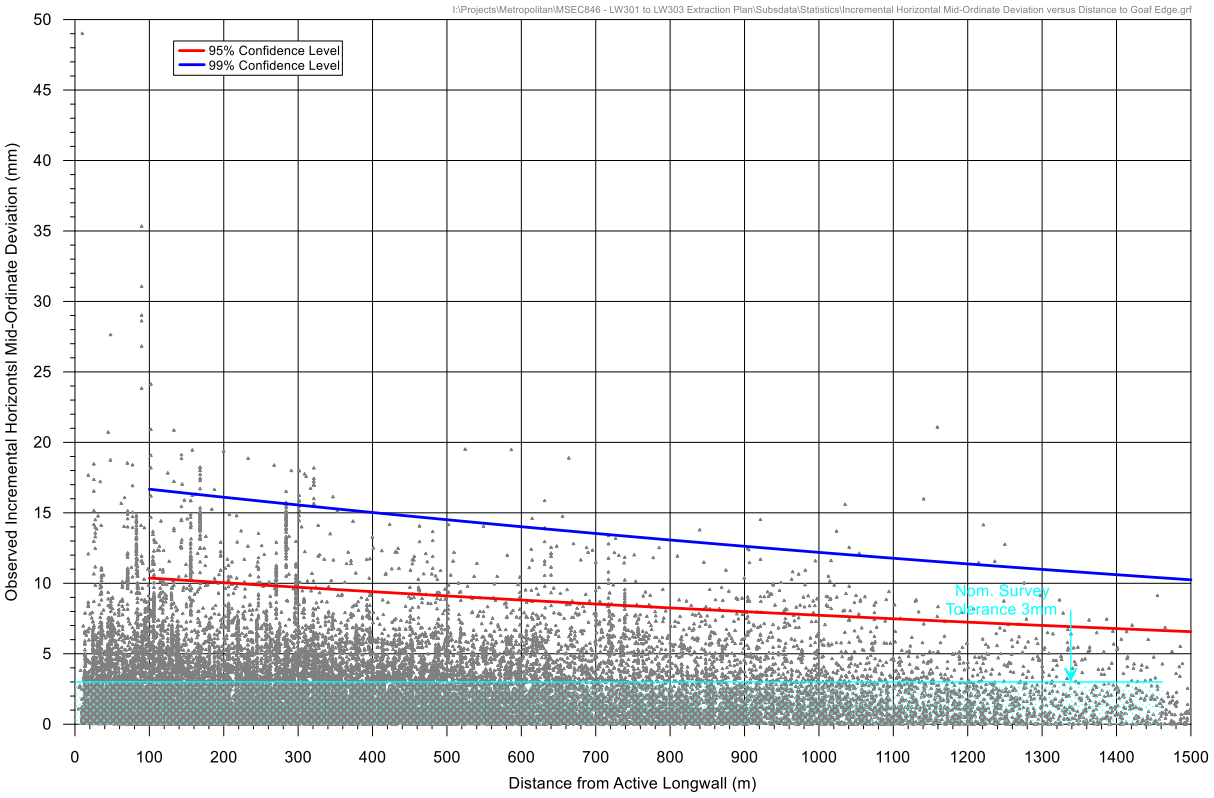


Figure 4 Observed Incremental Mid Ordinate Deviation versus Distance from Active Longwall for Marks Spaced at 20 m ±10 m

The incremental relative opening and closing and mid ordinate deviation for various probabilities for Bridge 2 at a distance of approximately 880 metres from an active longwall are summarised in Table 2.

Table 2 Incremental Relative Opening, Closing and Mid-Ordinate Deviation at Approximately 880 metres Distance from Active Longwall

	1 in 20 probability (95% confidence level)	1 in 100 probability (99% confidence level)	1 in 2000 probability (99.95% confidence level)
Opening	6 mm	10 mm	20 mm
Closing	5 mm	10 mm	21 mm
Mid-Ordinate Deviation	8 mm	13 mm	18 mm

The incremental relative opening and closing and mid ordinate deviation for various probabilities for Cawleys Road Overpass at a distance of approximately 1.67 kilometres from an active longwall are summarised in Table 3.

Table 3 Incremental Relative Opening, Closing and Mid-Ordinate Deviation at Approximately 1.67 kilometres Distance from Active Longwall

	1 in 20 probability (95% confidence level)	1 in 100 probability (99% confidence level)	1 in 2000 probability (99.95% confidence level)
Opening	4 mm	7 mm	14 mm
Closing	5 mm	9 mm	19 mm
Mid-Ordinate Deviation	7 mm	10 mm	16 mm

An assessment of Bridge 2 and Cawleys Road overpass by Cardno was undertaken for the extraction of Longwalls 301 to 303 and indicated that the bridges were sensitive to small differential movements. Given closer proximity of Bridge 2 to the extracted longwalls, a high accuracy monitoring system, using fibre optic monitoring, was implemented by the RMS technical committee to monitor movements at Bridge 2. A monitoring system for Cawleys Road overpass using fixed survey prisms was established.

It is recommended assessment of the bridges be undertaken by the RMS technical committee to review the suitability of the monitoring and management strategies that were developed for Longwalls 301 to 303.

Summary

The M1 Princes Motorway is located greater than 850 metres to the east of Longwall 304. The two nearest bridges, Bridge 2 and Cawleys Road Overpass, are located 880 m and 1.67 km from Longwall 304 respectively. The RMS infrastructure is located outside the Study Area for Longwall 304. At these distances, the RMS infrastructure is not expected to experience measurable conventional subsidence movements but could experience low level far-field horizontal movements.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301-303 are updated and continued, in consultation with RMS, to manage the potential impacts on the RMS infrastructure. It is expected that the RMS infrastructure can be maintained in safe and serviceable conditions with the implementation of the appropriate monitoring and management strategies.

Yours sincerely

Peter DeBono

Mine Subsidence Engineering Consultants

Attachments:

Drawing No. MSEC1013-08 – Longwall 304 – RMS

I:\Projects\Metropolitan\MSEC1013 - LW304 Stakeholders Consultation\AcadData\MSEC1013-08 RMS.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COAL
METROPOLITAN COLLIERY
LONGWALL 304
RMS

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	1:12500	MSEC1013-08	02

313 000 314 000 312 000
6 218 000 6 217 000 6 216 000 6 215 000
Grid to MGA co-ordinates

CAWLEYS ROAD OVERPASS
CAWLEYS CK
WORONORA RESERVOIR
STUDY AREA
20mm SUBSIDENCE CONTOUR
OLD PRINCES HIGHWAY
LW304
LW303
LW302
LW301
1670m
930m
850m
880m
M1 PRINCES MOTORWAY
CUTTING 13563
CUTTING 10425
EMBANKMENT
CUTTING 13562
CUTTING 10426
CUTTING 13561
CUTTING 10427
DYKE
CUTTING 13560
CUTTING 10428
EMBANKMENT
EMBANKMENT
WILSONS CK
PRINCES HIGHWAY UNDERPASS (BRIDGE 2)
CUTTING 13559
MAIN WEST FAULT
POWELL FAU
FAULT

LEGEND
- RMS INFRATRUCTURE- M1 PRINCES MOTORWAY
- BRIDGES
- CUTTINGS
- EMBANKMENTS
- CULVERTS
- GEOLOGICAL FAULTS AT SEAM LEVEL

APPENDIX 3

GLOSSARY OF TERMS AND DEFINITIONS

Some of the more common mining terms used in the built features management plan are defined below:

Angle of draw The angle of inclination from the vertical of the line connecting the goaf edge to the limit of subsidence (which is usually taken as 20 millimetres [mm] of subsidence).

Closure The reduction in the horizontal distance between valley sides. The magnitude of closure, typically expressed in mm, is the greatest reduction in distance between any two points on opposing valley sides. The observed closure movement across a valley is the total movement resulting from various mechanisms, including conventional mining induced movements, valley closure movements, far-field effects, downhill movements and other possible strata mechanisms.

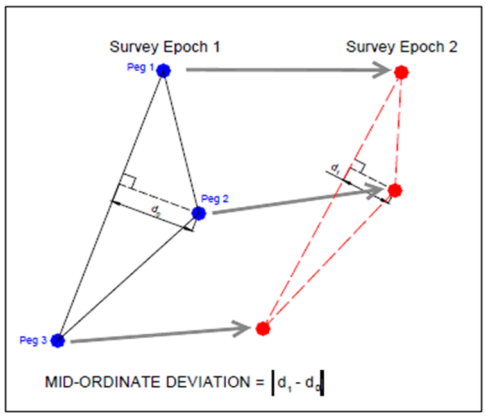
Confidence Level The likelihood that an observed value will be less than the stated value.

Distortion (of a structure) The change is dimension, shape or geometry of a structural element resulting in the development of stresses and strains in that element.

Far-field movements The measured horizontal movements at pegs that are located over solid unmined coal areas beyond the longwall panel edges. Far-field horizontal movements tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain.

Horizontal displacement The horizontal movement of a point on the surface of the ground as it settles above an extracted panel.

Mid-Ordinate Deviation Horizontal displacement measured across a monitoring line. Mid-ordinate deviation is a measure of horizontal shear deformation and can also be described by other parameters including: horizontal tilt; horizontal curvature; angular distortion; and shear index. Mid-ordinate deviation is illustrated in the following sketch:



Probability of Exceedance The probability that an observed value will be greater than the stated value.

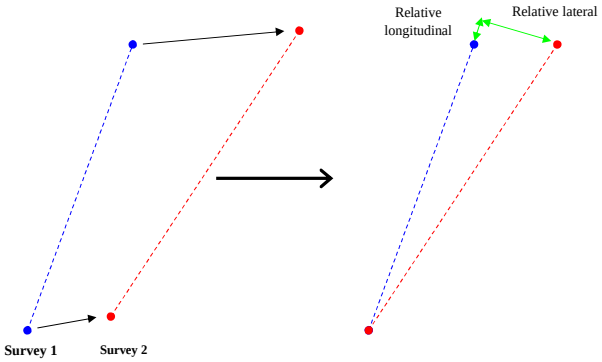
Relative Movement

Relative movement is the change in position between two or more surveyed points. Relative movement is normally measured along two or three axes (δX, δY, δZ) and the axes can be aligned in any convenient direction (e.g. along a monitoring line, aligned with a feature, aligned with north). (Also referred to as Differential Movement).

Relative movement of the **ground** at RMS Bridge 2 refers to movement of ground survey points located at the bridges supporting columns and blade walls relative to other such ground points.

Relative movement of the **structure** of RMS Bridge 2 refers to movement of a point on the bridge structure relative to other such points.

Relative Lateral and Longitudinal Horizontal Movements refer to relative horizontal movement across and along the alignment of two ground monitoring survey marks respectively. For the survey of bridges, the longitudinal direction adopted is the direction in which the bridge girders span (i.e. in the direction of traffic movement).



Strain

The change in the horizontal distance between two points divided by the original horizontal distance between the points. Strain is dimensionless and can be expressed as a decimal, a percentage or in parts per notation.

Tensile Strains occur where the distance between two points or survey pegs increases and **Compressive Strains** occur where the distance between two points decreases.

Subsidence

The vertical movement of a point on the ground surface as it settles above an extracted panel, but, 'subsidence of the ground' in some references can include both a vertical and horizontal movement component. Subsidence is usually expressed in units of mm. In this document subsidence relates only to vertical movement.

Tilt The change in the slope of the ground as a result of differential subsidence, and is calculated as the change in subsidence between two points divided by the horizontal distance between those points. Tilt is, therefore, the first derivative of the subsidence profile. Tilt is usually expressed in units of millimetres per metre (mm/m). A tilt of 1 mm/m is equivalent to a change in grade of 0.1 percent, or 1 in 1000.

Upsidence Upsidence results from the dilation or buckling of near surface strata at or near the base of a valley. The magnitude of upsidence, which is typically expressed in mm, is the difference between the observed subsidence profile within the valley and the conventional subsidence profile expected in flat terrain.

APPENDIX 4

METROPOLITAN COLLIERY LONGWALL MINING – LW 301-303 RISK ASSESSMENT AS APPLIED TO RMS ASSETS

Roads & Maritime Services

Metropolitan Colliery Longwall Mining – LW301-303

Risk Assessment as Applied to RMS Assets

250981/REP/001

Issue | 7 November 2016

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 250981-00

Arup
Arup Pty Ltd ABN 18 000 966 165

Arup
Level 17
1 Nicholson Street
East Melbourne VIC 3002
Australia
www.arup.com

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Document Verification

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Job title		Metropolitan Colliery Longwall Mining – LW301-303			**Job number** 250981-00
Document title		Risk Assessment as Applied to RMS Assets			**File reference**
Document ref		250981/REP/001			
Revision	**Date**	**Filename**	20160902 RMS Report - Draft 1.docx		
Draft 1	02 Sep 2016	**Description**	First draft		
			Prepared by	Checked by	Approved by
		Name	Jenny Li	Nigel Cann	Nigel Cann
		Signature			
Draft 2	29 Sep 2016	**Filename**	20160929 RMS Report - Draft 2.docx		
		Description	Second draft incorporating feedback comments		
			Prepared by	Checked by	Approved by
		Name	Jenny Li	Jenny Li	Nigel Cann
		Signature			
Draft 3	20 Oct 2016	**Filename**	20161020 RMS Report - Draft 3.docx		
		Description	Third draft – includes assessment of Cawley Road Overpass		
			Prepared by	Checked by	Approved by
		Name	Jenny Li	Jenny Li	Nigel Cann
		Signature			
Issue	07 Nov 2016	**Filename**	20161107 RMS LW301-303 Report - ISSUE.docx		
		Description	Issue		
			Prepared by	Checked by	Approved by
		Name	Jenny Li	Jenny Li	Nigel Cann
		Signature			
				Issue Document Verification with Document	✓

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Appendices

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Risk Register

Appendix B

Workshop Participants

Appendix C

Workshop Agenda

Appendix D

Risk Criteria

Appendix E

Peabody Presentation

Appendix F

MSEC Report

1 Introduction

Arup has been engaged by Roads & Maritime Services (RMS) to undertake a risk assessment with regards to the impacts on RMS assets arising from subsidence due to the mining of longwalls LW301-303 in the Metropolitan Mine which is owned by a subsidiary of Peabody Energy (Peabody).

Previous risk assessments were completed in 2009 and 2013 on the impacts of subsidence from LW20-22 and LW23-27 respectively. A history of the impacts of subsidence has been gained, along with knowledge about the performance of mitigation control measures applied and the reliability of the monitoring systems utilised.

As with the previous assessments, the concern of RMS is the possible impacts from the mining of LW301-303 on its surface assets with a specific emphasis on how the mining might result in financial loss to RMS, loss of functionality of the assets with regards to the road users (motorists and public) and possible life safety issues, should the mining adversely impact on any of the assets.

The process adopted by Arup follows closely the principles set out in AS/NZS ISO31000:2009 – Risk Management, and also the various standards of RMS, specifically those relating to the assessment of risks posed by subsidence mining.

Arup undertook an inspection of the assets followed by a facilitated workshop with relevant stakeholders to firstly identify the assets at risk and then ascertain the risks posed to those assets from the mining of LW301-303. This same workshop also considered various mitigation and control measures and determined the effectiveness of these in reducing risk levels.

The events and activities identified in the workshop will be addressed and managed in the Built Features Management Plan for LW301-303.

2 Description of Proposed Mining

Peabody, or Metropolitan Colliery (MC), proposes to extract longwalls LW301-303 as part of its ongoing underground coal mining operations within the Bulli Seam at the Metropolitan Mine. The mine is located in the Southern Coalfield of New South Wales. The overall layout of longwalls LW301-303 is shown in Figure 1.

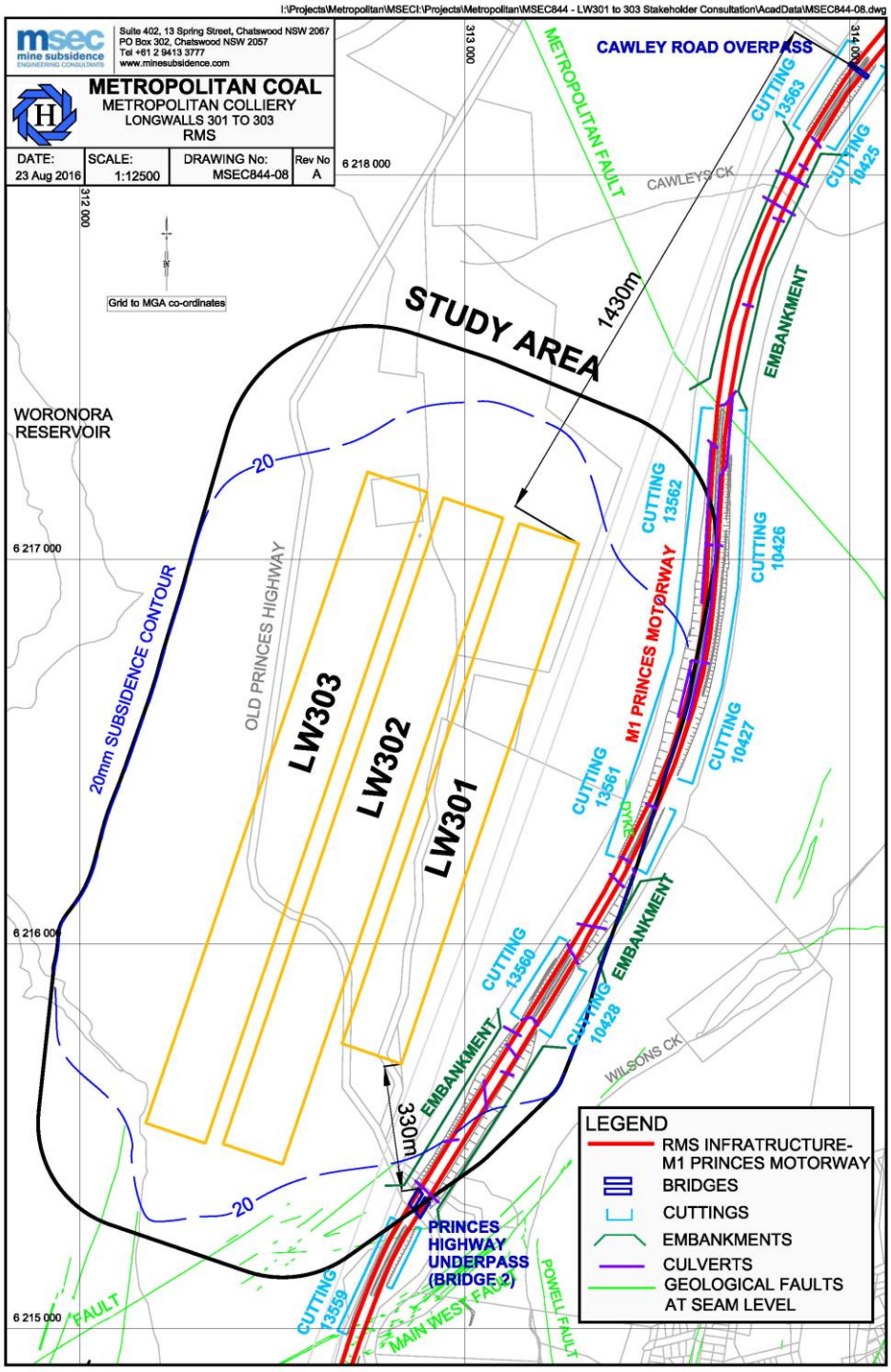

Figure 1: Layout of LW301-303

3 RMS Assets Affected

Figure 1 shows the extent of the proposed mining in relation to various RMS assets.

The RMS guidelines [Ref 1] define the zone of interest for infrastructure impacts as being five times the depth of cover. With a depth of cover of approximately 400m, the zone of interest extends some 2km from the longwalls.

The M1 Princes Motorway is located to the east of LW301-303. The distance of the M1 from LW301-303 varies from 210m near the finishing (southern) end of LW301 to 335m near the commencing (northern) end of LW301. There is also a series of cuttings and embankments up to a maximum height of approximately 20m along the M1.

There are two bridges (BN616/617) carrying the northbound and southbound traffic on the M1 Princes Motorway over the old Princes Highway and are located approximately 330m from LW301. The next nearest bridge is Cawley Road Overpass (BN615), which is located approximately 1.43km to the north east of LW303.

A series of culverts of varying diameters from 375mm to 1800mm cross the M1 Princes Motorway. A number of the culverts are asbestos cement pipes. In addition to the culverts, there are also a number of other drainage structures, such as kerbs, gutters, pits and drainage pipes. The largest culvert comprises two 1800mm pipes located to the north east of the longwalls at Cawley's Creek.

It should be noted the two large culverts and Cawley Road Overpass are located well outside the predicted 20mm subsidence contour.

3.1 Predicted Ground Movements

Mine Subsidence Engineering Consultants Pty Ltd (MSEC) presented their predictions of ground movements for RMS assets from the mining of LW301-303, and a broad assessment of impact on the assets in a report which is included as Appendix F.

3.1.1 Movements Affecting the M1 Motorway

The following is a summary of the ground movement predictions for the M1 Motorway, as stated in the MSEC report in Appendix F:

- The maximum predicted conventional tilt and curvature are less than the expected limits of survey accuracy (i.e. 0.5mm/m for tilt and 0.01km^{-1} for curvature).
- The M1 will potentially experience far-field horizontal movements of up to 115mm, based on a 95% confidence level, from a database of observed far-field horizontal movements in the Southern Coalfield.
- Similarly from the Southern Coalfields survey database, the 95% confidence intervals for the maximum total strains that the individual survey bays above

solid coal (100-250m) experienced at any time during mining are 0.4mm/m tensile and compressive.

- Predicted valley closure across the culvert at the location of the M1 is less than 20mm.
- Valley closure is not expected to occur in the cuttings along the M1, however, minor closure movements could be observed due to potential horizontal movements.

3.1.2 Movements Affecting Bridges

Because of the critical function of Bridge 2, and as for other bridges, RMS requires assessment of the effects of ground movements of magnitudes that have 1 in 100 and 1 in 2000 probability of exceedance due to mining. This is consistent with the limit state approach to bridge design (and checking) embodied in the Bridge Design Standard (AS5100). MSEC has therefore produced values for incremental relative opening, closing and mid-ordinate deviation at various probabilities, including 1 in 100 and 1 in 2000, to be applied to the bridge elements in both the longitudinal and transverse directions of the bridge for the assessment of potential effects on the bridge structure. Refer to the MSEC report in Appendix F for the relative movement values at various probabilities of exceedance.

The following is a summary of the ground movement predictions for Bridge 2, derived from the MSEC report in Appendix F.

At Bridge 2, a distance of approximately 330m from the closest point of the longwalls, the predicted subsidence parameters are less than survey tolerance, which is typically 20mm for subsidence, 0.5mm/m for tilt and $0.01km^{-1}$ for curvature. The absolute horizontal movements measured at distances greater than 330m are in the order of 95mm based on the 95% confidence level.

Differential horizontal movements, which are most significant for the bridge structures, are difficult to predict since the potential values of relative movement are typically very small. For Bridge 2, there is the added complication that the spacing of bridge support elements varies from 5-18m as compared to the commonly used spacing between survey points along monitoring lines of approximately 20m.

Cawley Road Overpass is located at a distance of 1.43km from Longwall 301 at its nearest point. At this distance, observed far-field movements from the Southern Coalfields database are close to nominal survey tolerance and observed differential horizontal movement data is predominantly within survey tolerance.

However, as for Bridge 2, Cawley Road Overpass needs to be assessed for low probability differential ground movements and MSEC has provided values for incremental relative opening, closing and mid-ordinate deviation at various probabilities of exceedance, including 1 in 100 and 1 in 2000, to be applied to the bridge elements for the assessment of potential effects.

3.2 Assessment of Ground Movement Impacts

3.2.1 Assessment of Impacts on M1 Motorway

The MSEC report in Appendix F included the following broad assessment of impacts on the M1 Motorway.

The predicted conventional vertical subsidence for the M1 resulting from the extraction of LW301-303 is very small and the predicted tilts and curvatures are less than the expected limits of survey tolerance (i.e. 0.5mm/m for tilt and 0.01km^{-1} for curvature). Adverse impacts to the M1, including the road pavement, slopes, culverts, barriers and furniture, resulting from conventional subsidence movements is considered unlikely.

MSEC recommended that monitoring and management strategies are developed to manage the potential impacts on the M1, which would allow for the motorway to be maintained in a safe and serviceable condition.

3.2.2 Assessment of Bridges

A detailed quantitative assessment of the potential impacts of ground movements from Longwalls 301 to 303 on Bridge 2 (BN616/617) has been undertaken by the RMS Technical Committee. The Committee commissioned the bridge specialist on the committee (Cardno) to investigate and report on the potential effects on the bridge of the 1 in 100 and 1 in 2000 exceedance probability for differential ground movements. The report on that investigation was issued to the committee in May 2015. As ground movements of varying probability of exceedance were investigated, this could be considered to be a detailed quantitative risk assessment.

In summary, the assessment found that the 1 in 100 probability differential ground movements could be tolerated by the structure with only relatively minor cracking as the worst consequence. It found that the 1 in 2000 probability differential ground movements could produce unacceptable effects including structural failure at some locations, if they occurred at disadvantageous locations. It this unlikely event, mining of the longwall may have to be terminated earlier than planned.

A similar detailed quantitative assessment of the effects of low probability differential ground movements on the Cawley Road Overpass was carried out. It found that the Cawley Road Overpass can tolerate the predicted ground movements up to the 1 in 2000 probability values.

4 Risk Workshop

On 25 August 2016, a risk workshop was convened at the RMS Offices in Wollongong. The purpose of this workshop was to assess the risks posed to the assets of the RMS from this proposed longwall mining operation. A list of the participants at the workshop is included in Appendix B. The agenda is attached in Appendix C.

Peabody Energy provided an overview of the LW301-303 extraction area, an update on the mine activities and the current location and an update on the subsidence performance to date and inspections of the RMS assets (refer to Appendix E).

This workshop was qualitative and used the RMS look up sheets for assessing both frequency and consequence. These sheets have been adopted as the standard by the RMS when assessing the risk posed to their assets from subsidence mining. The look up sheets for assessing frequency, consequence, and the risk matrix are included in Appendix D.

The assets considered in the risk assessment included:

- Bridge 2 – BN616 (southbound) and BN617 (northbound);
- Cawley Road Overpass – BN615;
- Carriageway;
- Culverts;
- Kerb;
- Cuttings;
- Embankments;
- Furniture;
- Drains;
- Variable Message Sign (VMS); and
- Other structures such as power lines (which are not RMS assets but failure may affect RMS assets).

The workshop used the risk register from the previous studies (LW20-22 and LW23-27) as the basis of discussion and reviewed each of the risks. For new items, a check-list of Assets and Fault/Failure modes was used to trigger thoughts and discussion. This information was recorded in the risk register, attached in Appendix A.

5 Results

A total of 19 risk events were identified during the workshop, of which 11 were not considered to present a credible risk (the level of possible impacts was not measurable). Additional mitigations were discussed for 11 risk events.

The risk profile before and after the application of additional mitigation measures is presented in Table 1. It should be noted that all the additional mitigations suggested involve monitoring which does not change the risk ratings of the event.

Table 1: Risk Profile Before and After Implementation of Additional Mitigations

Receptor	Infrastructure				Functionality				Safety			
Risk Level	E	H	M	L	E	H	M	L	E	H	M	L
Base Risk Score	0	1	2	3	0	2	0	4	0	0	1	5
Final Risk Score	0	1	2	3	0	2	0	4	0	0	1	5

5.1 Carriageway

Generally tensile strains are expected on the carriageway due to mining of LW301-303. Hence tensile cracking would be expected as a result of normal subsidence movements. The level of predicted strain is relatively low (0.7mm/m for a 99% confidence level). Hence small tensile cracks can be expected. Minor humping is possible if shear occurs along some geological structure. Hence, in terms of the carriageway, there could be deformations such as minor cracks and humps due to the mining of LW301-303.

Visual inspections at the end of each panel would be appropriate to check for any cracks or deformations caused by the mining activities. RMS also performs drive-through checks during mining. A base line inspection needs to be recorded prior to commencement of mining.

The workshop group discussed that if possible, the planned resurfacing of the carriageway by RMS should be delayed until after LW303 has been mined (planned to be completed by quarter 1, 2019). This can remediate the road for any damage caused by the mining activities, as well as general road use wear and tear. In the interim crack sealing could be carried out where tension cracks occur.

5.2 Culverts

With valley closure movements less than 20mm anticipated, there are unlikely to be anything more than minor impacts on the culverts.

For the culverts a pre-mining condition assessment using CCTV should be completed and any further inspections should be performed as per the Monitoring Plan.

5.3 Cuttings

Stabilisation of the cuttings has recently been completed, and the post stabilisation risk rating of these cuttings is underway. It is anticipated that the Assessed Risk level (ARL) of the cuttings will be no worse than ARL3. It is unlikely that there will be any change in the risk ratings due to mining due to the low level of mining related movements anticipated.

For the cuttings, a survey is proposed at the end of completion of each panel. Monitoring of the transmission lines will also provide early indications for the cuttings within the 20mm subsidence contour. If the measurements exceed predicted levels, this may trigger a survey to be completed along the cuttings.

The regular RMS maintenance inspections are to include monitoring of rock fall.

5.4 Bridge and Overpass

Bridges BN616 and BN617 have been setup to allow for monitoring of differential movements between key points on the structures. The monitoring provisions include installation of survey targets fixed at key points and FBG sensor cable to measure relative movement of key points at the tops of piers and abutments. The monitoring systems aim to detect distortion of the bridges which can then be assessed by Cardno to determine the effects on the structure.

The monitoring strategy for the Cawley Road Overpass (BN615) includes only the installation of survey targets fixed at key points. This aim to detect distortion of the bridges which can then be assessed by Cardno to determine the effects on the structure. If significant differential movements are detected, increase frequency of monitoring to understand the trend of movement.

The transmission lines and Princes Hwy are also monitored by survey and this data can be used to predict potential impacts at the bridges. If significant relative movements are detected, then the frequency of monitoring at bridges should be increased to understand the trend of movement.

6 Conclusions

A risk assessment workshop has been completed to understand the risks to RMS assets from the mining of longwalls LW301-303. The events and activities identified in the workshop will be addressed and managed in the Built Features Management Plan for LW301-303.

It is recommended that the existing monitoring of the assets is to continue and be adaptive to unexpected subsidence changes.

Appendix A

Risk Register

ROADS & MARITIME SERVICES

RISK ASSESSMENT - SUBSIDENCE IMPACTS ON RMS ASSETS FROM LONGWALLS LW301-303

RISK REGISTER - 7 November 2016 | ISSUE | REV A

ID	ASSET	FAILURE TYPE	EVENT	Infra			Function			Safety			COMMENT	ADDITIONAL MITIGATION	Infra			Function			Safety			COMMENT
				F	C	R	F	C	R	F	C	R			F	C	R	F	C	R	F	C	R	
1	Carriageway	Cracking in the transverse direction	Build up of tensile stresses in the carriageway adjacent to LW301 causing cracks in the transverse direction.	D	1	L	D	1	L	D	1	L	Pavement cracks in the transverse direction (due to longitudinal strains) would not be extensive. Strains are expected to be tensile within the 20mm subsidence contour but would be of low order - approximately 0.4mm/m (95% confidence level). It is likely that multiple cracks will form that can be resolved by crack sealing. Extensive zones of compressive strains are not anticipated and with compressive stains of approximately 0.4mm/m (95% confidence level), no discernable impacts are anticipated.	End of Panel check visual inspection would be appropriate. Also continue RMS drive through check during mining. Base Line inspection needs to be recorded.	D	1	L	D	1	L	D	1	L	
2		Cracking in longitudinal direction	Build up of tensile stresses in the carriageway causing cracks in the longitudinal direction.	D	1	L	D	1	L	D	1	L	Pavement cracks in the longitudinal direction (due to transverse strains) would not be extensive due to the limited width of pavement in the transverse direction. Strains are expected to be tensile within the 20mm subsidence contour but would be of low order - approximately 0.4mm/m (95% confidence level). Over a 12m carriage way width, the maximum single crack would be <5mm. More likely, multiple cracks of smaller widths will form that can be resolved by crack sealing. For compressive strains, no impacts are anticipated due to the 12m carriageway width.	End of Panel check visual inspection would be appropriate. Also continue RMS drive through check during mining. Base Line inspection needs to be recorded.	D	1	L	D	1	L	D	1	L	
3		Stepping	Rapid pavement failure, leading to hump or step										Not credible for the proposed longwalls.										
4		Deformations through geological structures and cut fill interfaces.	Structures to south of area at seam level. Dyke at Cutting 13561.	E	2	L	E	2	L	E	2	L	Small deformations expected (humping and cracking). Can be detected through drive throughs and corrected as required.	End of Panel check visual inspection would be appropriate. Also continue RMS drive through check during mining. Base Line inspection needs to be recorded.	E	2	L	E	2	L	E	2	L	Planned resurfacing by RMS should be delayed till after LW303 - Q1 2019 if condition allows.

5	Culvert	Culvert cracking due to mining movements	Culvert joints open, culvert damage (minor cracking)	E	3	M	E	1	L	E	1	L	If there is shearing movement, there should not be any issues. Probability of fault movement is very low as the mining is planned to not cause movement in the faults. Most culverts are asbestos cement. Pipes <500mm diameter, stresses would not cause a problem unless the pipes are already frail.	Premining condition assessment of culverts (using CCTV). Further inspections as per Monitoring Plan.	E	3	M	E	1	L	E	1	L	
6		Lose culvert grading	Ponding.										Not credible for the proposed longwalls.											
7	Kerb	Kerb/gutter cracking / buckling	Included as part of Pavement Assessment.																					
8	Cuttings	Excessive ground movement causing localised instability	Material falling onto the road. Remediation works already completed include grooming of slopes, shot-creting, fencing, rock netting and benching already completed. These treated slopes are in cuttings closest to LW301-303 and were re-rated by RMS in 10/16 as ARL4. The predicted movements are relatively minor - <50mm for subsidence and <20mm for valley closure, and these movements will not change the risk ratings for these slopes.										Tensile cracking at the top of the cuttings could occur and this could cause water infiltration. However, the dyke is more likely to weather. Cuttings at Cawleys Road Overpass (CRO) – These cuttings are rated ARL2 (high risk), but are located ~1300m from the start line of LW301. Also, the Metropolitan Fault lies between LW301 and CRO, thereby forming a barrier to mining related movements at the cuttings. While movements of concern are not expected, these cuttings will be included in the monitoring proposed for CRO. Cuttings (2) south of LW301 – The nearer cutting rated ARL3 is ~870m from the LW301 finish line, and the other rated ARL2 is ~1120m from the LW301 finish line. While no discernable movements are expected at these cuttings from the mining of LW301-303, the cuttings will be monitored in accordance with Table 9 of the BFMP.	Survey monitoring at the completion of mining of each longwall. Monitoring of the transmission lines will provide early indications for the cuttings within the 20mm subsidence contour. If the measurements exceed predicted levels, this may trigger a survey to be completed along the cuttings. Maintenance inspections to include monitoring of rock fall. Inspection will be carried out during the daytime network inspection which occurs at a frequency of once per week with the direction alternating.									Refer attached memo.
9	Embankments	Excessive ground movement leading to localised slip failure	Cracks, water, instability.										These are flexible earth structures. Any issues are hypothetical. Not credible for the proposed longwalls.											
10	Furniture		Damage and serviceability issues.										Not credible for the proposed longwalls.											
11	Drains (above cuttings)		Damage to drains.										Not credible for the proposed longwalls.											
12	VMS	Excessive ground movement	Damage to the VMS.										Not credible for the proposed longwalls.											

| | | |

14	Bridge 2 (BN616 - southbound / 617 - northbound)	Distortion of bridge elements leading to inconsequential cracking (<0.1mm)	Differential movements between key points on the bridge of up to 5mm									The probability of occurrence of differential movement of this magnitude is as low as 1 in 10. No credible consequences.	Monitoring of differential movements between key points in structure from which effects on the bridge can be assessed. Monitoring systems includes surveying (to pick up 70% key points) and FBG sensor (to pick up 40-50% of key points, but much more accurate). If significant differential movements are detected, increase frequency of monitoring to understand the trend of movement.									
15		Distortion of bridge elements leading to cracking that may require repair (between 0.1mm and 1.0mm)	Differential movements between key points on the bridge of 6mm to 15mm.	B	1	M	B	2	H	B	1	M	The probability of occurrence of differential movement of this magnitude is in the order of 1 in 100. Works to repair cracks will affect old Princes Hwy, not the M1.	As above. No economical mitigation measures to prevent the "failure" are possible.	B	1	M	B	2	H	B	1	M	
16		Distortion of bridge elements leading to development of wide cracks that would be considered as structural failure (>1.0mm)	Differential movements between key points on the bridge of 16mm to 44mm.	E	5	H	E	5	H	E	2	L	The probability of occurrence of differential movement of this magnitude is in the order of 1 in 2000. If differential movement is at a disadvantageous location, structural failure in the form of severe cracking could occur. This would be unacceptable, and the planned end-of-panel location must be brought forward to a position recommended by the Technical Committee well before differential movements reach this magnitude, for a termination of mining earlier than planned to avoid failure of the structure.	As above. No economical mitigation measures to prevent the "failure" are possible.	E	5	H	E	5	H	E	2	L	
17	Cawley Road Overpass (BN615)	Distortion of bridge elements leading to inconsequential cracking (<0.1mm)	Differential movements between key points on the bridge of up to 10mm.									The probability of occurrence of differential movement of this magnitude is as low as 1 in 10. No credible consequences.	Monitoring of differential movements between key points in structure from which effects on the bridge can be assessed. If significant differential movements are detected, increase frequency of monitoring to understand the trend of movement.									
18		Distortion of bridge elements leading to cracking that may require repair (between 0.1mm and 1.0mm)	Differential movements between key points on the bridge greater than 10mm and up to 20mm (the upper bound value).									The probability of occurrence of differential movement of this magnitude is in the order of 1 in 100 to 1 in 2000. No credible consequences.	As above.									

NOTE:
RMS guidelines state a coverage zone of 5 times depth of mine (~2km).
All mitigation measures, regardless of the cell in which they are recorded, are deemed to apply to all risk events. Furthermore, control and mitigation measures listed in the report are also deemed to apply to all risk events in the risk register.

AECOM Australia Pty Ltd
Level 21, 420 George Street
Sydney NSW 2000
PO Box Q410
QVB Post Office NSW 1230
Australia
www.aecom.com

+61 2 8934 0000 tel
+61 2 8934 0001 fax
ABN 20 093 846 925

Memorandum

To	Dick Lee Shoy - Chair Technical Committee	Page	1
CC	Technical Committee		
Subject	LW301 to 303: Revised risk ratings for cuttings		
From	Henk Buys		
File/Ref No.	60342368-1.3	Date	28-Oct-2016

1 Introduction

A risk assessment workshop was held on 25-08-2016 to satisfy the requirements for the BFMP-RMS for extraction of Metropolitan coal's longwalls LW701 to LW703. Risks in relation to stability of the existing cuttings along the M1 Princes Motorway in the vicinity of these longwalls were considered at the workshop. The cuttings are listed in MSEC letter report dated 24 August 2016 titled 'Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Roads and Maritime Services Infrastructure'. At the time the risk ranking for these cuttings was ARL2 in accordance with the RMS Guide to Slope Risk Analysis. These cuttings have recently been stabilised and subsequent to the workshop the post stabilisation risk rankings for the cuttings were completed. The updated risk rankings are provided in the table below:

Table 1: Updated risk rankings for cuttings

Cutting	Updated risk ranking	Comment
10425	ARL2	Not stabilised – At Cawleys Road overpass
10426	ARL4	Stabilised
10427	ARL4	Stabilised
10428	ARL4	Stabilised
10430	ARL3	Not stabilised – Approx 870m south of LW301
13557	ARL2	Not stabilised – Approx 1,120m south of LW301
13560	ARL4	Stabilised
13561	ARL4	Stabilised
13562	ARL4	Stabilised
13563	ARL2	Not stabilised – At Cawleys Road overpass

2 Discussion

2.1 Stabilised cuttings (10426, 10427, 10428, 13560, 13561, 13562)

Subsidence of less than 50mm is anticipated at the stabilised cuttings. This together with the substantial stabilisation measures carried out at these cuttings, no observable changes are anticipated at these cuttings. These cuttings will be inspected in accordance with Table 9 of the BFMP.

AECOM

2.2 Cuttings at Cawleys Road overpass (10425, 13563)

These cuttings are approximately 1300m from the LW301 start line. In addition, the Metropolitan Fault between LW301 and Cawleys road overpass forms a barrier to mining related movement at the cuttings. Hence no discernible movement is anticipated at these cuttings. However, due to the ARL2 risk ranking of these cuttings, visual inspections of these cuttings will be triggered by transmission line survey movements and absolute 3D movements as for Cawleys Road overpass. If these triggers are exceeded, visual inspections of the cuttings will be carried out to assess any change in their condition.

2.3 Cuttings south of LW301 (10430, 13557)

Cutting 10430 has an ARL3 ranking and is some 870m from the LW301 finish line. No change in risk ranking for this cutting is anticipated.

Cutting 13557 has an ARL2 ranking, however it is some 1120m from the LW301 finish line. This cutting is unlikely to undergo discernible movements as a result of mining.

Whilst no changes in risk ranking of these cuttings are anticipated, these cutings will be monitored in accordance with Table 9 of the BFMP.

Henk Buys
Technical Director
henk.buys@aecom.com

Mobile: +61 0448 997 500
Direct Dial: +61 2 8934 0127

Appendix B

Workshop Participants

ROADS & MARITIME SERVICES

RISK ASSESSMENT - SUBSIDENCE IMPACTS ON RMS ASSETS

ATTENDANCE SHEET – 25 August 2016

Transport Roads & Maritime Services

Name	Position	Organisation
Nigel Cam	Facilitator – Risk Engineer	ARUP
Henk Buys.	Geotech Engineer	AECOM.
AARON HAGENBACH	ENVIRONMENTAL ENGINEER	RESOURCE STRATEGIES
DICK LEE SHOY	CHAIRMAN-TECHNICAL COMMITTEE	RMS
Cyril Gunaratna	Pavement Manager	RMS
Richard Woods	BRIDGE ENGINEER	CARDNO
Matthew Brunton	Monitoring Engineer	Monitor Optics
PETER DEBONO	MINE SUBSIDENCE ENGINEER	MSEC
JON DEGOTARDI	TECHNICAL SERVICES MANAGER	PEABODY
Dony Castro	Bridge Maintenance Planner	RMS

Appendix C

Workshop Agenda

Peabody ENERGY Metropolitan Colliery

Meeting with Roads & Maritime Services [Technical Committee]

LW301-303 Extraction Plan – Built Features Management Plan
M1 Princes Motorway

25 August 2016 – 10am to 3pm
Wollongong RMS Office - Level 4 Conference Room

Agenda

Purpose of meeting:

- To discuss the subsidence predictions relevant to LW301-303 prepared by MSEC in their letter report dated 11 July 2016.
- Assess the risks relevant to LW301-303 for the Extraction Plan in accordance with the DP&E and DRE Draft *Guidelines for the Preparation of Extraction Plans*.*
- Review existing controls, procedures and programs and update if required for the LW301-303 BFMP.

Item	Detail	Who	Time:
1.	Update on mine activities and current location	Peabody	10am
2.	Short overview of the LW301-303 extraction area		
3.	Subsidence predictions for LW301-303	MSEC	10:15
4.	Update on subsidence performance to date and inspections re: RMS assets (M1 Princes Motorway)	MSEC/Peabody	10:30
5.	Discussion on specific RMS assets including: • Pavement • Bridges (Bridge 2; Cawley Road Overpass) • Cuttings/Embankments • Drains/Culverts • High Accuracy Fibre Optic Monitoring System • Conventional Survey/Visual Inspections • Management Measures • Contingency Measures	Peabody/RMS/MSEC	10:45
6.	Risk assess any changes that may have bearing on the performance of the assets. Review existing controls, procedures and programs in existing BFMP (M1 Princes Motorway) for continued suitability and feasibility and update if required.	Peabody/RMS	12:30
7.	Next Steps • Draft LW301-303 BFMP – for comment	Peabody	2:30-3pm
		TOTAL	4-5 hrs

*The Draft *Guidelines for the Preparation of Extraction Plans* require the BFMPs to include:

- *the results of risk assessment conducted by a competent person in accordance with relevant standards and guidelines;*
- *description of the investigation and analysis methods used in determining the risk control measures and procedures, carried out by a competent person;*
- *description of all risk control measures and procedures, including a statement of the feasibility to manage identified risks; and*
- *a proposed program for implementation of the proposed risk control measures and procedures.*

Appendix D

Risk Criteria

ROADS & MARITIME SERVICES

RISK ASSESSMENT - SUBSIDENCE IMPACTS ON RMS ASSETS

FREQUENCY

Level	Descriptor	Alt. Description	Description	Chance %	Frequency
O	**Absolutely Certain**	Definite	This event will occur / known to occur now *- Will occur several (many) times each year and many times (constantly) during this project*	99.99	Several times each year
A	**Almost Certain**	Frequent	This event is expected to occur in most circumstances *- Expected to occur more than once during the duration of this project*	95	1 / year
B	**Likely**	Probable	This event will probably occur in most circumstances *- Expected to occur once during the duration of the project*	10	at least 1 / 10 years
C	**Possible**	Occasional	This event might (should) occur at some time *- Not likely to occur in life of project, but it is possible.*	1	at least 1 / 100 years
D	**Unlikely**	Remote	This event could occur at some time *- Unlikely (very) to occur in life of project*	0.1	at least 1 / 1,000 years
E	**Rare**	Very Unlikely	This event may occur in exceptional circumstances *- Examples of this have occurred historically, but it is not anticipated for this project*	0.01	at least 1 / 10,000 years
F	**Hypothetical**	Barely credible	Theoretically possible but never occurred to date (anywhere in the world) *- Often applied to natural events*	1.00E-03	every Million years

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ROADS & MARITIME SERVICES

RISK ASSESSMENT - SUBSIDENCE IMPACTS ON RMS ASSETS

CONSEQUENCES

Level	Descriptor	Infrastructure			Amenity			Safety / Societal Cost
		Pavement etc	Bridges	Cost	Access	Speed	Political	
1	**Insignificant**	Minor damage	Minor repairable damage	< $50 k	Some loss in condition	No traffic effect	No political impact	No injuries or health effects
2	**Minor**	Noticeable damage	Damage that will deteriorate if not repaired quickly	< $100 k	One lane closed for < half day; One planned lane closure < 1 day	Speed reduction for < 1 month - 80 kph	Minimal political impact (brief press coverage)	First aid treatment or minor damage to vehicles
3	**Moderate**	Significant damage	Significant damage	< $1 M	One lane closed for < 1 day	Speed reduction for > 1 month - 80 kph or < 1 day - 40 kph	Political impact (press coverage)	Medical treatment required
4	**Major**	Extensive damage	Major damage - restricted speed	< $10 M	One lane closed for > 1 day	Speed reduction for < 1 month - 40 kph	Significant political impact (extensive negative press coverage)	Extensive injuries or one or two permanent disabilities
5	**Catastrophic**	Loss of use of carriageway	Extensive damage. One carriageway closed until repaired	< $50 M	One carriageway closed for > 1 day or both carriageways for < 2 day	Speed reduction for > 1 month - 40 kph	Major political impact (Commission of Enquiry)	Single fatality or severe permanent disabilities to several people
6	**Unthinkable**		Total failure of bridge or closed until repaired	> $50 M	Both carriageways closed for > 2 day	Speed restrictions for > 12 months - 40 kph		Multiple fatalities

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ROADS & MARITIME SERVICES

RISK ASSESSMENT - SUBSIDENCE IMPACTS ON RMS ASSETS

RISK MATRIX

LIKELIHOOD		CONSEQUENCES					
		1 (Insignificant)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Catastrophic)	6 (Unthinkable)
Multiple	O	H	E	E	E	E	E
Almost Certain	A	H	H	E	E	E	E
Likely	B	M	H	H	E	E	E
Possible	C	L	M	H	E	E	E
Unlikely	D	L	L	M	H	E	E
Rare	E	L	L	M	H	H	E
Hypothetical	F	L	L	L	M	H	H

Low	Low risk; managed by routine procedures.
Moderate	Moderate risk; requires above normal attention.
High	High risk; ALARP must be applied.
Extreme	Extreme risk; not acceptable and must be reduced.

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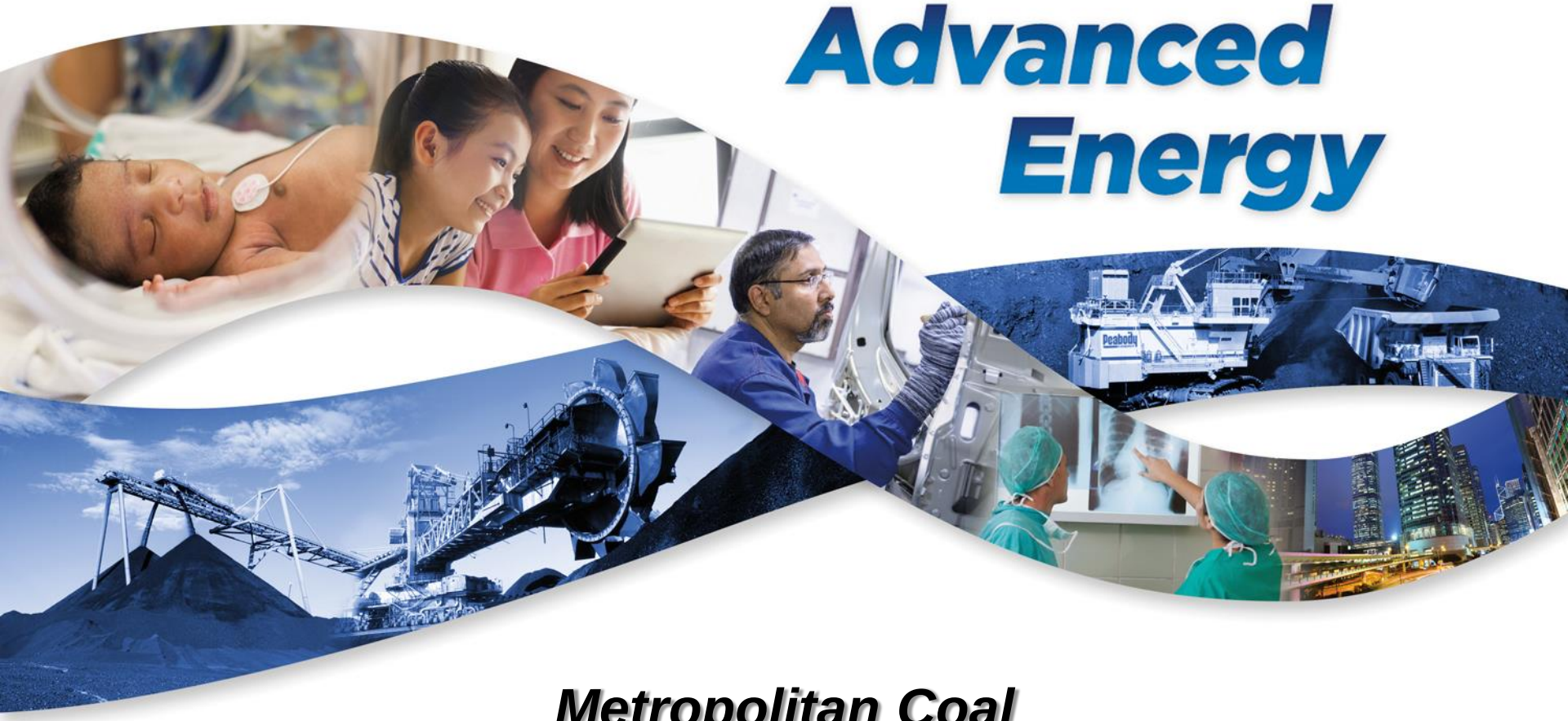
Appendix E

Peabody Presentation



Metropolitan Coal
Longwalls 301-303 Extraction Plan
Built Features Management Plan

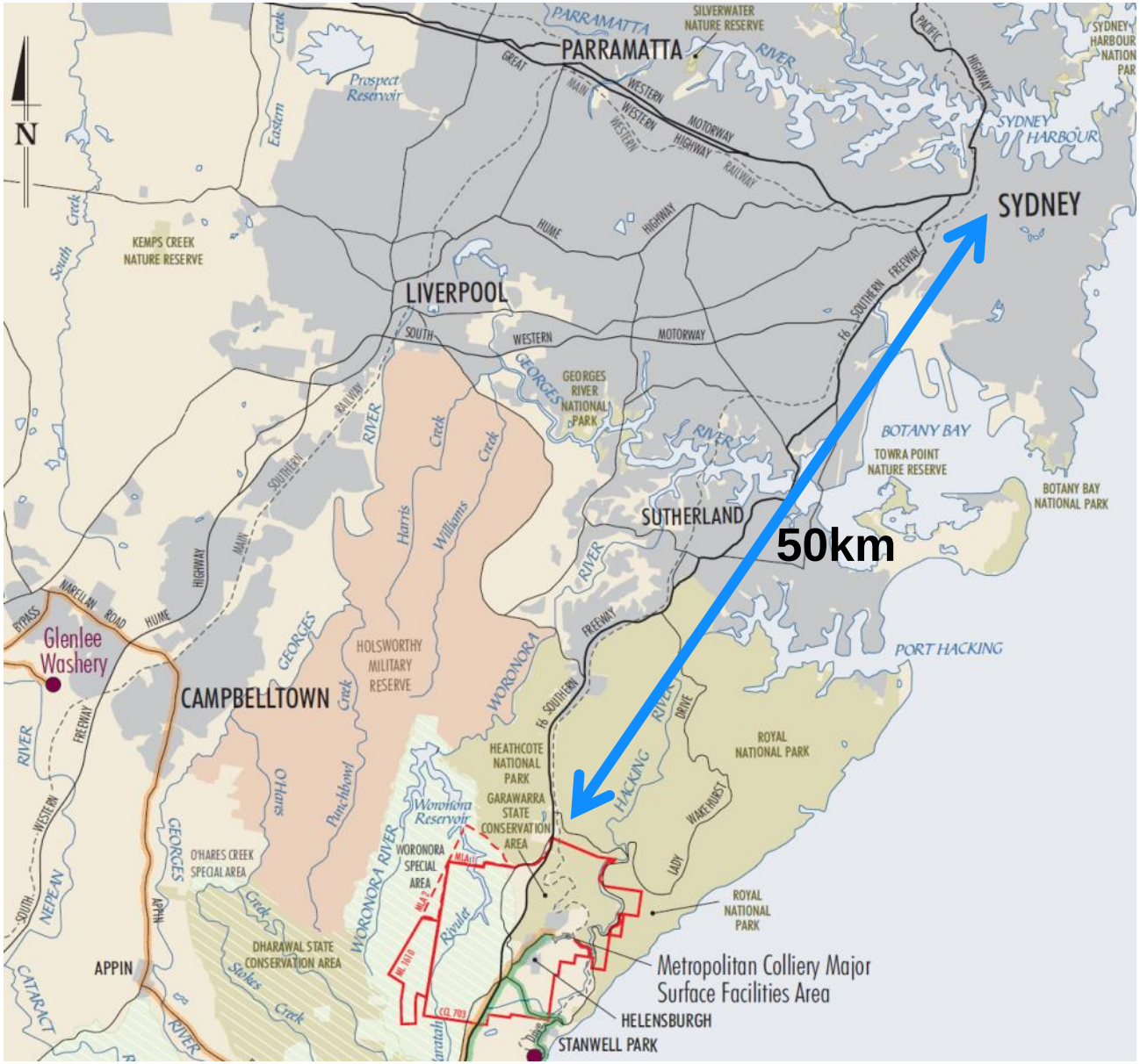
25 August 2016

Jon Degotardi

Technical Services Manager

Peabody ENERGY

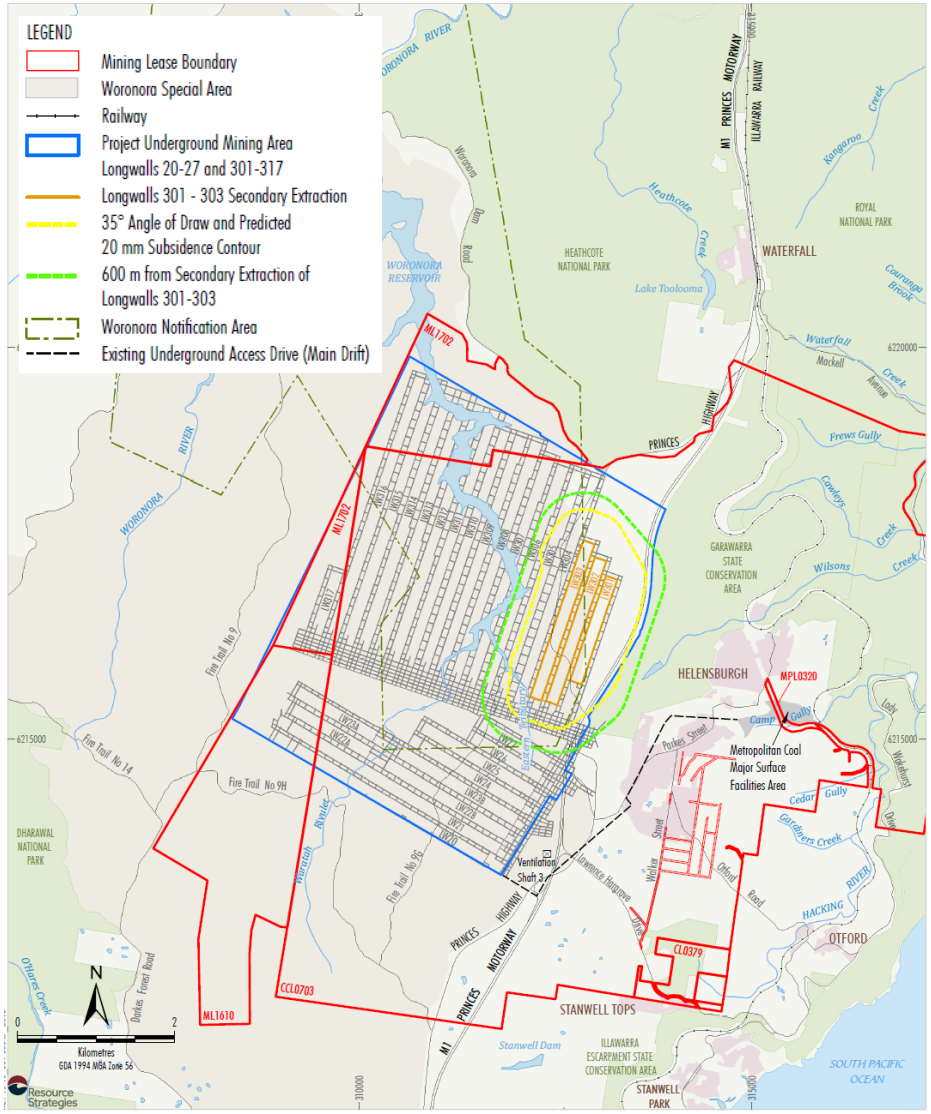
Metropolitan Colliery



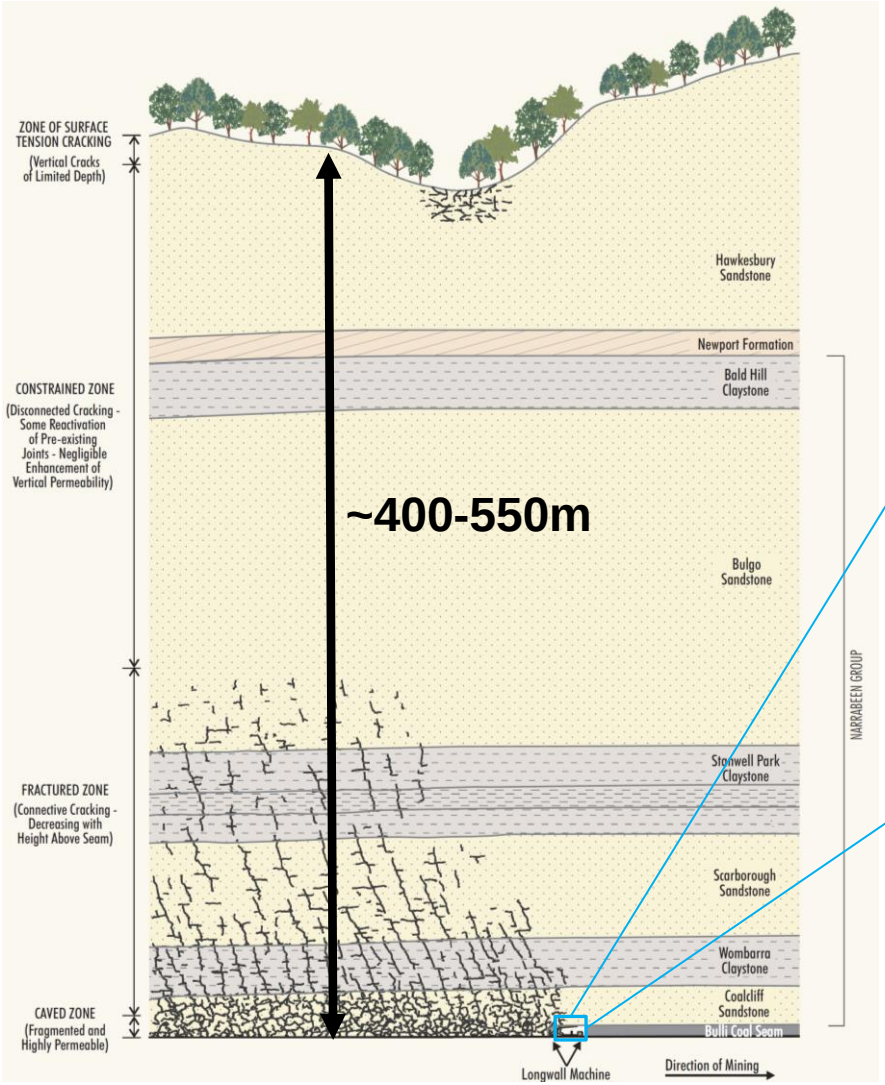
Approved Metropolitan Coal Project

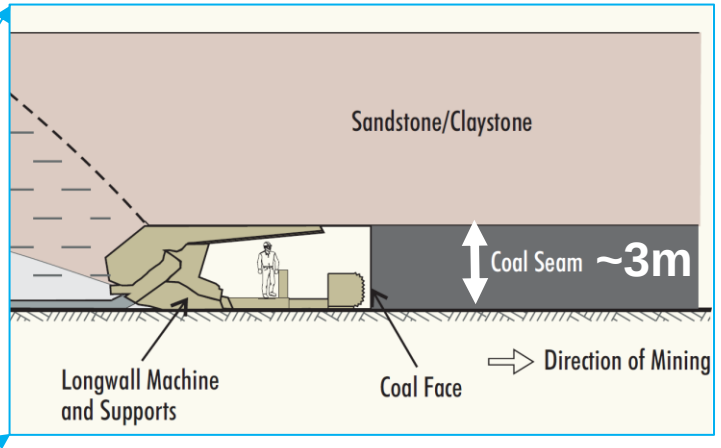
Metropolitan Coal Project EA

- "Project Underground Mining Area" – Blue Line
- Longwalls 301-303 are located **wholly within** the extent of the "Project Underground Mining Area"
- LW20-26 mined to date
- LW27 completion in 2017
- LW301-303 Extraction Plan



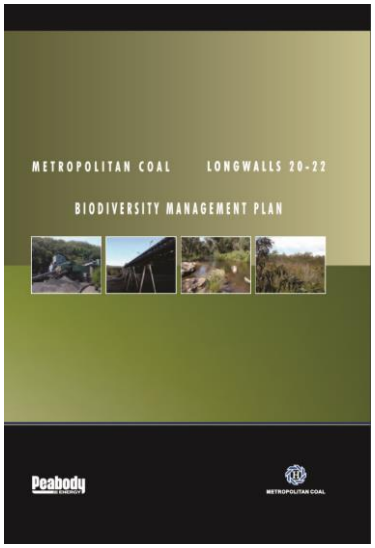
Approved Metropolitan Coal Project

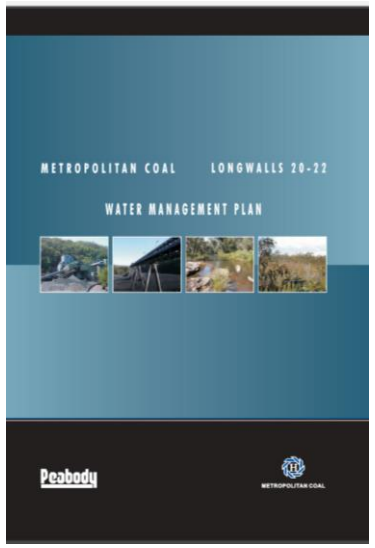


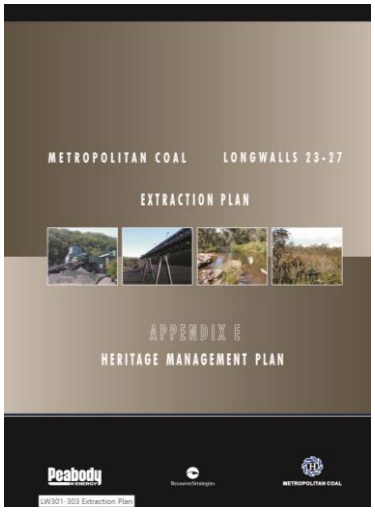


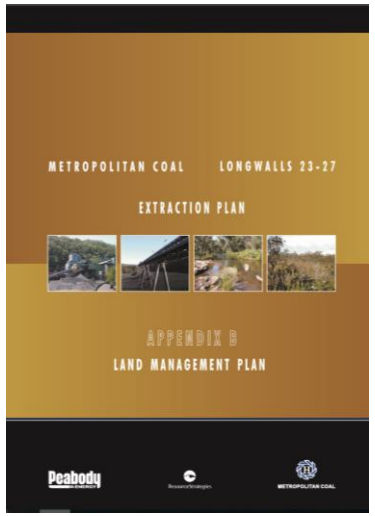
Existing Extraction Plans (+ Sub-Plans)

- LW23-27 & LW20-22
- **Built Features Management Plan(s)**
  - **Roads and Maritime Services**
- Water Management Plan
- Biodiversity Management Plan
- Land Management Plan
- Heritage Management Plan
- Public Safety Management Plan





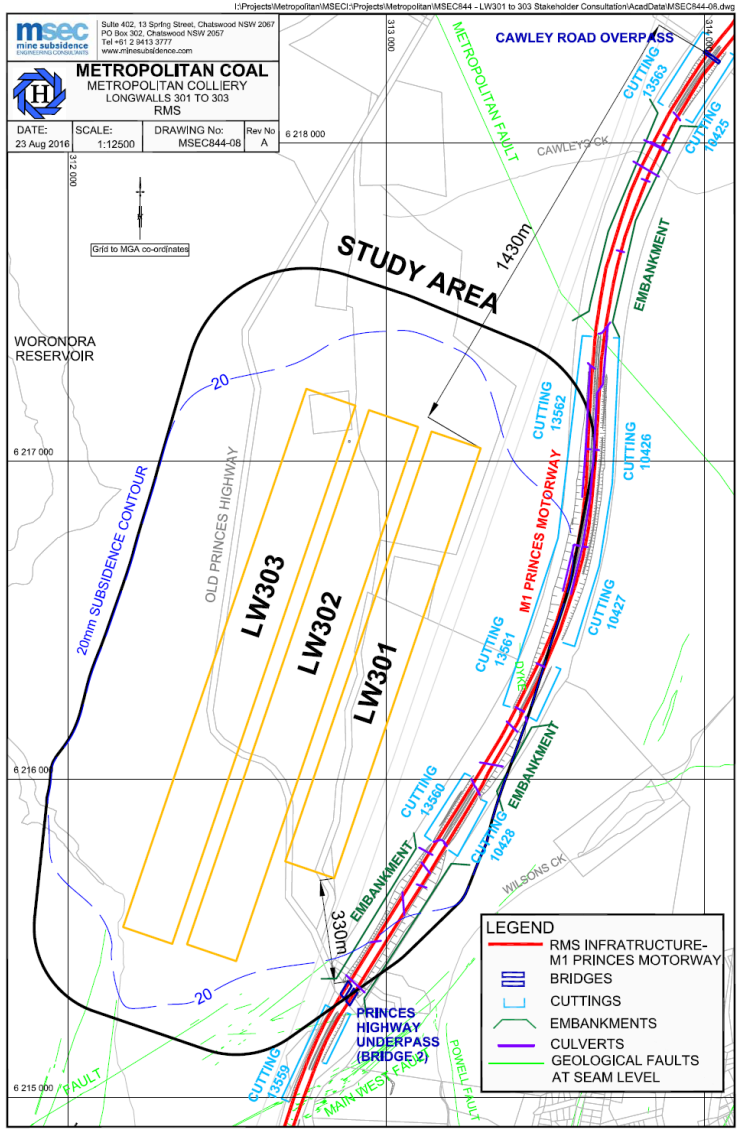




LW301-303 Extraction Plan

LW301-303 Extraction Plan - BFMP

- MSEC (11 July 2016) Subsidence Predictions.
- Pavement, Cuttings, Embankments, Culverts
- Bridge 2 (330 m at nearest point)
- Cawley Road Overpass (>1 km)



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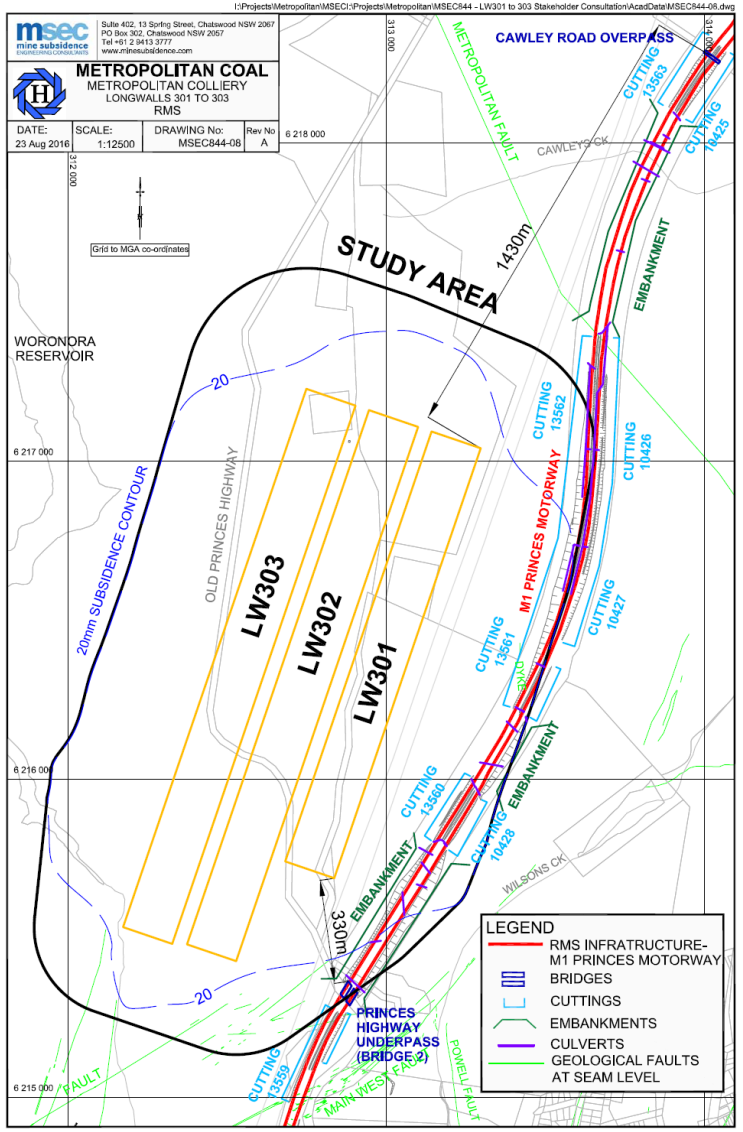
LW301-303 Extraction Plan

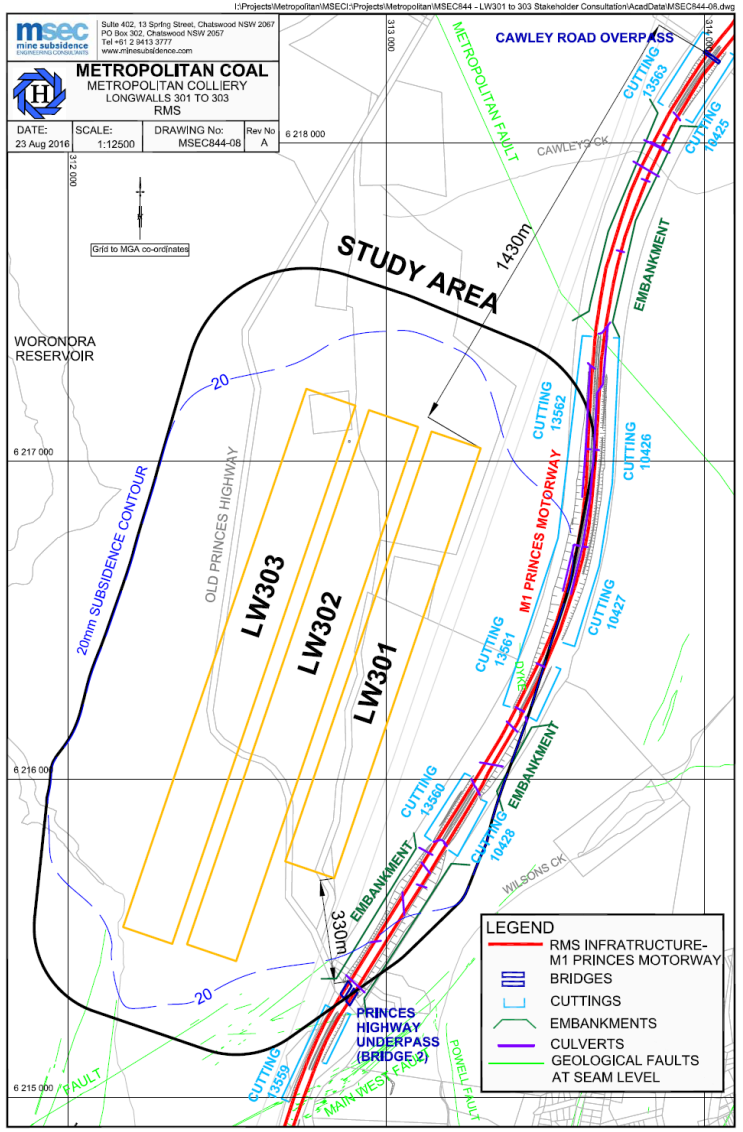
- Up to 50 mm vertical subsidence resulting from the extraction of Longwalls 301 to 303.
- Maximum predicted conventional tilts and curvatures are less than expected levels of survey tolerance.
- Far-field horizontal movements of up to 115 mm (based on 95% confidence level).
- Geological features include Metropolitan Fault (north-east), dyke with surface exposure in cutting and other mapped faults (south-east).



Approved Metropolitan Coal Project

LW301-303 Extraction Plan

- Valley closure is not expected to occur in the cuttings along the M1 Princes Motorway (however minor closure movements could be observed due to horizontal movements).
- Expected the M1 Princes Motorway can be maintained in safe and serviceable conditions with implementation of monitoring and management strategies (in consultation with RMS).
- At distance, Cawley Road Overpass is unlikely to experience adverse impacts.
- Bridge 2 (330 m at nearest point) to continue program of high accuracy monitoring.

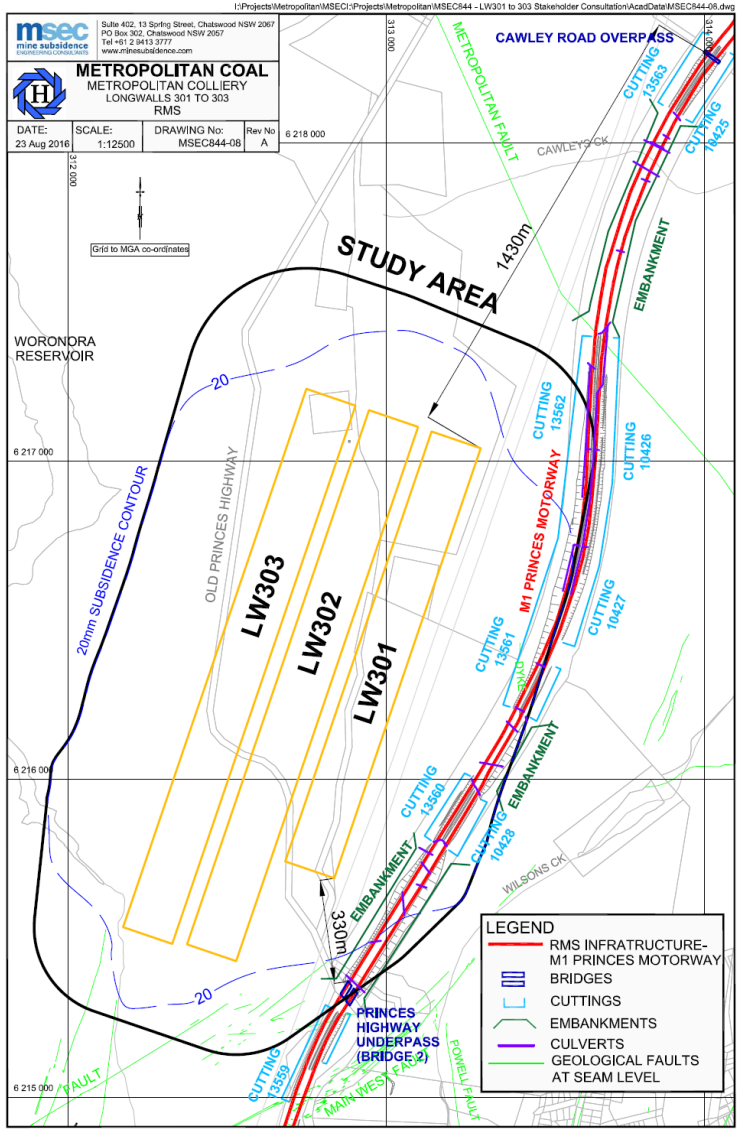


LW301-303 Extraction Plan

Project Approval Condition

- The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

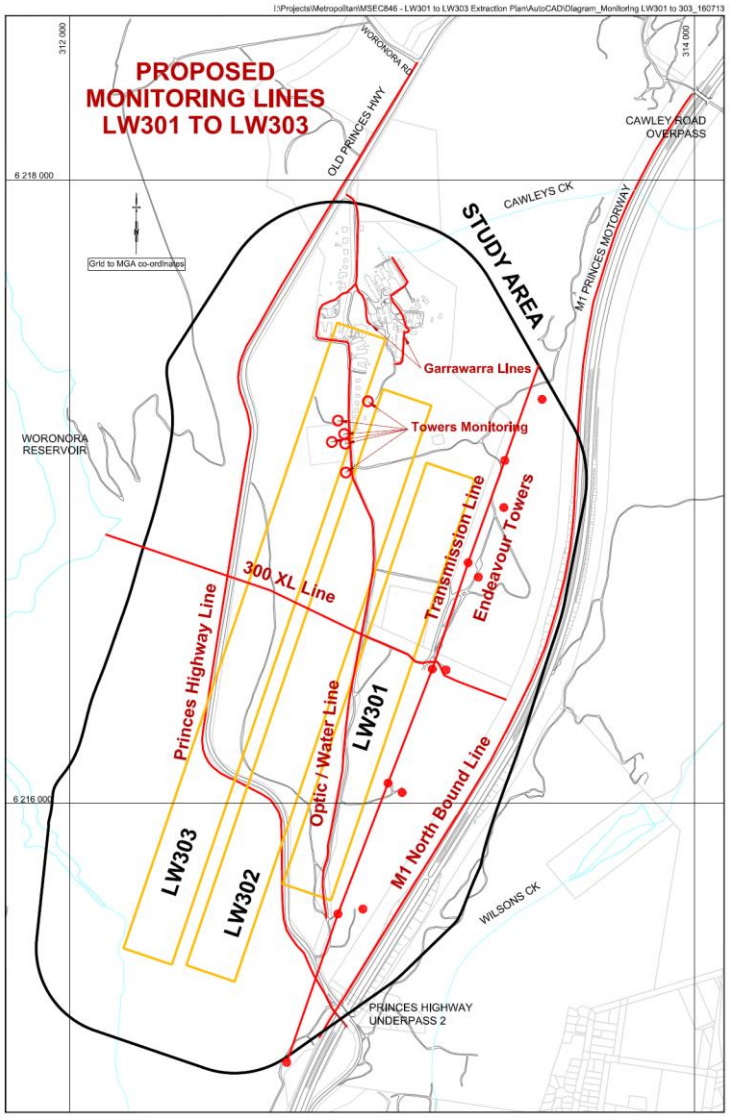
  Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.



LW301-303 Extraction Plan

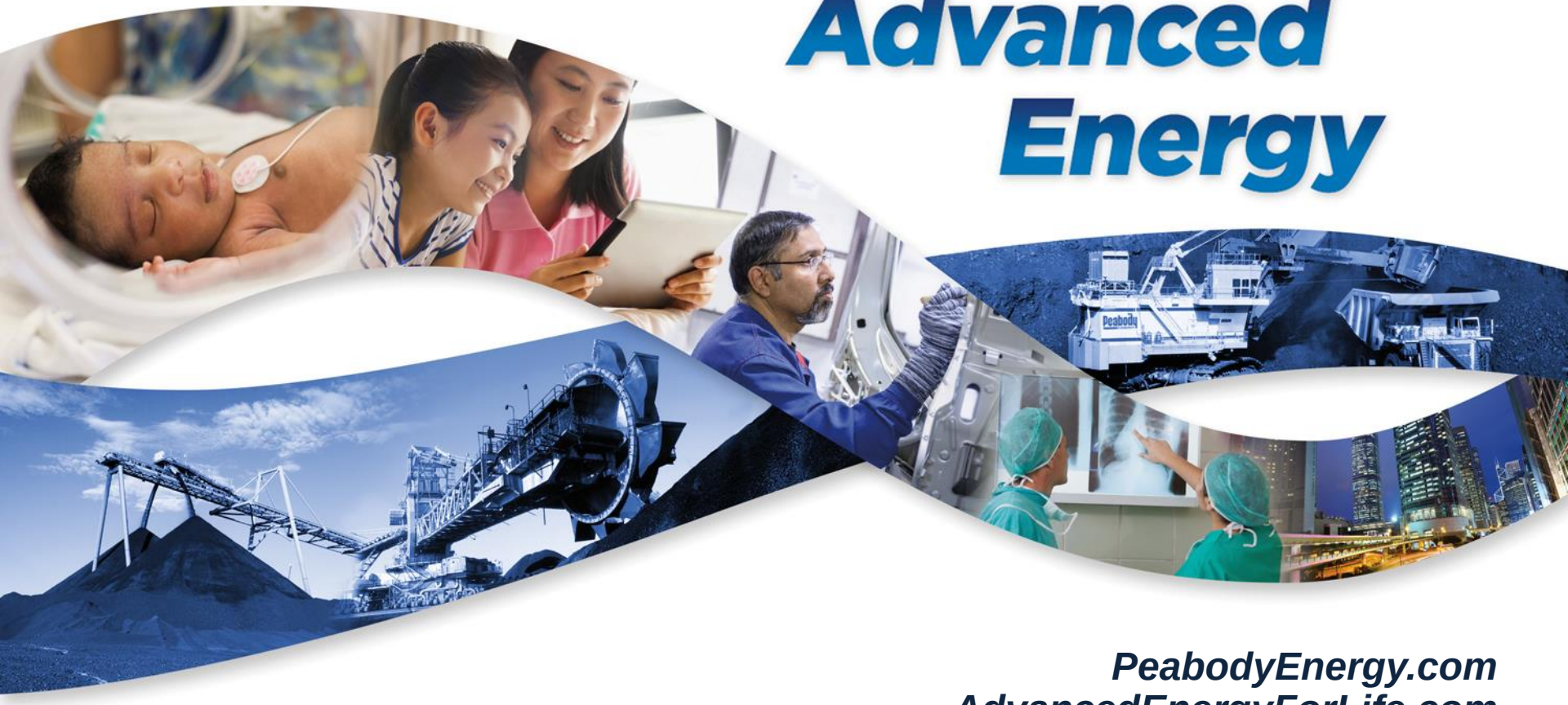
Monitoring Plan

- Subsidence Lines
  - M1 Princes Motorway
  - Transmission Line



Peabody ENERGY

Advanced Energy



PeabodyEnergy.com
AdvancedEnergyForLife.com

Appendix F

MSEC Report

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

6th September 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-08

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Roads and Maritime Services Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Roads and Maritime Services (RMS) infrastructure resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery.

The locations of the RMS infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC844-08. The M1 Princes Motorway is located to the east of Longwalls 301 to 303. The distance of the M1 Princes Motorway from Longwalls 301 to 303 varies from 210 metres near the finishing (southern) end of Longwall 301 to 335 metres near the commencing (northern) end of Longwall 301.

A series of cuttings and embankments up to a maximum height of approximately 20 metres are shown in the attached Drawing No. MSEC844-08. A summary of the rock cuttings is provided in Table 1.

Table 1 Summary of RMS Rock Cuttings

RMS Slope Number	RMS Assessed Risk Level (ARL)	Length (m)	Maximum Slope Height (m)	Average Slope Angle (degrees)
13563	2	202	17	65
13562	2	531	18	70
13561	2	599	13	62
13560	2	231	8	70
10425	2	188	9	66
10426	2	503	15	55
10427	2	452	14	55
10428	2	192	9	65

A bridge is located at the crossing of the M1 Princes Motorway with the Old Princes Highway (Bridge 2), and is located approximately 330 metres from Longwall 301. The next nearest bridge is Cawley Road Overpass, which is located approximately 1.43 kilometres to the north east of Longwall 303.

A series of culverts cross the M1 Princes Motorway, as shown on Drawing No. MSEC844-08. The culverts comprise pipes of varying diameters from 375 mm to 1800 mm. The pipe materials comprise asbestos cement (pipes up to

600 mm diameter) and steel reinforced concrete (pipes up to 1800 mm diameter). In addition to the culverts, there are also a number of other drainage structures, such as kerbs, gutters, pits and drainage pipes. The largest culvert comprises two 1800mm pipes located to the north east of the longwalls at Cawley's Creek.

The predictions and impact assessments for the RMS infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the RMS Infrastructure

A summary of the maximum predicted values of total subsidence, tilt and curvature for the M1 Princes Motorway, resulting from the extraction of Longwalls 301 to 303, is provided in Table 2. The values are the maxima anywhere along the section of the motorway located within the Study Area.

Table 2 Predicted Total Subsidence, Tilt and Curvature for the M1 Princes Motorway Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	< 20	< 0.5	< 0.01	< 0.01
After LW302	50	< 0.5	< 0.01	< 0.01
After LW303	50	< 0.5	< 0.01	< 0.01

The maximum predicted conventional tilt and curvature are negligible and less than typical limits of survey accuracy (i.e. 0.5 mm/m for tilt and 0.01 km^{-1} for curvature).

Princes Motorway will potentially experience low level far-field horizontal movement. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield.

The observed incremental far-field horizontal movements, resulting from the extraction of longwalls in the Southern Coalfield, are provided in Figure 1. The data are based on survey marks located outside of the mining area (i.e. above solid coal).

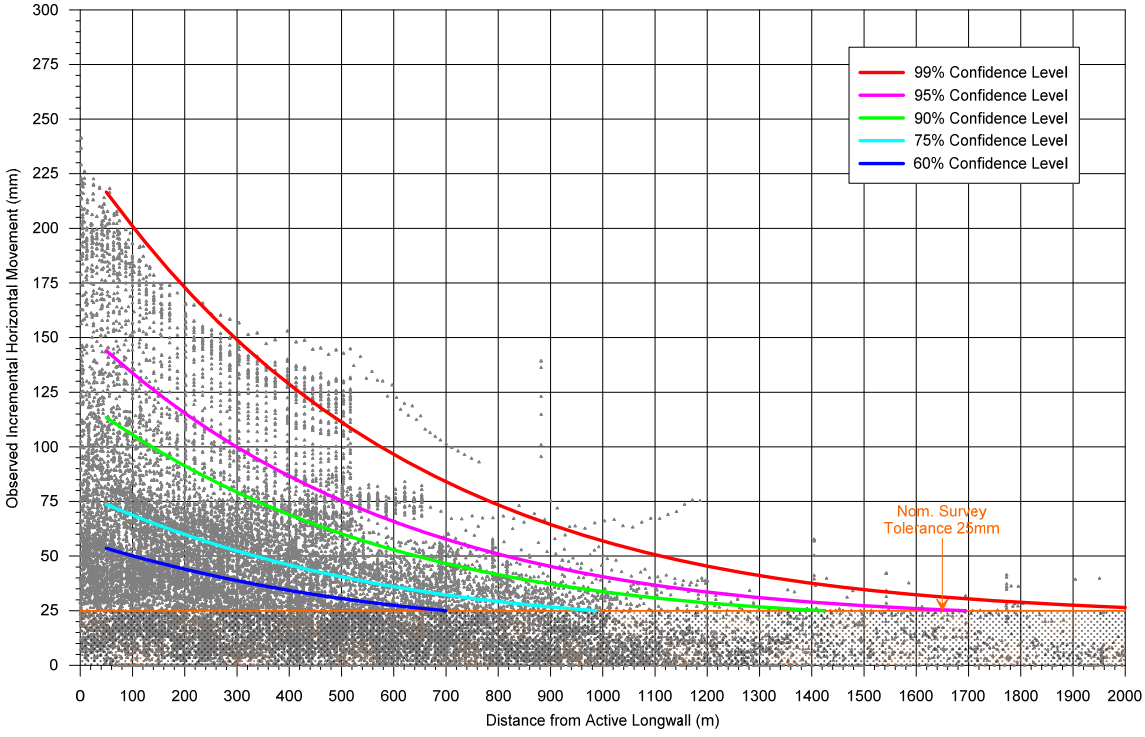


Figure 1 Observed Incremental Far-field Horizontal Movements from the Southern Coalfield (Solid Coal)

The absolute horizontal movements measured at distances greater than 210 metres from mining are in the order of 115 mm based on the 95 % confidence level. These low level movements comprise a large proportion of survey tolerance. Far-field horizontal movements tend to be bodily movements orientated towards the mining area. The strains associated with these low level horizontal movement are not expected to be measurable.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the RMS infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The M1 Princes Motorway is located at distances of 200 metres or greater from the longwalls. The database of measured strains has therefore been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located outside and within 100 metres to 250 metres of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

A histogram of the maximum observed tensile and compressive strains measured in survey bays located above solid coal, for monitoring lines in the Southern Coalfield, is provided in Figure 2. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

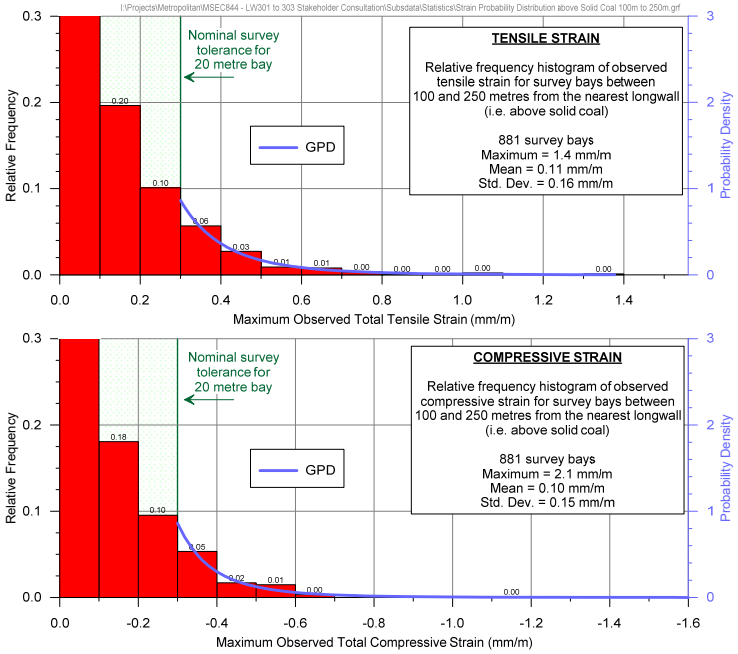


Figure 2 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Solid Coal (100 to 250 metres)

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above solid coal, based on the fitted GPDs, is provided in Table 3.

Table 3 Probabilities of Exceedance for Strain for Survey Bays Located above Solid Coal

Strain (mm/m)		Probability of Exceedance
Compression	-2.0	1 in 9,840
	-1.5	1 in 3000
	-1.0	1 in 635
	-0.5	1 in 55
	-0.3	1 in 10
Tension	+0.3	1 in 9
	+0.5	1 in 36
	+1.0	1 in 410
	+1.5	1 in 2,200
	+2.0	1 in 8,000

The 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal (100 to 250 metres) experienced at any time during mining are 0.4 mm/m tensile and compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.7 mm/m tensile and 0.6 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures and the streams are shown in Drawing No. MSEC844-08.

There are no identified geological structures above the longwalls. The M1 Princes Motorway crosses the Metropolitan Fault approximately 500 metres to the north east of Longwall 301 and several faults to the south east of Longwalls 301 and 302 intersecting the M1 Princes Motorway at approximately 340 metres. The absolute horizontal movements measured at distances of 500 metres and 340 metres from mining are in the order of 75 mm and 95 mm respectively based on the 95 % confidence level. It is noted that these faults are identified at seam level and surface expression of faults may occur at different locations, or faults may not have continuity to the ground surface.

A drainage line crosses the M1 Princes Motorway approximately 210 metres east of the finishing end of Longwall 301, as shown on Drawing No. MSEC844-08. Predicted valley closure across the culvert at the location of the M1 Princes Motorway is less than 20 mm.

A second drainage line is located to the north of the longwalls at Cawley's Creek. Due to the shortened commencing end of the longwalls, the culvert is located approximately 1060 metres from the nearest longwall (Longwall 301). At this distance, the culvert is not predicted to experience valley related movements due to the extraction of the Longwalls 301 to 303.

Valley closure is not expected to occur in the cuttings along the M1 Princes Motorway, however, minor closure movements could be observed due to potential horizontal movements.

Impact Assessments for the M1 Princes Motorway

The predicted conventional vertical subsidence for the M1 Prince Motorway resulting from the extraction of Longwalls 301 to 303 are very small and the predicted tilts and curvatures are less than the expected limits of survey tolerance. Adverse impacts to the M1 Princes Motorway, including the road pavement, slopes, culverts, barriers and furniture, resulting from conventional subsidence movements is considered unlikely.

The M1 Princes Motorway will potentially experience far-field horizontal movements resulting from the extraction of the Longwalls 301 to 303 of up to 115 mm, based on the 95% confidence level.

There are no major geological features to the east of the longwalls near the M1 Princes Motorway. The mapped geological features are shown on Drawing No. MSEC846-08. The Metropolitan Fault intersects the M1 Princes Motorway at approximately 500 metres to the north east of Longwall 301. There are mapped faults to the south east of Longwalls 301 and 302, intersecting the M1 Princes Motorway at approximately 340 metres from the longwalls. A dyke with a surface exposure is also present to the east of Longwall 301 at approximately 380 metres from Longwall 301. There is the potential for far-field horizontal movements to result in the minor differential movement near the faults and potential shearing and/or stepping in the road pavement. The faults have been mapped at seam level and surface expressions have not been identified. The mapped dyke has been identified in the motorway cuttings. There is also the potential for far-field horizontal movements to result in differential movement at the interface of cut and fill areas along the motorway corridor.

The M1 Princes Motorway crosses a valley and an associated drainage culvert to the east of the Longwall 301 finishing end. The predicted valley closure due to Longwalls 301 to 303 is less than 20 mm. A second valley and culvert are located at Cawley's Creek, approximately 930 metres from Longwall 303. Adverse impacts to the culverts resulting from conventional subsidence and valley related movements is considered unlikely.

It is recommended that monitoring and management strategies are developed, in consultation with RMS, to manage the potential impacts on the M1 Princes Motorway. It is expected that the motorway can be maintained in safe and serviceable conditions with the implementation of the appropriate monitoring and management strategies.

Impact Assessments for the Bridges

An assessment of Bridge 2 (RMS reference BN616-southbound and BN617-northbound) has been undertaken by the RMS technical committee, which was formed prior to the commencement of the extraction of Longwall 20 to assess and monitor potential impacts to RMS assets due to the extraction of longwalls at Metropolitan Colliery. A letter report MSEC696-02 dated 30th June 2014 was prepared based on a preliminary layout of Longwalls 301 to 317. The distance of the bridge from the longwalls is unchanged at 330 metres hence the impact assessments are the same as previously reported. A summary of the subsidence predictions and impact assessments for Bridge 2 is provided below.

- At a distance of approximately 330 metres, the predicted subsidence parameters are less than survey tolerance, which is typically 20mm for subsidence, 0.5mm/m for tilt and 0.01km^{-1} for curvature. The predicted conventional subsidence parameters indicate that with high accuracy survey, minor subsidence, tilt and hogging curvature may be observed, but sagging curvature is unlikely to be observed.
- The absolute horizontal movements measured at distances greater than 330 metres are in the order of 95 mm based on the 95% confidence level. An absolute horizontal movement of 105 mm based on the 95% confidence level was provided in the MSEC696-02 report. The updated data set as presented in Figure 1 results in a slightly lower value of observed horizontal movement, however the difference of 10 mm does not change the impact assessments for the bridge.
- It is difficult to predict differential horizontal movements since the potential values of relative movement are typically very small and much of the scatter in the observed data is the result of survey accuracy. Also, a spacing between pegs of 20 metres is commonly used along monitoring lines, and this distance is larger than the typical column and blade wall spacing for Bridge 2.
- Differential horizontal movement was assessed by analysing the far-field horizontal movement data discussed above. The data set was analysed to determine incremental relative opening and closing and incremental mid ordinate deviation.
- The incremental relative opening and closing and mid ordinate deviation for various probabilities at a distance of approximately 330 metres from an active longwall are summarised in Table 4 and Table 5.

Table 4 Incremental Relative Opening, Closing and Mid-Ordinate Deviation at Approximately 330 metres Distance from Active Longwall

	1 in 20 probability (95% confidence level)	1 in 100 probability (99% confidence level)	1 in 2000 probability (99.95% confidence level)
Opening	8 mm	14 mm	44 mm
Closing	6 mm	13 mm	44 mm
Mid-Ordinate Deviation	9 mm	15 mm	32 mm

Table 5 Incremental Relative Opening, Closing and Mid-Ordinate Deviation due to First Panel Extraction Only

	1 in 20 probability (95% confidence level)	1 in 100 probability (99% confidence level)	1 in 2000 probability (99.95% confidence level)
Opening	5 mm	10 mm	25 mm
Closing	4 mm	9 mm	32 mm
Mid Ordinate Deviation	5 mm	8 mm	14 mm

- The differential movements presented in Table 4 and Table 5 should be applied to the bridge elements in both the longitudinal and transverse direction of the bridge. The application of the differential movements to short bridge element spacing (e.g. columns approximately 5m apart), was discussed by the technical committee and it was agreed that the movements should be applied directly to shorter element spacing.
- The differential longitudinal movement, opening (+ve) and closing (-ve) should be applied to the longitudinal and transverse direction as an opening and closing movement, between piers, and between columns. The mid-ordinate deviation should be applied to an out of plane movement of one pier relative to adjacent piers, which are spaced at 13.5 metres at abutments and 18.3 metres in the centre, as well as between columns which are approximately 5 metres apart.
- Faults have been identified at seam level to the west and to the east of Bridge 2. The nearest faults, Main West and Powel are approximately 235 metres horizontal distance from Bridge 2. There are no mapped surface expressions of the faults. The projected alignments of these faults do not intersect the location of Bridge 2. There is a low likelihood of the identified structures directly impacting Bridge 2, however other potential unidentified structures may be present at or near the bridge location.

A decision was made by the RMS technical committee to monitor potential movements of Bridge 2 using a high accuracy fibre optic monitoring system, along with conventional surveying methods. The monitoring system is being established to record baseline readings during the extraction of Longwalls 26 and 27, prior to the commencement of Longwall 301.

Cawley Road Overpass is located at 1.43 kilometres from Longwall 301 at its nearest point. At this distance, observed far-field movements as shown in Figure 1 are close to nominal survey tolerance and observed differential movement data is predominantly within survey tolerance. Differential horizontal movement was assessed by analysing the far-field horizontal movement data. The data set was analysed to determine incremental relative opening and closing and incremental mid ordinate deviation at a distance of approximately 1.43 kilometres from an active longwall.

The incremental relative opening and closing and mid ordinate deviation for various probabilities at a distance of approximately 1.43 kilometres from an active longwall are summarised in Table 6.

Table 6 Incremental Relative Opening, Closing and Mid-Ordinate Deviation at Approximately 1.43 kilometres Distance from Active Longwall

	1 in 20 probability (95% confidence level)	1 in 100 probability (99% confidence level)	1 in 2000 probability (99.95% confidence level)
Opening	4 mm	7 mm	14 mm
Closing	5 mm	9 mm	19 mm
Mid-Ordinate Deviation	7 mm	10 mm	18 mm

At this distance, adverse impact to Cawley Road Overpass resulting from the extraction of Longwalls 301 to 303 is considered unlikely, however an assessment of the structure should be undertaken to assess the sensitivity of the structure to potential differential movements a result of Longwalls 301 to 303.

Summary

The M1 Princes Motorway is located greater than 210 metres to the east of Longwalls 301 to 303. The previous experience from the Southern Coalfield has found that the potential impacts on bitumen seal and asphaltic pavements can be managed with the implementation of suitable monitoring and management strategies.

It is recommended that monitoring and management strategies are developed, in consultation with RMS, to manage the potential impacts on the M1 Princes Motorway. It is expected that the motorway can be maintained in safe and serviceable conditions with the implementation of the appropriate monitoring and management strategies.

Bridge 2 is located approximately 330 metres from Longwall 301. A program of high accuracy monitoring of this bridge has been implemented by the RMS technical committee and will be outlined in the Built Features Management Plan for Longwalls 301 to 303. The culverts and Cawley Road Overpass are located outside the predicted 20 mm subsidence contour. Whilst these features could experience low level far-field horizontal movements, they are not expected to experience measurable strains or differential horizontal movements. Assessment of these structures should be undertaken by the RMS technical committee to assess the sensitivity of these structures to potential differential movements a result of Longwalls 301 to 303.

Yours sincerely

Peter DeBono

Mine Subsidence Engineering Consultants

Attachments:

Drawing No. MSEC844-08 – Longwalls 301 to 303 – RMS Infrastructure

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COAL

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
RMS

DATE:	SCALE:	DRAWING No:	Rev No
23 Aug 2016	1:12500	MSEC844-08	A

313 000 314 000 312 000
6 218 000 6 217 000 6 216 000 6 215 000

Grid to MGA co-ordinates

CAWLEY ROAD OVERPASS
METROPOLITAN FAULT
CAWLEYS CK
CUTTING 13563
CUTTING 10425
EMBANKMENT
1430m
STUDY AREA
WORONORA RESERVOIR
20
20mm SUBSIDENCE CONTOUR
OLD PRINCES HIGHWAY
LW303
LW302
LW301
CUTTING 13562
CUTTING 10426
M1 PRINCES MOTORWAY
CUTTING 13561
CUTTING 10427
DYKE
CUTTING 13560
EMBANKMENT
CUTTING 10428
EMBANKMENT
WILSONS CK
330m
PRINCES HIGHWAY UNDERPASS (BRIDGE 2)
CUTTING 13559
FAULT
MAIN WEST FAULT
POWELL FAULT

LEGEND
- RMS INFRATRUCTURE- M1 PRINCES MOTORWAY
- BRIDGES
- CUTTINGS
- EMBANKMENTS
- CULVERTS
- GEOLOGICAL FAULTS AT SEAM LEVEL

APPENDIX 5

METROPOLITAN COLLIERY LONGWALL MINING – LW 304-306 RISK ASSESSMENT AS APPLIED TO RMS ASSETS

Roads & Maritime Services

Metropolitan Colliery Longwall Mining – LW304-306

Risk Assessment as Applied to RMS Assets

264172/REP/001

ISSUE | 7 February 2019

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 264172-00

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Arup Pty Ltd ABN 18 000 966 165

Arup
Level 17
1 Nicholson Street
East Melbourne VIC 3002
Australia
www.arup.com

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Document Verification

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Job title		Metropolitan Colliery Longwall Mining – LW304-306			**Job number** 264172-00
Document title		Risk Assessment as Applied to RMS Assets			**File reference**
Document ref		264172/REP/001			
Revision	**Date**	**Filename**	20180918 RMS LW304-306 Report - Draft 1.docx		
Draft 1	19 Nov 2018	**Description**	First draft		
			Prepared by	Checked by	Approved by
		Name	Ben Smith	Nigel Cann	Nigel Cann
		Signature			
Issue	07 Feb 2019	**Filename**	20190207 RMS LW304-306 Report - Issue.docx		
		Description	Workshop participant feedback		
			Prepared by	Checked by	Approved by
		Name	Ben Smith	Nigel Cann	Nigel Cann
		Signature			
		Signature			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
				Issue Document Verification with Document	✓

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1 Introduction

Arup has been engaged by Roads & Maritime Services (RMS) to undertake a risk assessment with regards to the impacts on RMS assets arising from subsidence due to the mining of longwalls LW304-306 in the Metropolitan Mine which is owned by a subsidiary of Peabody Energy (Peabody).

Previous risk assessments were completed in 2009, 2013 and 2016 on the impacts of subsidence from LW20-22, LW23-27 and LW301-303 respectively. A history of the impacts of subsidence has been gained, along with knowledge about the performance of mitigation control measures applied and the reliability of the monitoring systems utilised.

As with the previous assessments, the concern of RMS is the possible impacts from the mining of LW304-306 on its surface assets with a specific emphasis on how the mining might result in financial loss to RMS, loss of functionality of the assets with regards to the road users (motorists and public) and possible life safety issues, should the mining adversely impact on any of the assets.

The process adopted by Arup follows closely the principles set out in AS/NZS ISO31000:2009 – Risk Management, and the various standards of RMS, specifically those relating to the assessment of risks posed by subsidence mining.

Arup facilitated a workshop with relevant stakeholders to firstly identify the assets at risk and then ascertain the risks posed to those assets from the mining of LW304-306. This same workshop also considered various mitigation and control measures and determined the effectiveness of these in reducing risk levels.

The events and activities identified in the workshop will be addressed and managed in the Built Features Management Plan for LW304-306.

2 Description of Proposed Mining

Peabody, or Metropolitan Colliery (MC), proposes to extract longwalls LW304-306 as part of its ongoing underground coal mining operations within the Bulli Seam at the Metropolitan Mine. The mine is located in the Southern Coalfield of New South Wales. The overall layout of longwalls LW304-306 is shown in Figure 1.

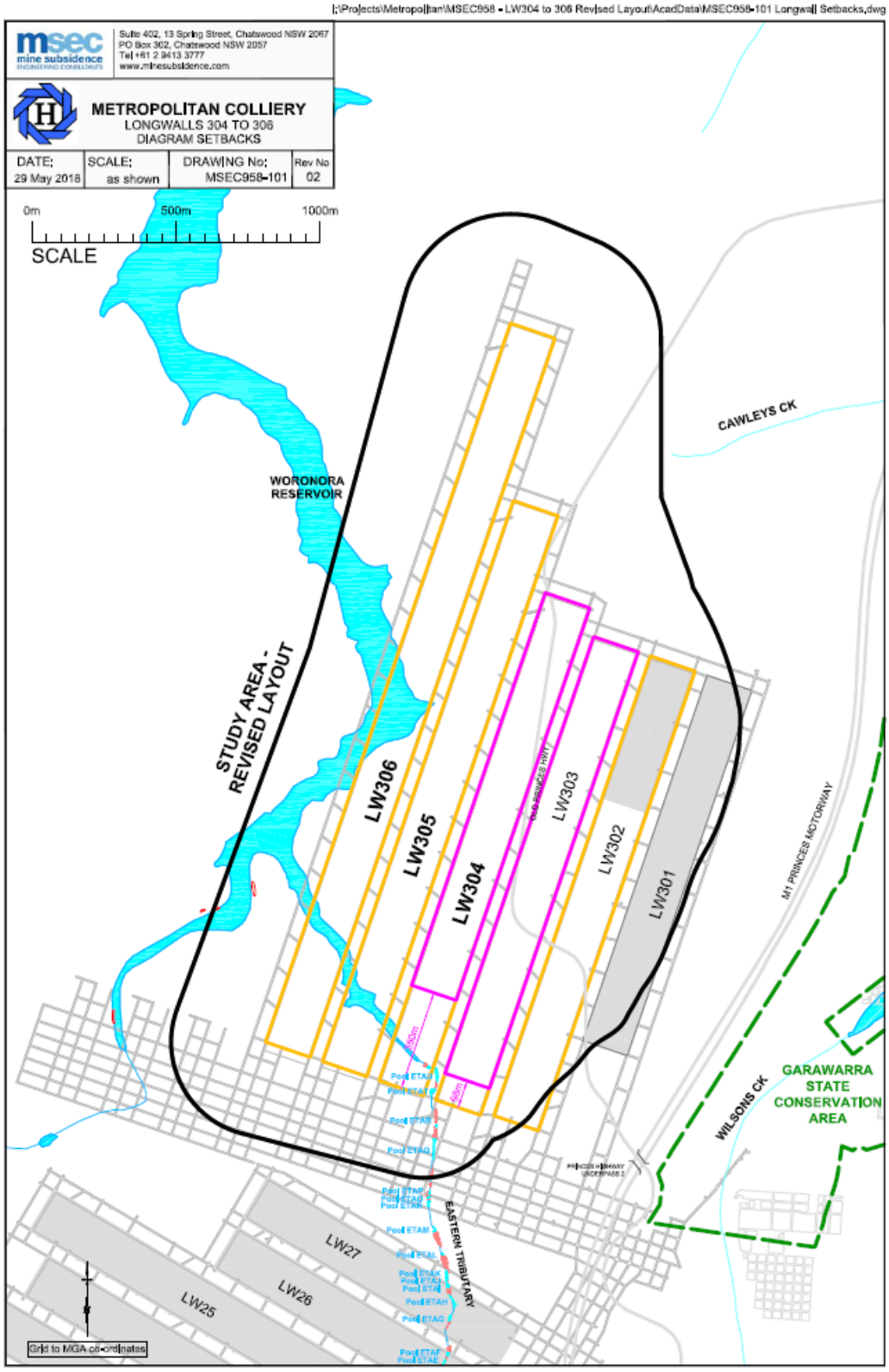

Figure 1: Layout of LW304-306

3 RMS Assets Affected

Figure 1 shows the extent of the proposed mining in relation to the RMS assets located along the Princes Motorway.

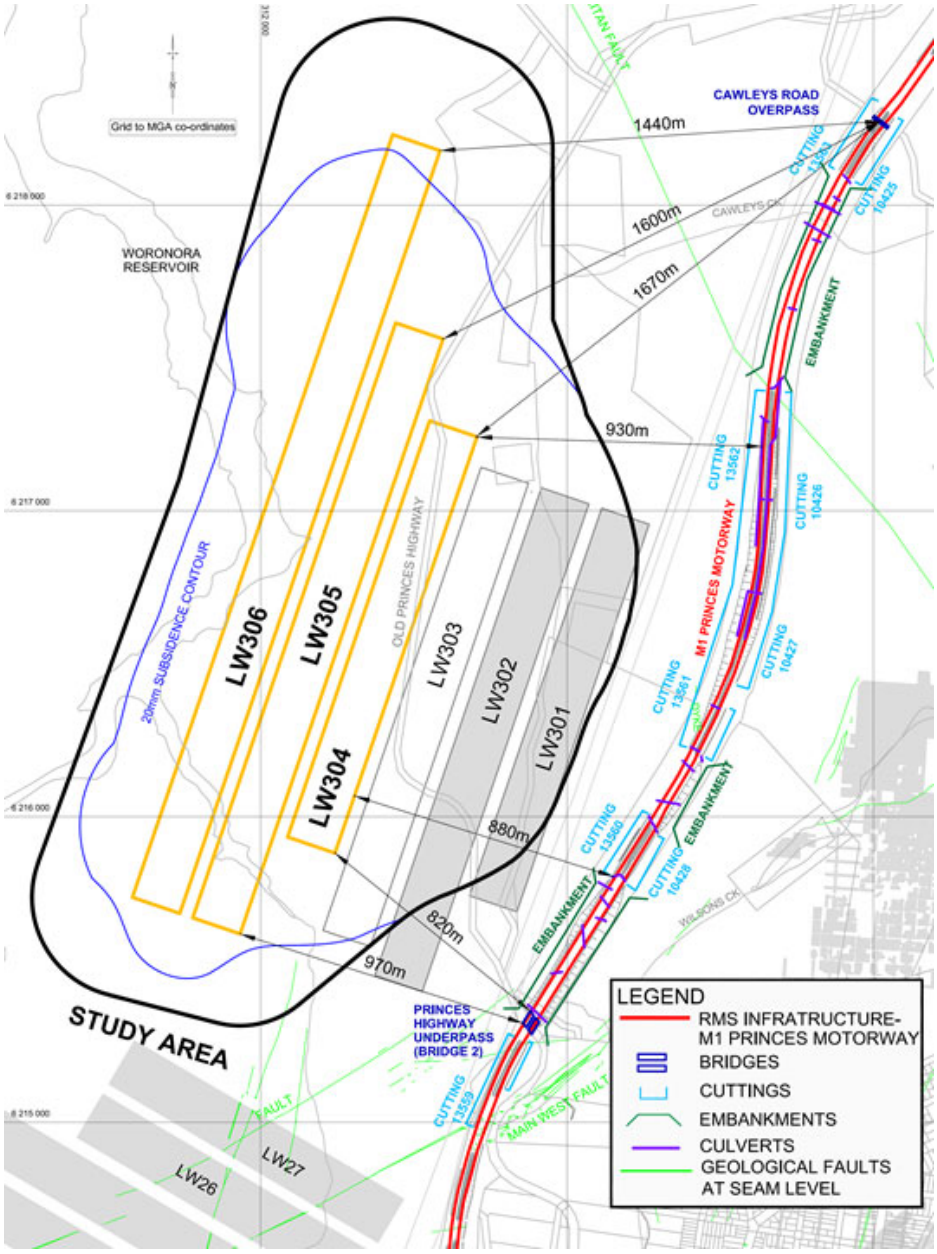

Figure 2: Plan position of RMS Assets to LW304-6

The RMS guidelines [Ref 1] define the zone of interest for infrastructure impacts as being five times the depth of cover. With a depth of cover of approximately 400 m, the zone of interest extends some 2 km from the longwalls.

The M1 Princes Motorway is located to the east of LW304-306. The distance of the M1 from LW304-306 varies from 800 m near the finishing (southern) end of LW304 to 903 m near the commencing (northern) end of LW304.

There are a series of cuttings and embankments up to a maximum height of approximately 20 m along the M1.

There are two bridges (BN616/617- shown as Bridge 2 in Figure 2) carrying the northbound and southbound traffic on the M1 Princes Motorway over the old Princes Highway and these are located approximately 820 m from the southern end of LW304. The next nearest bridge is Cawley Road Overpass (BN615), which is located approximately 1.44 km to the east of LW306, at its nearest point to the mining.

A series of culverts of varying diameters from 375 mm to 1800 mm cross the M1 Princes Motorway. A number of the culverts are asbestos cement pipes. In addition to the culverts, there are also a number of other drainage structures, such as kerbs, gutters, pits and drainage pipes. The largest culvert comprises two 1800 mm pipes located to the north east of the longwalls at Cawley's Creek.

It should be noted the two large culverts and Cawley Road Overpass are located well outside the predicted 20 mm subsidence contour.

3.1 Predicted Ground Movements

Mine Subsidence Engineering Consultants Pty Ltd (MSEC) presented their predictions of ground movements for RMS assets from the mining of LW304-306, and a broad assessment of impact on the assets in a report which is included asAppendix F.

3.1.1 Movements Affecting the M1 Motorway

The following is a summary of the ground movement predictions for the M1 Motorway:

- As with LW301-3, the maximum predicted conventional tilt and curvature are less than the expected limits of survey accuracy (i.e. 0.5 mm/m for tilt and 0.01 km^{-1} for curvature).
- The M1 will potentially experience far-field horizontal movements of up to 45 mm, based on a 95% confidence level, from a database of observed far-field horizontal movements in the Southern Coalfield.
- Similarly, from the Southern Coalfields survey database, the 95% confidence intervals for the maximum total strains that the individual survey bays above solid coal (100-250 m) experienced at any time during mining are 0.4mm/m tensile and compressive.
- Predicted valley closure across the culvert to the east of the finishing end of Longwall 301 is less than 20 mm.
- Valley closure is not expected to occur in the cuttings along the M1, however, minor closure movements could be observed due to potential horizontal movements.

3.1.2 Movements Affecting Bridges

Because of the critical function of Bridge 2, and as for other bridges, RMS requires assessment of the effects of ground movements of magnitudes that have 1 in 100 and 1 in 2000 probability of exceedance due to mining. This is consistent with the limit state approach to bridge design (and checking) embodied in the Bridge Design Standard (AS5100). MSEC has therefore produced values for incremental relative opening, closing and mid-ordinate deviation at various probabilities, including 1 in 100 and 1 in 2000, to be applied to the bridge elements in both the longitudinal and transverse directions of the bridge for the assessment of potential effects on the bridge structure.

The following is a summary of the ground movement predictions for Bridge 2, derived from the MSEC report in Appendix F.

At Bridge 2, a distance of approximately 820 m from the closest point of the longwalls, the predicted subsidence parameters are less than survey tolerance, which is typically 20 mm for subsidence, 0.5 mm/m for tilt and 0.01 km^{-1} for curvature. The absolute horizontal movements measured at distances greater than 800 m are in the order of 45 mm based on the 95% confidence level.

Differential horizontal movements, which are most significant for the bridge structures, are difficult to predict since the potential values of relative movement are typically very small. For Bridge 2, there is the added complication that the spacing of bridge support elements varies from 5-18 m as compared to the commonly used spacing between survey points along monitoring lines of approximately 20 m.

Cawley Road Overpass is located at 1.44 km from Longwall 306 at its nearest point. At this distance, observed far-field movements from the Southern Coalfields database are close to nominal survey tolerance and observed differential horizontal movement data is predominantly within survey tolerance.

However, as for Bridge 2, Cawley Road Overpass needs to be assessed for low probability differential ground movements and MSEC has provided values for incremental relative opening, closing and mid-ordinate deviation at various probabilities of exceedance, including 1 in 100 and 1 in 2000, to be applied to the bridge elements for the assessment of potential effects.

3.2 Assessment of Ground Movement Impacts

3.2.1 Assessment of Impacts on M1 Motorway

The MSEC report in Appendix F included the following broad assessment of impacts on the M1 Motorway.

The predicted conventional vertical subsidence for the M1 resulting from the extraction of LW301-303 is very small and the predicted tilts and curvatures are less than the expected limits of survey tolerance (i.e. 0.5 mm/m for tilt and 0.01 km^{-1} for curvature). Adverse impacts to the M1, including the road pavement,

slopes, culverts, barriers and furniture, resulting from conventional subsidence movements is considered unlikely.

MSEC recommended that monitoring and management strategies are developed to manage the potential impacts on the M1, which would allow for the motorway to be maintained in a safe and serviceable condition.

As LW304-6 are further away from the M1 than the extractions of LW301-3, the adverse impacts on the M1 assets resulting from conventional subsidence movements is also considered unlikely.

3.2.2 Assessment of Bridges

A detailed quantitative assessment of the potential impacts of ground movements from Longwalls 301 to 303 on Bridge 2 (BN616/617) has been undertaken by the RMS Technical Committee. The Committee commissioned the bridge specialist on the committee (Cardno) to investigate and report on the potential effects on the bridge of the 1 in 100 and 1 in 2000 exceedance probability for differential ground movements. The report on that investigation was issued to the committee in May 2015. As ground movements of varying probability of exceedance were investigated, this is considered to be a detailed quantitative risk assessment.

In summary, the assessment found that the 1 in 100 probability differential ground movements could be tolerated by the structure with only relatively minor cracking as the worst consequence. It found that the 1 in 2000 probability differential ground movements could produce unacceptable effects including structural failure at some locations, if they occurred at disadvantageous locations. In this unlikely event, mining of the longwall may have to be terminated earlier than planned.

A similar detailed quantitative assessment of the effects of low probability differential ground movements on the Cawley Road Overpass was carried out. It found that the Cawley Road Overpass can tolerate the predicted ground movements up to the 1 in 2000 probability values.

As LW304-6 are further away from the bridges and overpass than the extractions of LW301-3 and that no differential ground movements have occurred in disadvantageous locations to date, it is considered unlikely that such movements will occur with the mining of LW304-6.

4 Risk Workshop

On 18 September 2018, a risk workshop was convened at the RMS Offices in Wollongong. The purpose of this workshop was to assess the risks posed to the assets of the RMS from this proposed longwall mining operation. A list of the participants at the workshop is included in Appendix B. The agenda is attached in Appendix C.

Peabody Energy provided an overview of the LW304-306 extraction area, an update on the mine activities and the current location and an update on the subsidence performance to date.

This workshop was qualitative, used the RMS look up sheets for assessing both frequency and consequence. These sheets have been adopted as the standard by the RMS when assessing the risk posed to their assets from mining subsidence. The look up sheets for assessing frequency, consequence, and the risk matrix are included in Appendix D.

The assets considered in the risk assessment included:

- Pavement;
- Bridges (Bridge 2; Cawley Road Overpass);
- Cuttings/Embankments;
- Drains/Culverts.

Subsidence management procedures considered in the risk assessment included:

- High Accuracy Fibre Optic Monitoring System;
- Conventional Survey/Visual Inspections;
- Management Measures; and
- Contingency Measures.

The workshop used the risk register from the LW301-303 study (which in turn considered the risk registers from the LW20-22 and LW23-27 studies) as the basis of discussion and reviewed each of the risks. For new items, a check-list of Assets and Fault/Failure modes was used to trigger thoughts and discussion. This information was recorded in the risk register, attached in Appendix A.

5 Results

A total of 18 risk events were identified during the workshop, of which 11 were not considered to present a credible risk (the level of possible impacts was not measurable). Additional mitigations were discussed for 10 risk events.

Following the RMS Risk Matrix (see Appendix D), risks are assessed as being Extreme (E), High (H), Moderate (M) or Low (L). Table 1 shows the number of entries in the risk register which were assessed in each category before and after additional mitigation measures are applied. It should be noted that all the suggested additional mitigations include monitoring, which does not change the risk ratings of the event.

Table 1: Risk Profile Before and After Implementation of Additional Mitigations

Receptor	**Infrastructure**				**Functionality**				**Safety**			
Risk Level	E	H	M	L	E	H	M	L	E	H	M	L
Base Risk Score	0	1	2	3	0	2	0	4	0	0	1	5
Final Risk Score	0	1	2	3	0	2	0	4	0	0	1	5

5.1 Carriageway

At over 820m from Longwalls 304 to 306, the RMS assets are not expected to experience measurable conventional vertical subsidence, tilts, curvatures or strains (i.e. no greater than survey accuracy). Impacts to the carriageway from conventional subsidence movements is considered unlikely to occur due to the extraction of Longwalls 304 to 306.

Visual inspections at the end of each panel would be appropriate to check for any cracks or deformations caused by the mining activities. RMS also performs drive-through checks during mining. A base line inspection needs to be recorded prior to commencement of mining.

5.2 Culverts

With valley closure movements less than 20 mm anticipated, there are unlikely to be anything more than minor impacts on the culverts.

For the culverts a pre-mining condition assessment using CCTV should be completed and any further inspections should be performed as per the Monitoring Plan. A culvert inspection is required upon completion of mining operations for LW303; this could form the baseline for monitoring during LW304-306 operations.

5.3 Cuttings

The cuttings were stabilised and rerated prior to the extraction of LW301-303. New risk ratings were provided in the Built Features Management Plan (July 2018); the risks were re-rated as part of the end of panel risk rating. Three changes to risk rankings were made:

- Cutting 10425: ARL2 to ARL3;
- Cutting 13560: ARL4 to ARL3; and
- Cutting 13562; ARL4 to ARL3.

The reratings were due to natural effects and were not related to mining LW301 to LW303.

The risk ratings at cuttings at Cawleys Road Overpass (CRO) are unchanged Assessed Risk Level 2 (ARL2), but are located approximately 1300 m from the start line of LW301.

For the cuttings, a survey is proposed at completion of each panel. Monitoring of the transmission lines will also provide early indications for the cuttings within the 20 mm subsidence contour. If the measurements exceed predicted levels, this will trigger a survey to be completed along the cuttings.

The regular RMS maintenance inspections are to include monitoring of rock fall.

5.4 Bridge and Overpass

Bridge 2 (BN616 southbound / BN617 northbound) have been setup to allow for monitoring of differential movements between key points on the structures. The monitoring provisions include installation of survey targets fixed at key points and FBG sensor cable to measure relative movement of key points at the tops of piers and abutments. The monitoring systems aim to detect distortion of the bridges which can then be assessed by Cardno to determine the effects on the structure.

The monitoring strategy for the Cawley Road Overpass (BN615) includes only the installation of survey targets fixed at key points. This aims to detect distortion of the bridges which can then be assessed by Cardno to determine the effects on the structure. If significant differential movements are detected, the frequency of monitoring can be increased to further understand the trend of movement.

The transmission line is also monitored by survey and this data can be used to predict potential impacts at the bridges. If significant relative movements are detected, then the frequency of monitoring at bridges should be increased to understand the trend of movement.

In addition, the transmission line is monitored by an array of GNSS stations (high accuracy GPS stations which monitor absolute movement). Movements monitored at these stations can be used to assess the need for increased monitoring at the bridges. The closest stations to the bridges are:

- GNSS03 within 150m of Bridge 2;
- GNSS09 within 150m of Cawley Road Overpass.

6 Conclusions

A risk assessment workshop was undertaken in order to understand the risks to RMS assets from the mining of longwalls LW304-306. The events and activities identified in the workshop will be addressed and managed in the Built Features Management Plan for LW304-306.

It is recommended that the existing monitoring of the assets is to continue and be adaptive to unexpected subsidence changes.

Appendix A

Risk Register

ROADS & MARITIME SERVICES

RISK ASSESSMENT - SUBSIDENCE IMPACTS ON RMS ASSETS FROM LONGWALLS LW304-306

RISK REGISTER - 18 September 2018 | DRAFT | REV A

ID	ASSET	FAILURE TYPE	EVENT	Infra			Function			Safety			COMMENT	ADDITIONAL MITIGATION	Infra			Function			Safety			COMMENT
				F	C	R	F	C	R	F	C	R			F	C	R	F	C	R	F	C	R	
1	Carriageway	Cracking in the transverse direction	Build up of tensile stresses in the carriageway adjacent to LW301 causing cracks in the transverse direction.	E	1	L	E	1	L	E	1	L	Pavement cracks in the transverse direction (due to longitudinal strains) would not be extensive. Strains are expected to be tensile within the 20mm subsidence contour but would be of low order - approximately 0.4mm/m (95% confidence level). It is likely that multiple cracks will form that can be resolved by crack sealing. Extensive zones of compressive strains are not anticipated and with compressive stains of approximately 0.4mm/m (95% confidence level), no discernable impacts are anticipated.	End of Panel check visual inspection would be appropriate. Also continue RMS drive through check during mining. Base Line inspection after mining of LW303 needs to be recorded. Using GNSS studies to verify predictions	E	1	L	E	1	L	E	1	L	
2		Cracking in longitudinal direction	Build up of tensile stresses in the carriageway causing cracks in the longitudinal direction.	E	1	L	E	1	L	E	1	L	Pavement cracks in the longitudinal direction (due to transverse strains) would not be extensive due to the limited width of pavement in the transverse direction. Strains are expected to be tensile within the 20mm subsidence contour but would be of low order - approximately 0.4mm/m (95% confidence level). Over a 12m carriage way width, the maximum single crack would be <5mm. More likely, multiple cracks of smaller widths will form that can be resolved by crack sealing. For compressive strains, no impacts are anticipated due to the 12m carriageway width.	End of Panel check visual inspection would be appropriate. Also continue RMS drive through check during mining. Base Line inspection after mining of LW303 needs to be recorded. GNSS monitoring on the transmission line (early warning line) will provide early warning of movement anomalies	E	1	L	E	1	L	E	1	L	
3		Stepping	Rapid pavement failure, leading to hump or step										Not credible for the proposed longwalls.											
4		Deformations through geological structures and cut fill interfaces.	Structures to south of area at seam level. Dyke at Cutting 13561.	E	2	L	E	2	L	E	2	L	Small deformations expected (humping and cracking). Can be detected through drive throughs and corrected as required.	End of Panel check visual inspection would be appropriate. Also continue RMS drive through check during mining. Base Line inspection needs to be recorded. GNSS MONITORING WILL PROVIDE EARLY WARNING OF Potential MOVEMENTS	E	2	L	E	2	L	E	2	L	Planned resurfacing by RMS should be delayed till after LW303 - Q1 2019 if condition allows. Survey required immediately before and after resurfacing if it happens.
5	Culvert	Culvert cracking due to mining movements	Culvert joints open, culvert damage (minor cracking)	E	3	M	E	1	L	E	1	L	If there is shearing movement, there should not be any issues. Probability of fault movement is very low as the mining is planned to not cause movement in the faults. Most culverts are asbestos cement. Pipes <500mm diameter, stresses would not cause a problem unless the pipes are already frail.	Premining condition assessment of culverts (using CCTV). Further inspections as per Monitoring Plan. Culvert inspection required as per RMS program at end of panel LW303. Particularly Cawleys Creek culvert and ones near Bridge 2. GNSS will provide an early warning of movements that will indicate additional inspections may be required.	E	3	M	E	1	L	E	1	L	
6		Lose culvert grading	Ponding.										Not credible for the proposed longwalls.											
7	Kerb	Kerb/gutter cracking / buckling	Included as part of Pavement Assessment.										Not credible.											

ROADS & MARITIME SERVICES

RISK ASSESSMENT - SUBSIDENCE IMPACTS ON RMS ASSETS FROM LONGWALLS LW304-306

RISK REGISTER - 18 September 2018 | DRAFT | REV A

ID	ASSET	FAILURE TYPE	EVENT	Infra			Function			Safety			COMMENT	ADDITIONAL MITIGATION	Infra			Function			Safety			COMMENT
				F	C	R	F	C	R	F	C	R			F	C	R	F	C	R	F	C	R	
8	Cuttings	Excessive ground movement causing localised instability	Material falling onto the road. Remediation works already completed include grooming of slopes, shot-creting, fencing, rock netting and benching already completed. These treated slopes are in cuttings closest to LW301-303 and were re-rated by RMS in 10/16 as ARL4. The predicted movements are relatively minor - <50mm for subsidence and <20mm for valley closure, and these movements will not change the risk ratings for these slopes.	E	1	L							Cuttings were stabilised and rerated prior to extraction of LW301-3. New risk ratings provided in BFMP and will be reassessed as part of end of panel risk rating. It is unlikely there will be any change in these risk ratings. Tensile cracking at the top of the cuttings could occur and this could cause water infiltration. However, the dyke is more likely to weather. Cuttings at Cawleys Road Overpass (CRO) – These cuttings are rated ARL2 (high risk), but are located ~1300m from the start line of LW301. Also, the Metropolitan Fault lies between LW301 and CRO, thereby forming a barrier to mining related movements at the cuttings. While movements of concern are not expected, these cuttings will be included in the monitoring proposed for CRO. Cuttings (2) south of LW301 – The nearer cutting rated ARL3 is ~870m from the LW301 finish line, and the other rated ARL2 is ~1120m from the LW301 finish line. While no discernible movements are expected at these cuttings from the mining of LW301-303, the cuttings will be monitored in accordance with Table 9 of the BFMP.	Survey monitoring at the completion of mining of each longwall. Monitoring of the transmission lines will provide early indications for the cuttings within the 20mm subsidence contour. If the measurements exceed predicted levels, this may trigger a survey to be completed along the cuttings. GNSS monitoring data will give early warning of any movements. Maintenance inspections to include monitoring of rock fall. Inspection will be carried out during the daytime network inspection which occurs at a frequency of once per week with the direction alternating.	E	1	L							
9	Embankments	Excessive ground movement leading to localised slip failure	Cracks, water, instability.										These are flexible earth structures. Any issues are hypothetical. Not credible for the proposed longwalls.											
10	Furniture		Damage and serviceability issues.										Not credible for the proposed longwalls.											
11	Drains (above cuttings)		Damage to drains.										Not credible for the proposed longwalls.											
12	VMS	Excessive ground movement	Damage to the VMS.										Not credible for the proposed longwalls.											
13	Power lines (not an RMS asset) but may affect RMS assets	Tower / cable failure	Electrical hazard.										Not credible for the proposed longwalls due to the separation distances.											

ROADS & MARITIME SERVICES

RISK ASSESSMENT - SUBSIDENCE IMPACTS ON RMS ASSETS FROM LONGWALLS LW304-306

RISK REGISTER - 18 September 2018 | DRAFT | REV A

Transport Roads & Maritime Services NSW GOVERNMENT

ARUP

ID	ASSET	FAILURE TYPE	EVENT	Infra			Function			Safety			COMMENT	ADDITIONAL MITIGATION	Infra			Function			Safety			COMMENT
				F	C	R	F	C	R	F	C	R			F	C	R	F	C	R	F	C	R	
14	Bridge 2 (BN616 - southbound / 617 - northbound)	Distortion of bridge elements leading to inconsequential cracking (<0.1mm)	Differential movements between key points on the bridge of up to 5mm										The probability of occurrence of differential movement of this magnitude is as low as 1 in 10. No credible consequences.	Monitoring of differential movements between key points in structure from which effects on the bridge can be assessed. Monitoring systems includes surveying (to pick up 70% key points) and FBG sensor (to pick up 40-50% of key points, but much more accurate). If significant differential movements are detected, increase frequency of monitoring to understand the trend of movement.									
15		Distortion of bridge elements leading to cracking that may require repair (between 0.1mm and 1.0mm)	Differential movements between key points on the bridge of 6mm to 15mm.	C	1	L	C	2	M	C	1	L	The probability of occurrence of differential movement of this magnitude is in the order of 1 in 100. Works to repair cracks will affect old Princes Hwy, not the M1.	As above. No economical mitigation measures to prevent the "failure" are possible.	C	1	L	C	2	M	C	1	L	
16		Distortion of bridge elements leading to development of wide cracks that would be considered as structural failure (>1.0mm)	Differential movements between key points on the bridge of 16mm to 44mm.	E	5	H	E	5	H	E	2	L	The probability of occurrence of differential movement of this magnitude is in the order of 1 in 2000. If differential movement is at a disadvantageous location, structural failure in the form of severe cracking could occur. This would be unacceptable, and the planned end-of-panel location must be brought forward to a position recommended by the Technical Committee well before differential movements reach this magnitude, for a termination of mining earlier than planned to avoid failure of the structure.	As above. No economical mitigation measures to prevent the "failure" are possible.	E	5	H	E	5	H	E	2	L	
17	Cawley Road Overpass (BN615)	Distortion of bridge elements leading to inconsequential cracking (<0.1mm)	Differential movements between key points on the bridge of up to 10mm.										The probability of occurrence of differential movement of this magnitude is as low as 1 in 10. No credible consequences.	Monitoring of differential movements between key points in structure from which effects on the bridge can be assessed. If significant differential movements are detected, increase frequency of monitoring to understand the trend of movement.									
18		Distortion of bridge elements leading to cracking that may require repair (between 0.1mm and 1.0mm)	Differential movements between key points on the bridge greater than 10mm and up to 20mm (the upper bound value).										The probability of occurrence of differential movement of this magnitude is in the order of 1 in 100 to 1 in 2000. No credible consequences.	As above.									

ROADS & MARITIME SERVICES

RISK ASSESSMENT - SUBSIDENCE IMPACTS ON RMS ASSETS FROM LONGWALLS LW304-306

RISK REGISTER - 18 September 2018 | DRAFT | REV A

ID	ASSET	FAILURE TYPE	EVENT	Infra			Function			Safety			COMMENT	ADDITIONAL MITIGATION	Infra			Function			Safety			COMMENT
				F	C	R	F	C	R	F	C	R			F	C	R	F	C	R	F	C	R	

NOTE:

RMS guidelines state a coverage zone of 5 times depth of mine (~2km).

All mitigation measures, regardless of the cell in which they are recorded, are deemed to apply to all risk events. Furthermore, control and mitigation measures listed in the report are also deemed to apply to all risk events in the risk register.

Appendix B

Workshop Participants

ROADS & MARITIME SERVICES

RISK ASSESSMENT - SUBSIDENCE IMPACTS ON RMS ASSETS

ATTENDANCE SHEET – 18 September 2018

Transport Roads & Maritime Services

Name	Position	Organisation
Matthew Brunton	Snr Project Manager	Monitor Optics Systems
Henk Buys	Geotech Engineer	AECOM.
Richard Woods	Bridge Engineers	CARDNO
Felipe Palominos	Mining Engineer	Peabody.
Peter Debono	Mine Subsidence Engineer	MSEC.
DICK LEE SHOY	CHAIR, TECHNICAL COMMITTEE	RMS - CONSULTANT
JON DEGOTARDI	TECHNICAL SERVICES MANAGER	PEABODY
Dony Castro	Bridge Maintenance Planner	RMS
Vicki Temelkovski	A/ Pavement Planner	RMS.

Appendix C

Workshop Agenda

Peabody ENERGY Metropolitan Colliery

Meeting with Roads & Maritime Services [Technical Committee]

LW304-306 Extraction Plan – Built Features Management Plan
M1 Princes Motorway

18 September 2018 – 1pm to 4:30pm
Wollongong RMS Office - Level 4 Conference Room

Agenda

Purpose of meeting:

- To discuss the subsidence predictions relevant to LW304-306 prepared by MSEC
- Assess the risks relevant to LW301-303 for the Extraction Plan in accordance with the DP&E and DRE Draft *Guidelines for the Preparation of Extraction Plans*.*
- Review existing controls, procedures and programs and update if required for the LW304-306 BFMP.

Item	Detail	Who	Time:
	Introductions	Arup	1pm
1.	Update on mine activities and current location	Peabody	1:10pm
2.	Short overview of the LW304-306 extraction area		
3.	Subsidence predictions for LW304-306	MSEC	1:30
4.	Update on subsidence performance to date and inspections re: RMS assets (M1 Princes Motorway)	MSEC/Peabody	1:45
5.	Discussion on specific RMS assets including: • Pavement • Bridges (Bridge 2; Cawley Road Overpass) • Cuttings/Embankments • Drains/Culverts • High Accuracy Fibre Optic Monitoring System • Conventional Survey/Visual Inspections • Management Measures • Contingency Measures	Peabody/RMS/MSEC	2:15
6.	Risk assess any changes that may have bearing on the performance of the assets. Review existing controls, procedures and programs in existing BFMP (M1 Princes Motorway) for continued suitability and feasibility and update if required.	Peabody/RMS	3:30
7.	Next Steps • Draft LW304-306 Register and Report	Arup	4:00-4:30pm
		TOTAL	3.5 hrs

*The Draft *Guidelines for the Preparation of Extraction Plans* require the BFMPs to include:

- *the results of risk assessment conducted by a competent person in accordance with relevant standards and guidelines;*
- *description of the investigation and analysis methods used in determining the risk control measures and procedures, carried out by a competent person;*
- *description of all risk control measures and procedures, including a statement of the feasibility to manage identified risks; and*
- *a proposed program for implementation of the proposed risk control measures and procedures.*

Appendix D

Risk Criteria

ROADS & MARITIME SERVICES

RISK ASSESSMENT - SUBSIDENCE IMPACTS ON RMS ASSETS

FREQUENCY

Level	Descriptor	Alt. Description	Description	Chance %	Frequency
O	**Absolutely Certain**	Definite	This event will occur - known to occur now *- Will occur several (many) times each year and many times (constantly) during this project*	99.99	Several times each year
A	**Almost Certain**	Frequent	This event is expected to occur in most circumstances *- Expected to occur more than once during the duration of this project*	95	1 / year
B	**Likely**	Probable	This event will probably occur in most circumstances *- Expected to occur once during the duration of the project*	10	at least 1 / 10 years
C	**Possible**	Occasional	This event might (should) occur at some time *- Not likely to occur in life of project, but it is possible.*	1	at least 1 / 100 years
D	**Unlikely**	Remote	This event could occur at some time *- Unlikely (very) to occur in life of project*	0.1	at least 1 / 1,000 years
E	**Rare**	Very Unlikely	This event may occur in exceptional circumstances *- Examples of this have occurred historically, but it is not anticipated for this project*	0.01	at least 1 / 10,000 years
F	**Hypothetical**	Barely credible	Theoretically possible but never occurred to date (anywhere in the world) *- Often applied to natural events*	1.00E-03	every Million years

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ROADS & MARITIME SERVICES

RISK ASSESSMENT - SUBSIDENCE IMPACTS ON RMS ASSETS

CONSEQUENCES

Level	Descriptor	Infrastructure			Amenity			Safety / Societal Cost
		Pavement	Bridges	Cost	Access	Speed	Political	
1	**Insignificant**	Minor damage	Minor repairable damage	< $50 k	Some loss in condition	No traffic effect	No political impact	No injuries or health effects
2	**Minor**	Noticeable damage	Damage that will deteriorate if not repaired quickly	< $100 k	One lane closed for < half day. One planned lane closure < 1 day	Speed reduction for < 1 month - 80 kph	Minimal political impact brief press coverage)	First aid treatment or minor damage to vehicles
3	**Moderate**	Significant damage	Significant damage	< $1 Mk	One lane closed for < 1 day	Speed reduction for > 1 month - 80 kph or < 1 day - 40 kph	Political impact (press coverage)	Medical treatment required
4	**Major**	Extensive damage	Major damage - restricted speed	< $10 M	One lane closed for > 1 day	Speed reduction for < 1 month - 40 kph	Significant political impact (extensive negative press coverage)	Extensive injuries or one or two permanent disabilities
5	**Catastrophic**	Loss of use of carriageway	Extensive damage. One carriageway closed until repaired	< $50 M	One carriageway closed for > 1 day or both cways for < 2 day	Speed reduction for > 1 month - 40 kph	Major political impact (Commission of Enquiry)	Single fatality or severe permanent disabilities to several people
6	**Untenable**		Total failure of bridge or closed until repaired	> $50 M	Both carriageways closed for > 2 day	Speed restrictions for > 12 months - 40 kph		Multiple fatalities

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ROADS & MARITIME SERVICES

RISK ASSESSMENT - SUBSIDENCE IMPACTS ON RMS ASSETS

RISK MATRIX

		CONSEQUENCES					
LIKELIHOOD		1 (Insignificant)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Catastrophic)	6 (Unthinkable)
Multiple	O	H	E	E	E	E	E
Almost Certain	A	H	H	E	E	E	E
Likely	B	M	H	H	E	E	E
Possible	C	L	M	H	E	E	E
Unlikely	D	L	L	M	H	E	E
Rare	E	L	L	M	H	H	E
Hypothetical	F	L	L	L	M	H	H

Low	Low risk; managed by routine procedures.
Moderate	Moderate risk; requires above normal attention.
High	High risk; ALARP must be applied.
Extreme	Extreme risk; not acceptable and must be reduced.

ARUP

Appendix E

Peabody BFMP Presentation

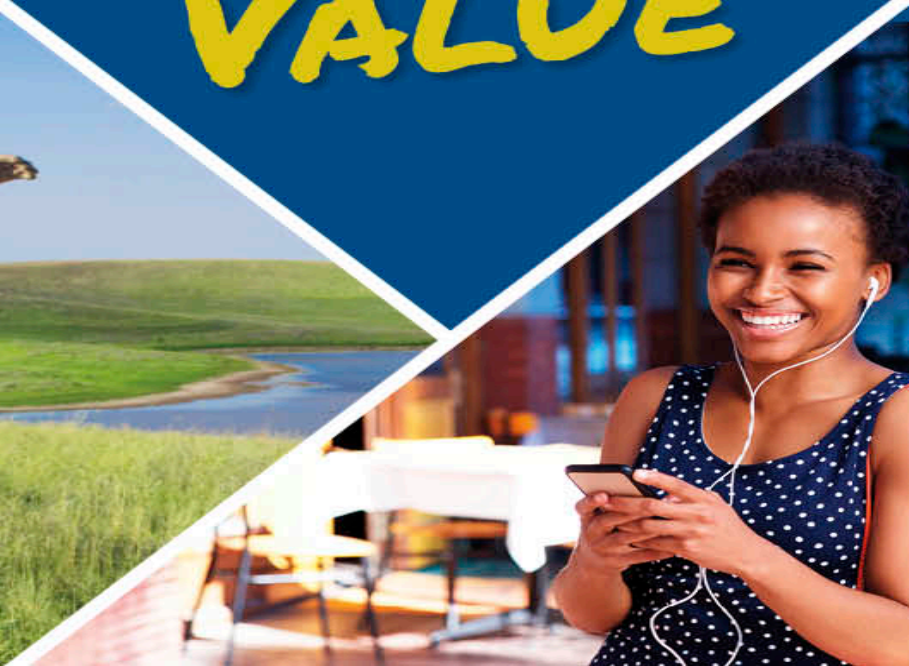
Metropolitan Coal
Longwalls 304-306
Built Features Management Plan
Roads & Maritime Services

DELIVERING RESULTS GENERATING VALUE

Jon Degotardi
Technical Services Manager

September, 2018

Peabody



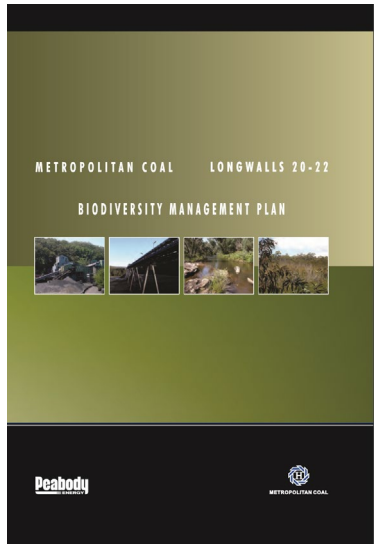
Peabody's
Metropolitan Mine

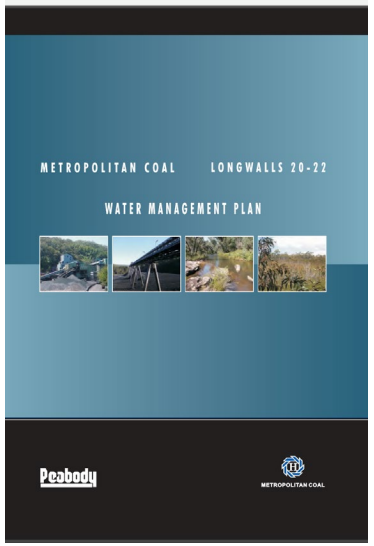
Metropolitan Colliery Location

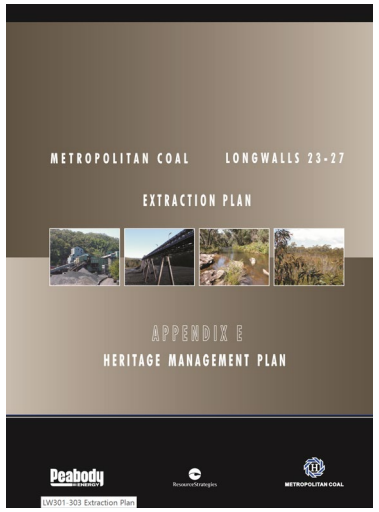
Peabody

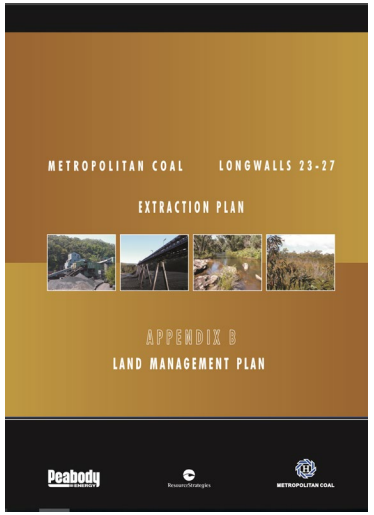
Extraction Plan Components

- **Built Features Management Plan(s)**
  - **Roads and Maritime Services**
- Water Management Plan
- Biodiversity Management Plan
- Land Management Plan
- Heritage Management Plan
- Public Safety Management Plan
- Subsidence Monitoring Program









Peabody

LW304-306 Extraction Plan

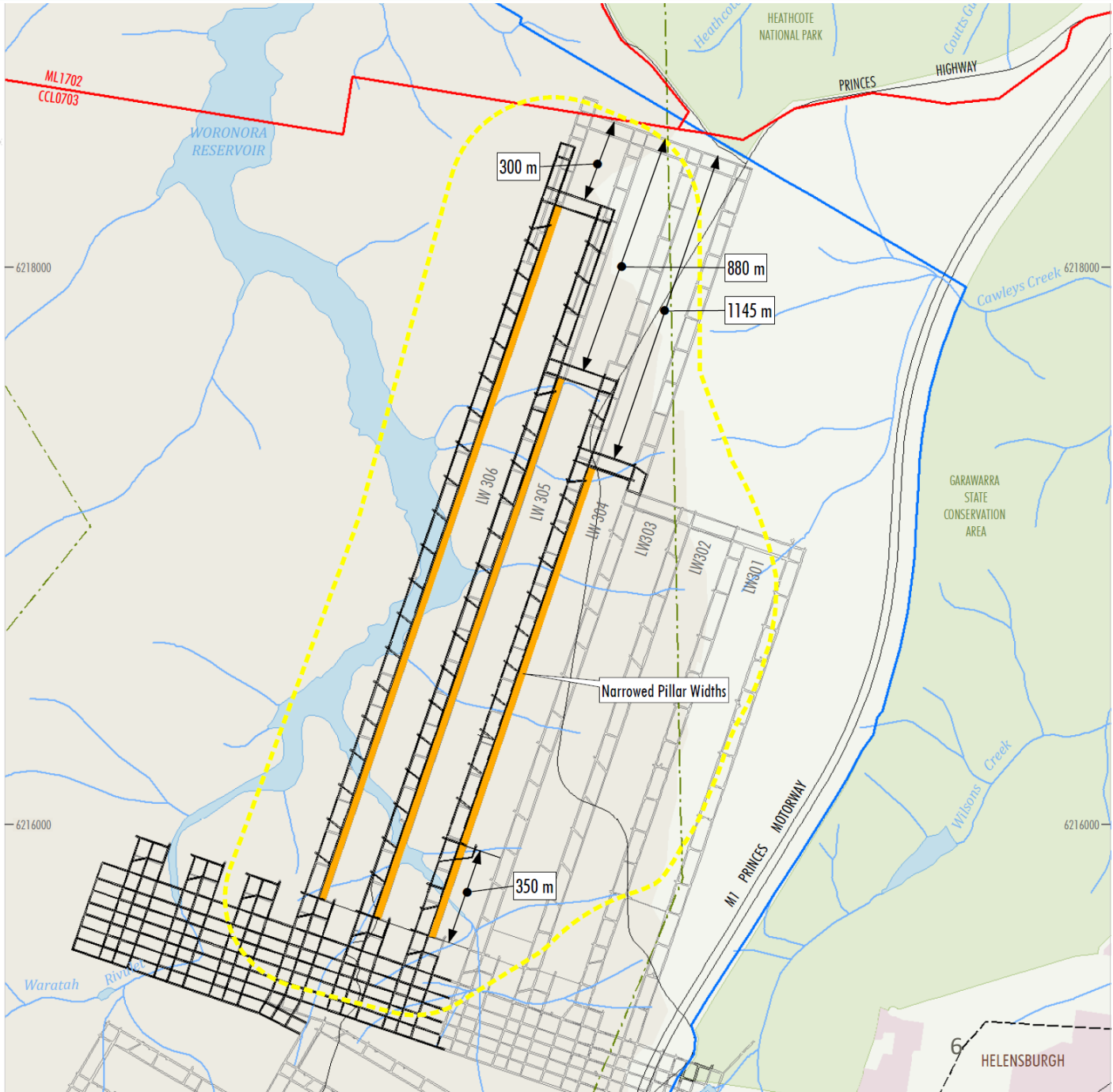
Project Approval Condition

- The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

  Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.

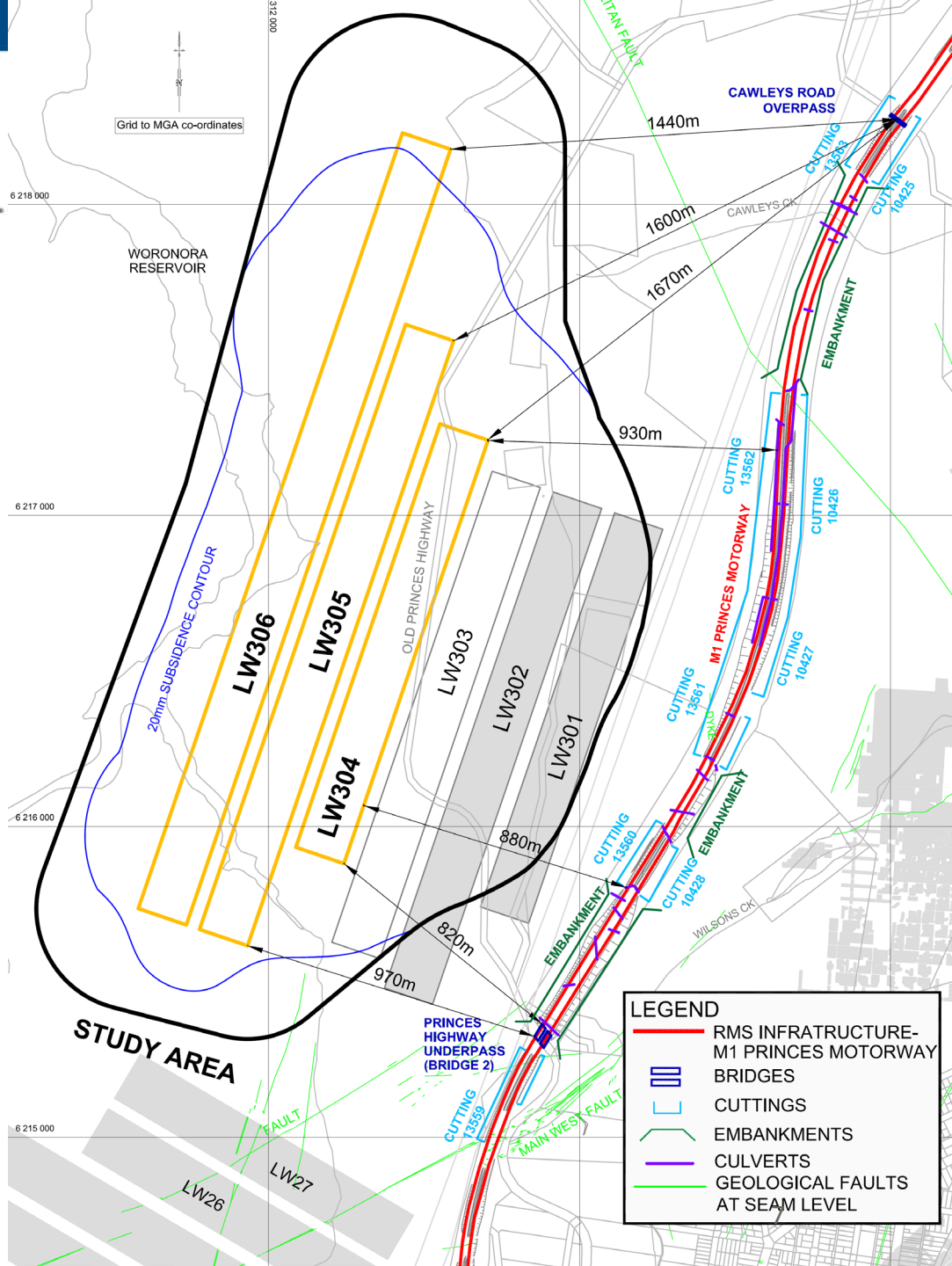
LW304-306 Extraction Plan Changes to Mine Layout

- 2,675m reduction in extraction length (~1/3 reduction). Planned lengths are:
  - LW304 – 1,438m
  - LW305 – 2,055m
  - LW306 – 2,933m
- Consolidation of the panel and chain pillar widths of Longwalls 304-306 to 163 m panel widths (void) and 45 m wide pillars (solid)
- Subject to approval from DP&E



LW304-306 Extraction Plan
Key Distances

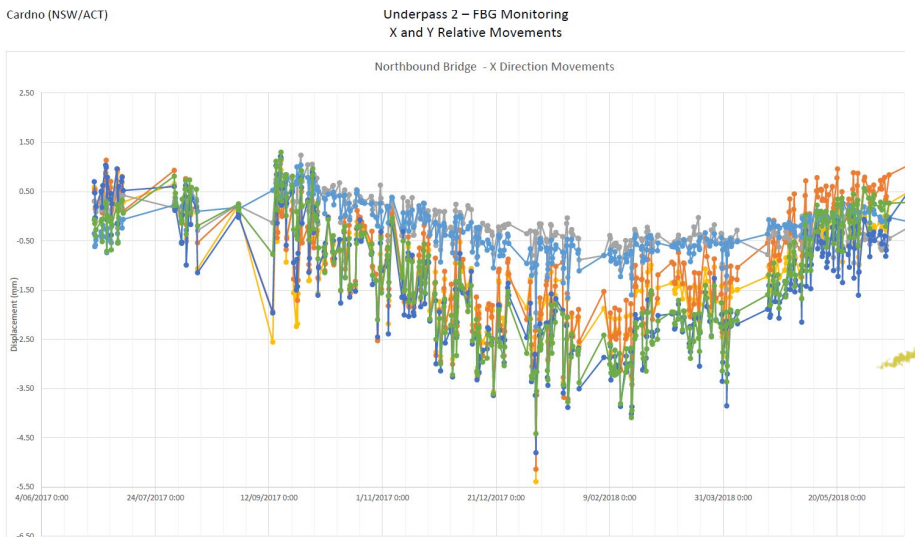
- Extraction area moving away from M1 Motorway
- Pavement, Cuttings, Embankments, Culverts (>0.8km)
- Bridge 2 (>0.8km)
- Cawley Bridge (>1.4 km)

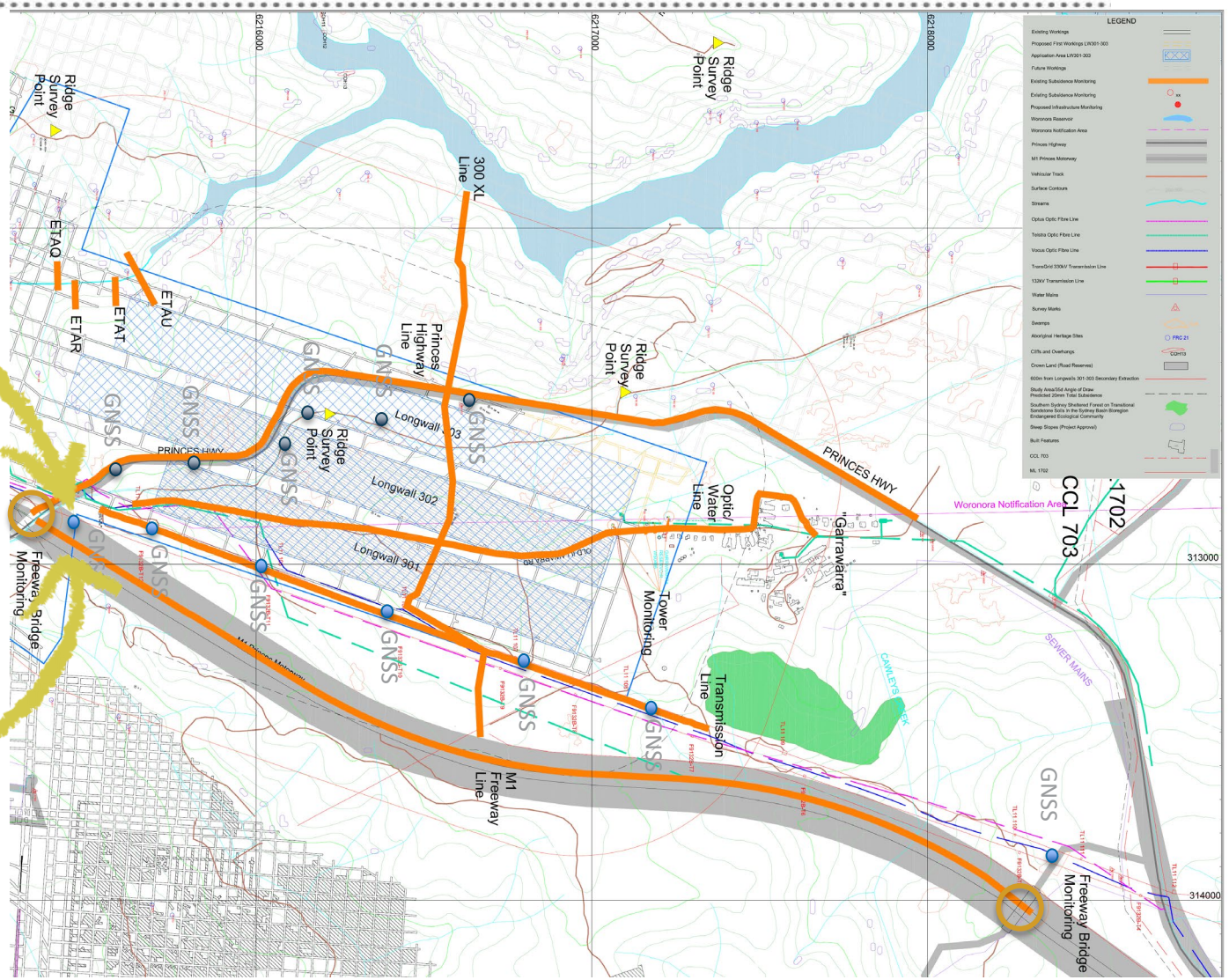


LW304-306 Extraction Plan Monitoring Program

Maintain LW301-303 regime as a minimum

- GNSS real time units
- Traditional survey
- FBG on Bridge 2



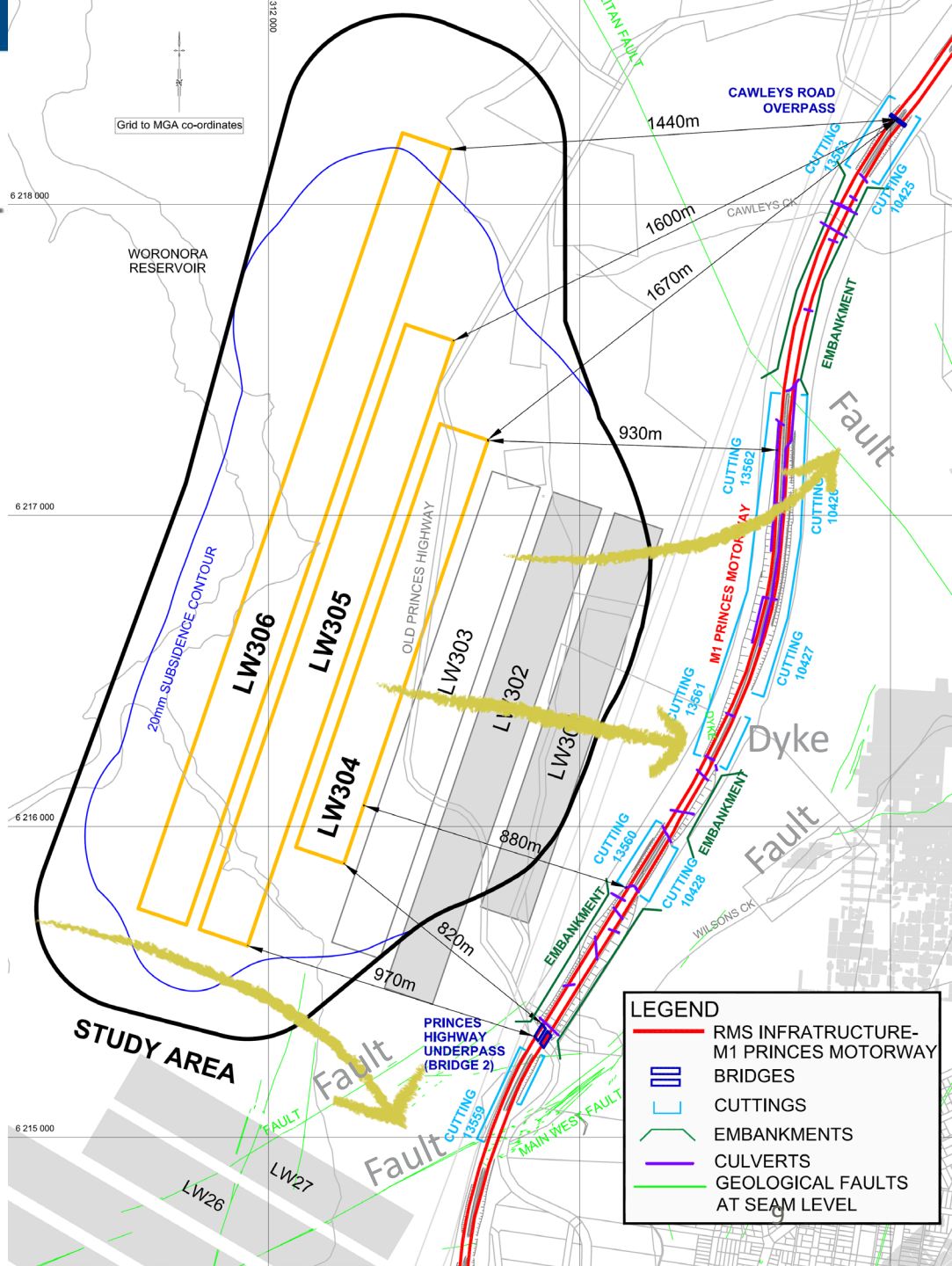


LW304-306 Extraction Plan
Geological Features

- Geological features relevant to M1 Motorway

- Structures include;
  - Metropolitan Fault (north-east),
  - dyke with surface exposure in cutting, and
  - other mapped faults (south-east).

- No changes to mapped features in vicinity of M1 Motorway since 2016 assessment for LW301-303.



Peabody

LW304-306
Subsidence Predictions

Appendix F

MSEC Subsidence Report

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

6th September 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-08

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Roads and Maritime Services Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Roads and Maritime Services (RMS) infrastructure resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery.

The locations of the RMS infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC844-08. The M1 Princes Motorway is located to the east of Longwalls 301 to 303. The distance of the M1 Princes Motorway from Longwalls 301 to 303 varies from 210 metres near the finishing (southern) end of Longwall 301 to 335 metres near the commencing (northern) end of Longwall 301.

A series of cuttings and embankments up to a maximum height of approximately 20 metres are shown in the attached Drawing No. MSEC844-08. A summary of the rock cuttings is provided in Table 1.

Table 1 Summary of RMS Rock Cuttings

RMS Slope Number	RMS Assessed Risk Level (ARL)	Length (m)	Maximum Slope Height (m)	Average Slope Angle (degrees)
13563	2	202	17	65
13562	2	531	18	70
13561	2	599	13	62
13560	2	231	8	70
10425	2	188	9	66
10426	2	503	15	55
10427	2	452	14	55
10428	2	192	9	65

A bridge is located at the crossing of the M1 Princes Motorway with the Old Princes Highway (Bridge 2), and is located approximately 330 metres from Longwall 301. The next nearest bridge is Cawley Road Overpass, which is located approximately 1.43 kilometres to the north east of Longwall 303.

A series of culverts cross the M1 Princes Motorway, as shown on Drawing No. MSEC844-08. The culverts comprise pipes of varying diameters from 375 mm to 1800 mm. The pipe materials comprise asbestos cement (pipes up to

600 mm diameter) and steel reinforced concrete (pipes up to 1800 mm diameter). In addition to the culverts, there are also a number of other drainage structures, such as kerbs, gutters, pits and drainage pipes. The largest culvert comprises two 1800mm pipes located to the north east of the longwalls at Cawley's Creek.

The predictions and impact assessments for the RMS infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the RMS Infrastructure

A summary of the maximum predicted values of total subsidence, tilt and curvature for the M1 Princes Motorway, resulting from the extraction of Longwalls 301 to 303, is provided in Table 2. The values are the maxima anywhere along the section of the motorway located within the Study Area.

Table 2 Predicted Total Subsidence, Tilt and Curvature for the M1 Princes Motorway Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	< 20	< 0.5	< 0.01	< 0.01
After LW302	50	< 0.5	< 0.01	< 0.01
After LW303	50	< 0.5	< 0.01	< 0.01

The maximum predicted conventional tilt and curvature are negligible and less than typical limits of survey accuracy (i.e. 0.5 mm/m for tilt and 0.01 km^{-1} for curvature).

Princes Motorway will potentially experience low level far-field horizontal movement. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield.

The observed incremental far-field horizontal movements, resulting from the extraction of longwalls in the Southern Coalfield, are provided in Figure 1. The data are based on survey marks located outside of the mining area (i.e. above solid coal).

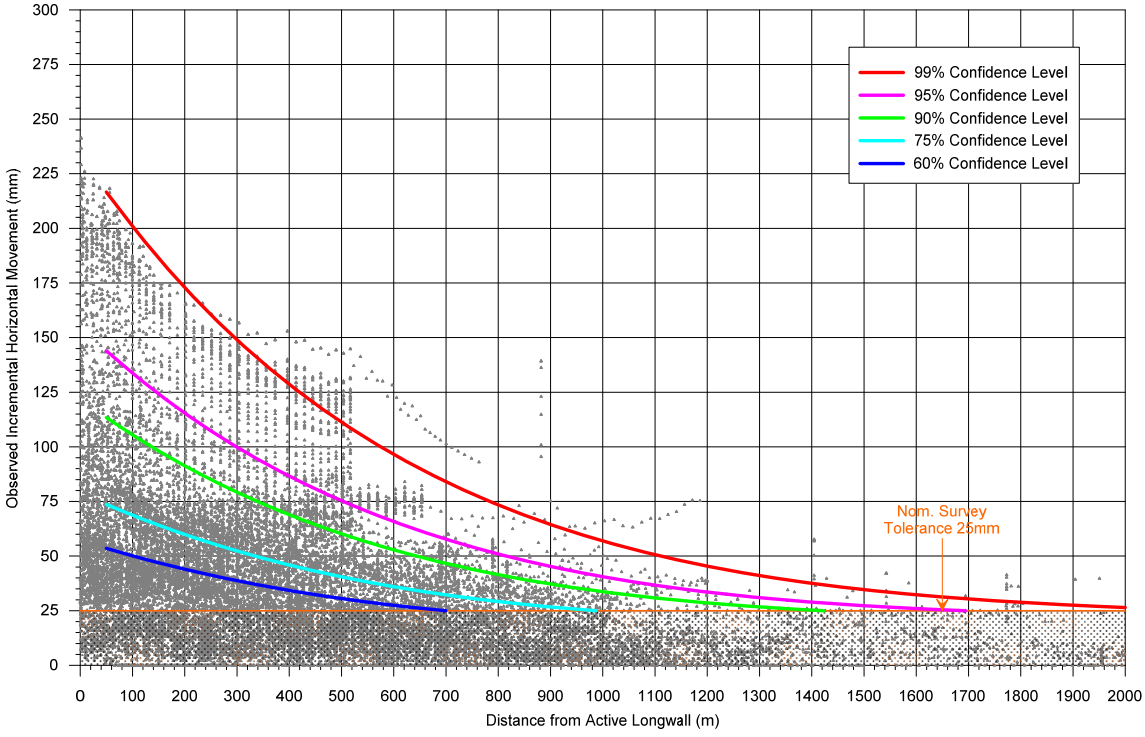


Figure 1 Observed Incremental Far-field Horizontal Movements from the Southern Coalfield (Solid Coal)

The absolute horizontal movements measured at distances greater than 210 metres from mining are in the order of 115 mm based on the 95 % confidence level. These low level movements comprise a large proportion of survey tolerance. Far-field horizontal movements tend to be bodily movements orientated towards the mining area. The strains associated with these low level horizontal movement are not expected to be measurable.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the RMS infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The M1 Princes Motorway is located at distances of 200 metres or greater from the longwalls. The database of measured strains has therefore been analysed to extract the maximum tensile and compressive strains that have been measured at any time during the extraction of the previous longwalls in the Southern Coalfield, for survey bays that were located outside and within 100 metres to 250 metres of the nearest longwall goaf edge, which has been referred to as "*above solid coal*".

A histogram of the maximum observed tensile and compressive strains measured in survey bays located above solid coal, for monitoring lines in the Southern Coalfield, is provided in Figure 2. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

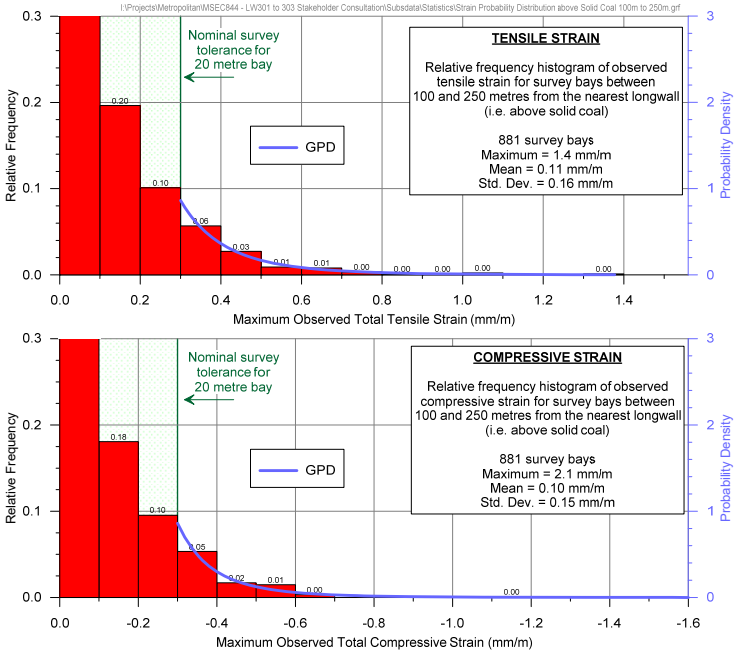


Figure 2 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Solid Coal (100 to 250 metres)

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above solid coal, based on the fitted GPDs, is provided in Table 3.

Table 3 Probabilities of Exceedance for Strain for Survey Bays Located above Solid Coal

Strain (mm/m)		Probability of Exceedance
Compression	-2.0	1 in 9,840
	-1.5	1 in 3000
	-1.0	1 in 635
	-0.5	1 in 55
	-0.3	1 in 10
Tension	+0.3	1 in 9
	+0.5	1 in 36
	+1.0	1 in 410
	+1.5	1 in 2,200
	+2.0	1 in 8,000

The 95 % confidence intervals for the maximum total strains that the individual survey bays above solid coal (100 to 250 metres) experienced at any time during mining are 0.4 mm/m tensile and compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above solid coal experienced at any time during mining are 0.7 mm/m tensile and 0.6 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures and the streams are shown in Drawing No. MSEC844-08.

There are no identified geological structures above the longwalls. The M1 Princes Motorway crosses the Metropolitan Fault approximately 500 metres to the north east of Longwall 301 and several faults to the south east of Longwalls 301 and 302 intersecting the M1 Princes Motorway at approximately 340 metres. The absolute horizontal movements measured at distances of 500 metres and 340 metres from mining are in the order of 75 mm and 95 mm respectively based on the 95 % confidence level. It is noted that these faults are identified at seam level and surface expression of faults may occur at different locations, or faults may not have continuity to the ground surface.

A drainage line crosses the M1 Princes Motorway approximately 210 metres east of the finishing end of Longwall 301, as shown on Drawing No. MSEC844-08. Predicted valley closure across the culvert at the location of the M1 Princes Motorway is less than 20 mm.

A second drainage line is located to the north of the longwalls at Cawley's Creek. Due to the shortened commencing end of the longwalls, the culvert is located approximately 1060 metres from the nearest longwall (Longwall 301). At this distance, the culvert is not predicted to experience valley related movements due to the extraction of the Longwalls 301 to 303.

Valley closure is not expected to occur in the cuttings along the M1 Princes Motorway, however, minor closure movements could be observed due to potential horizontal movements.

Impact Assessments for the M1 Princes Motorway

The predicted conventional vertical subsidence for the M1 Prince Motorway resulting from the extraction of Longwalls 301 to 303 are very small and the predicted tilts and curvatures are less than the expected limits of survey tolerance. Adverse impacts to the M1 Princes Motorway, including the road pavement, slopes, culverts, barriers and furniture, resulting from conventional subsidence movements is considered unlikely.

The M1 Princes Motorway will potentially experience far-field horizontal movements resulting from the extraction of the Longwalls 301 to 303 of up to 115 mm, based on the 95% confidence level.

There are no major geological features to the east of the longwalls near the M1 Princes Motorway. The mapped geological features are shown on Drawing No. MSEC846-08. The Metropolitan Fault intersects the M1 Princes Motorway at approximately 500 metres to the north east of Longwall 301. There are mapped faults to the south east of Longwalls 301 and 302, intersecting the M1 Princes Motorway at approximately 340 metres from the longwalls. A dyke with a surface exposure is also present to the east of Longwall 301 at approximately 380 metres from Longwall 301. There is the potential for far-field horizontal movements to result in the minor differential movement near the faults and potential shearing and/or stepping in the road pavement. The faults have been mapped at seam level and surface expressions have not been identified. The mapped dyke has been identified in the motorway cuttings. There is also the potential for far-field horizontal movements to result in differential movement at the interface of cut and fill areas along the motorway corridor.

The M1 Princes Motorway crosses a valley and an associated drainage culvert to the east of the Longwall 301 finishing end. The predicted valley closure due to Longwalls 301 to 303 is less than 20 mm. A second valley and culvert are located at Cawley's Creek, approximately 930 metres from Longwall 303. Adverse impacts to the culverts resulting from conventional subsidence and valley related movements is considered unlikely.

It is recommended that monitoring and management strategies are developed, in consultation with RMS, to manage the potential impacts on the M1 Princes Motorway. It is expected that the motorway can be maintained in safe and serviceable conditions with the implementation of the appropriate monitoring and management strategies.

Impact Assessments for the Bridges

An assessment of Bridge 2 (RMS reference BN616-southbound and BN617-northbound) has been undertaken by the RMS technical committee, which was formed prior to the commencement of the extraction of Longwall 20 to assess and monitor potential impacts to RMS assets due to the extraction of longwalls at Metropolitan Colliery. A letter report MSEC696-02 dated 30th June 2014 was prepared based on a preliminary layout of Longwalls 301 to 317. The distance of the bridge from the longwalls is unchanged at 330 metres hence the impact assessments are the same as previously reported. A summary of the subsidence predictions and impact assessments for Bridge 2 is provided below.

- At a distance of approximately 330 metres, the predicted subsidence parameters are less than survey tolerance, which is typically 20mm for subsidence, 0.5mm/m for tilt and 0.01km^{-1} for curvature. The predicted conventional subsidence parameters indicate that with high accuracy survey, minor subsidence, tilt and hogging curvature may be observed, but sagging curvature is unlikely to be observed.
- The absolute horizontal movements measured at distances greater than 330 metres are in the order of 95 mm based on the 95% confidence level. An absolute horizontal movement of 105 mm based on the 95% confidence level was provided in the MSEC696-02 report. The updated data set as presented in Figure 1 results in a slightly lower value of observed horizontal movement, however the difference of 10 mm does not change the impact assessments for the bridge.
- It is difficult to predict differential horizontal movements since the potential values of relative movement are typically very small and much of the scatter in the observed data is the result of survey accuracy. Also, a spacing between pegs of 20 metres is commonly used along monitoring lines, and this distance is larger than the typical column and blade wall spacing for Bridge 2.
- Differential horizontal movement was assessed by analysing the far-field horizontal movement data discussed above. The data set was analysed to determine incremental relative opening and closing and incremental mid ordinate deviation.
- The incremental relative opening and closing and mid ordinate deviation for various probabilities at a distance of approximately 330 metres from an active longwall are summarised in Table 4 and Table 5.

Table 4 Incremental Relative Opening, Closing and Mid-Ordinate Deviation at Approximately 330 metres Distance from Active Longwall

	1 in 20 probability (95% confidence level)	1 in 100 probability (99% confidence level)	1 in 2000 probability (99.95% confidence level)
Opening	8 mm	14 mm	44 mm
Closing	6 mm	13 mm	44 mm
Mid-Ordinate Deviation	9 mm	15 mm	32 mm

Table 5 Incremental Relative Opening, Closing and Mid-Ordinate Deviation due to First Panel Extraction Only

	1 in 20 probability (95% confidence level)	1 in 100 probability (99% confidence level)	1 in 2000 probability (99.95% confidence level)
Opening	5 mm	10 mm	25 mm
Closing	4 mm	9 mm	32 mm
Mid Ordinate Deviation	5 mm	8 mm	14 mm

- The differential movements presented in Table 4 and Table 5 should be applied to the bridge elements in both the longitudinal and transverse direction of the bridge. The application of the differential movements to short bridge element spacing (e.g. columns approximately 5m apart), was discussed by the technical committee and it was agreed that the movements should be applied directly to shorter element spacing.
- The differential longitudinal movement, opening (+ve) and closing (-ve) should be applied to the longitudinal and transverse direction as an opening and closing movement, between piers, and between columns. The mid-ordinate deviation should be applied to an out of plane movement of one pier relative to adjacent piers, which are spaced at 13.5 metres at abutments and 18.3 metres in the centre, as well as between columns which are approximately 5 metres apart.
- Faults have been identified at seam level to the west and to the east of Bridge 2. The nearest faults, Main West and Powel are approximately 235 metres horizontal distance from Bridge 2. There are no mapped surface expressions of the faults. The projected alignments of these faults do not intersect the location of Bridge 2. There is a low likelihood of the identified structures directly impacting Bridge 2, however other potential unidentified structures may be present at or near the bridge location.

A decision was made by the RMS technical committee to monitor potential movements of Bridge 2 using a high accuracy fibre optic monitoring system, along with conventional surveying methods. The monitoring system is being established to record baseline readings during the extraction of Longwalls 26 and 27, prior to the commencement of Longwall 301.

Cawley Road Overpass is located at 1.43 kilometres from Longwall 301 at its nearest point. At this distance, observed far-field movements as shown in Figure 1 are close to nominal survey tolerance and observed differential movement data is predominantly within survey tolerance. Differential horizontal movement was assessed by analysing the far-field horizontal movement data. The data set was analysed to determine incremental relative opening and closing and incremental mid ordinate deviation at a distance of approximately 1.43 kilometres from an active longwall.

The incremental relative opening and closing and mid ordinate deviation for various probabilities at a distance of approximately 1.43 kilometres from an active longwall are summarised in Table 6.

Table 6 Incremental Relative Opening, Closing and Mid-Ordinate Deviation at Approximately 1.43 kilometres Distance from Active Longwall

	1 in 20 probability (95% confidence level)	1 in 100 probability (99% confidence level)	1 in 2000 probability (99.95% confidence level)
Opening	4 mm	7 mm	14 mm
Closing	5 mm	9 mm	19 mm
Mid-Ordinate Deviation	7 mm	10 mm	18 mm

At this distance, adverse impact to Cawley Road Overpass resulting from the extraction of Longwalls 301 to 303 is considered unlikely, however an assessment of the structure should be undertaken to assess the sensitivity of the structure to potential differential movements a result of Longwalls 301 to 303.

Summary

The M1 Princes Motorway is located greater than 210 metres to the east of Longwalls 301 to 303. The previous experience from the Southern Coalfield has found that the potential impacts on bitumen seal and asphaltic pavements can be managed with the implementation of suitable monitoring and management strategies.

It is recommended that monitoring and management strategies are developed, in consultation with RMS, to manage the potential impacts on the M1 Princes Motorway. It is expected that the motorway can be maintained in safe and serviceable conditions with the implementation of the appropriate monitoring and management strategies.

Bridge 2 is located approximately 330 metres from Longwall 301. A program of high accuracy monitoring of this bridge has been implemented by the RMS technical committee and will be outlined in the Built Features Management Plan for Longwalls 301 to 303. The culverts and Cawley Road Overpass are located outside the predicted 20 mm subsidence contour. Whilst these features could experience low level far-field horizontal movements, they are not expected to experience measurable strains or differential horizontal movements. Assessment of these structures should be undertaken by the RMS technical committee to assess the sensitivity of these structures to potential differential movements a result of Longwalls 301 to 303.

Yours sincerely

Peter DeBono

Mine Subsidence Engineering Consultants

Attachments:

Drawing No. MSEC844-08 – Longwalls 301 to 303 – RMS Infrastructure

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COAL

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
RMS

DATE:	SCALE:	DRAWING No:	Rev No
23 Aug 2016	1:12500	MSEC844-08	A

313 000 314 000 312 000
6 218 000 6 217 000 6 216 000 6 215 000

Grid to MGA co-ordinates

CAWLEY ROAD OVERPASS
METROPOLITAN FAULT
CAWLEYS CK
CUTTING 13563
CUTTING 10425
EMBANKMENT
1430m
STUDY AREA
WORONORA RESERVOIR
20
20mm SUBSIDENCE CONTOUR
OLD PRINCES HIGHWAY
LW303
LW302
LW301
CUTTING 13562
CUTTING 10426
M1 PRINCES MOTORWAY
CUTTING 13561
CUTTING 10427
DYKE
CUTTING 13560
EMBANKMENT
CUTTING 10428
EMBANKMENT
WILSONS CK
330m
PRINCES HIGHWAY UNDERPASS (BRIDGE 2)
CUTTING 13559
FAULT
MAIN WEST FAULT
POWELL FAULT

LEGEND
- RMS INFRATRUCTURE- M1 PRINCES MOTORWAY
- BRIDGES
- CUTTINGS
- EMBANKMENTS
- CULVERTS
- GEOLOGICAL FAULTS AT SEAM LEVEL

APPENDIX 6

BUILT FEATURES MANAGEMENT PLAN - SUBSIDENCE IMPACT REGISTER

Built Features Management Plan - Subsidence Impact Register

Impact Register Number[1]	Built Feature[2]	Impact Description	Does Impact Exceed the Built Feature Performance Measure/Indicators? (Yes/No)	Management Measures Implemented	Were Management Measures Effective? (Yes/No)

Notes:

1: Fill out all details in the Assessment Form and record the register number here.

2: Built feature (e.g. road pavement, etc.).

Built Features Management Plan – Subsidence Impact Register
Assessment Form

Date:

Observer (Name and position):

Register Number (i.e. Number 1, 2, etc.):

Longwall Number and Chainage:

Location of Observed Impact:

(Examples: location of culvert, include GPS co-ordinates and a sketch)

Description of Observed Impact:

(Examples: nature and extent of impact - cracks in road etc any relevant information, attach photographs)

Person Notified:	Manager - Technical Services	☐

Description of Photographs:

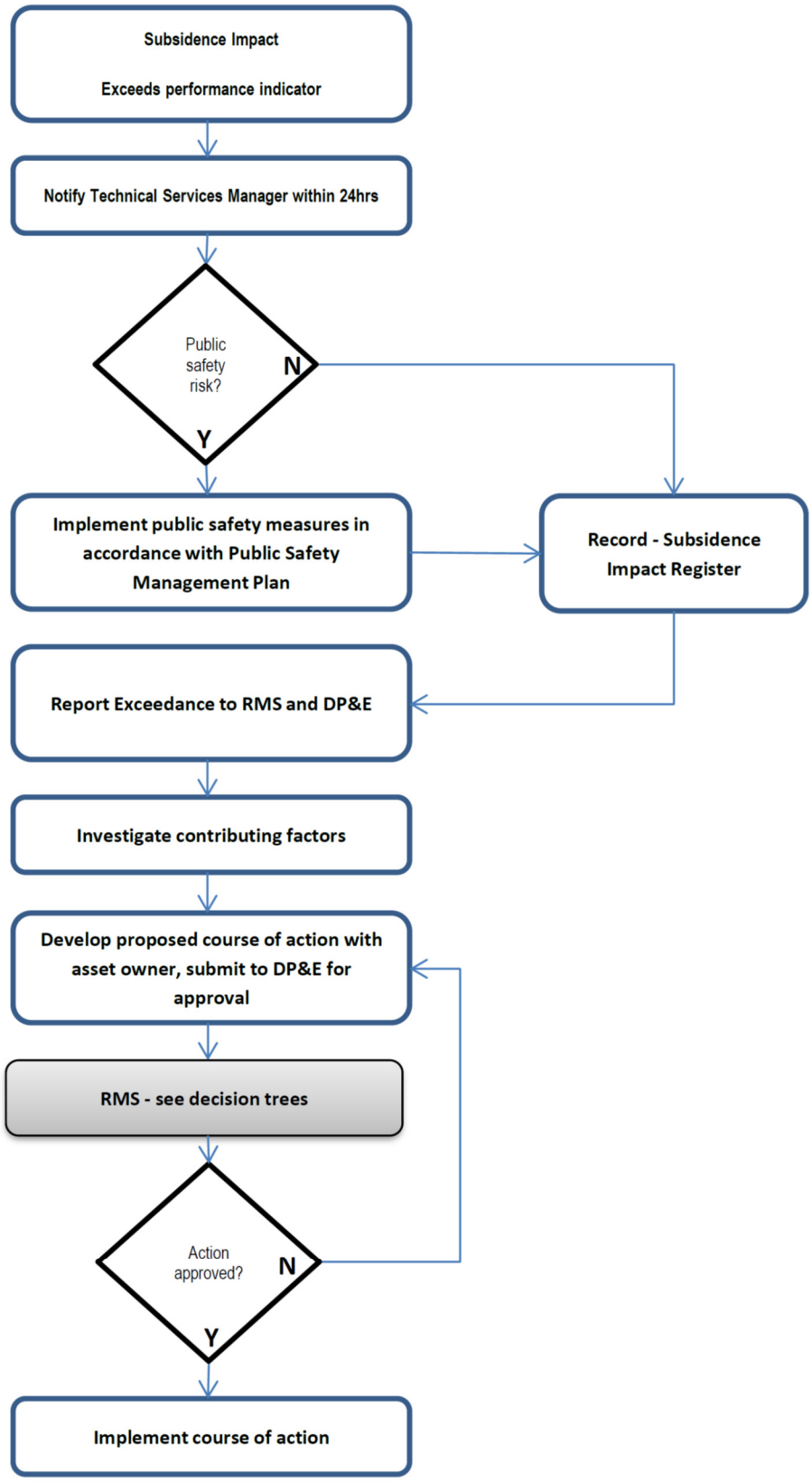
Actions Required:	Contingency Plan Initiated	☐
	Incident Notification	☐
	Safety Measures/Public Safety Management Plan Requirements	☐

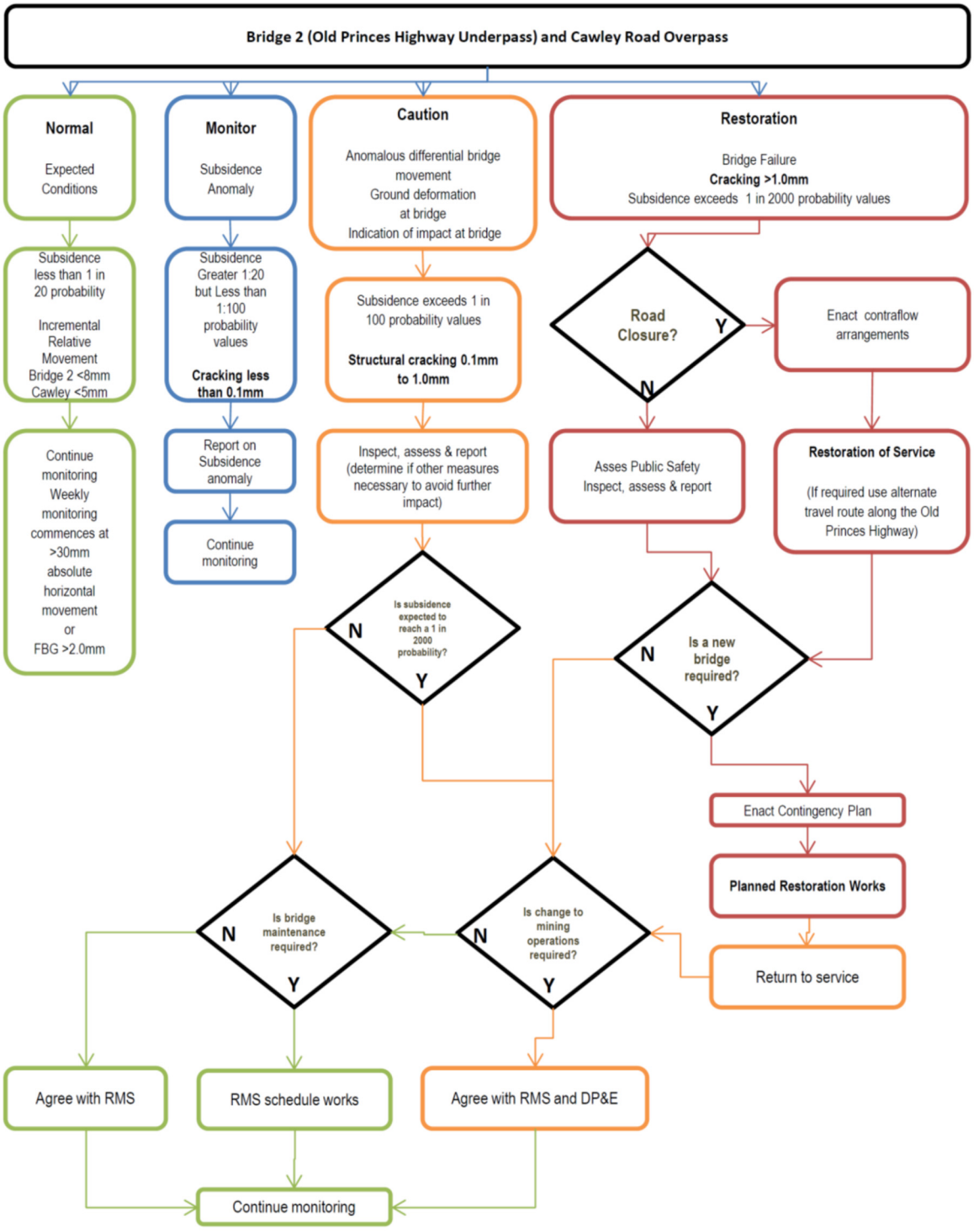
Management or Contingency Measures Implemented:

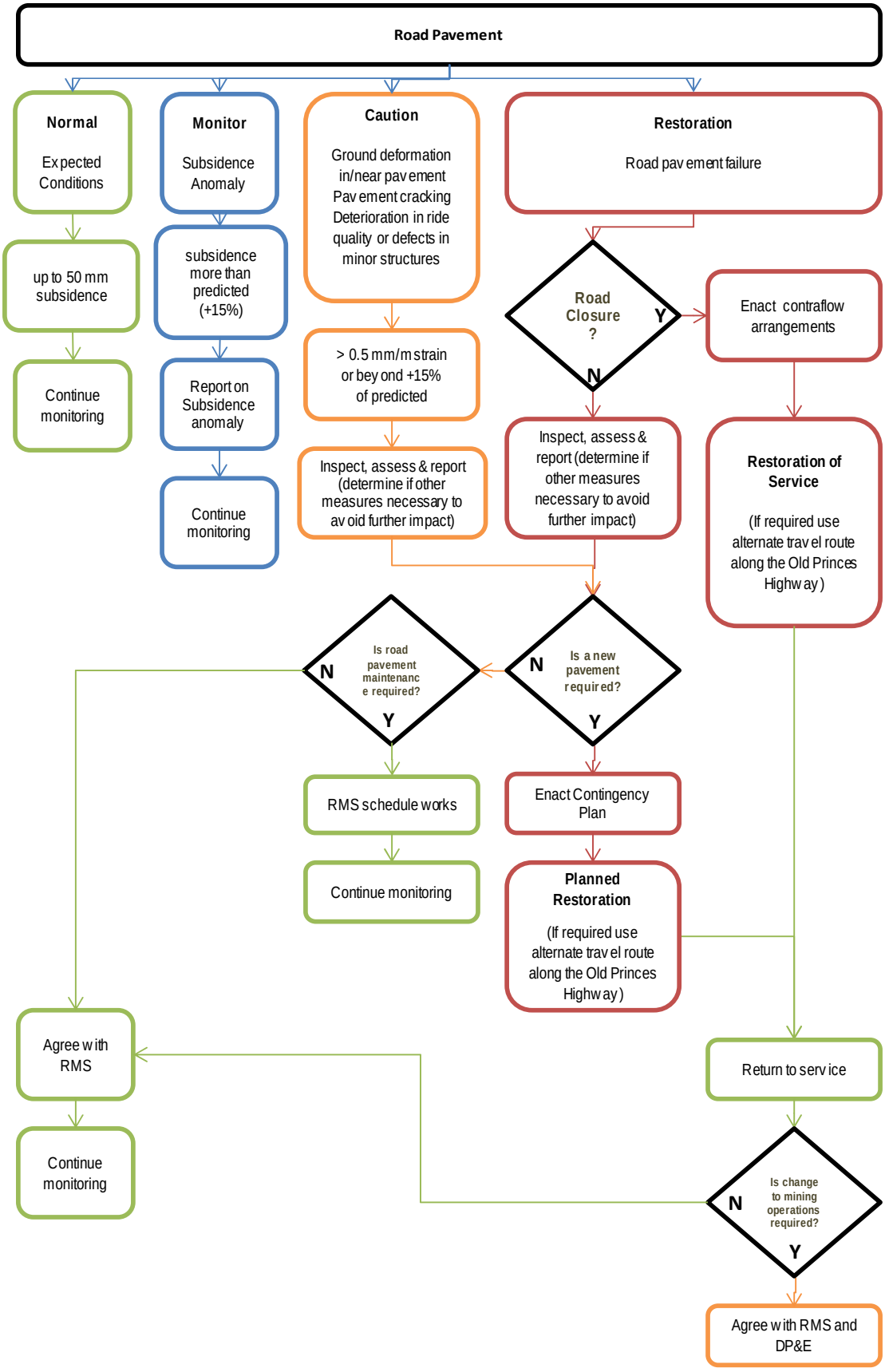
Effectiveness of Management or Contingency Measures:

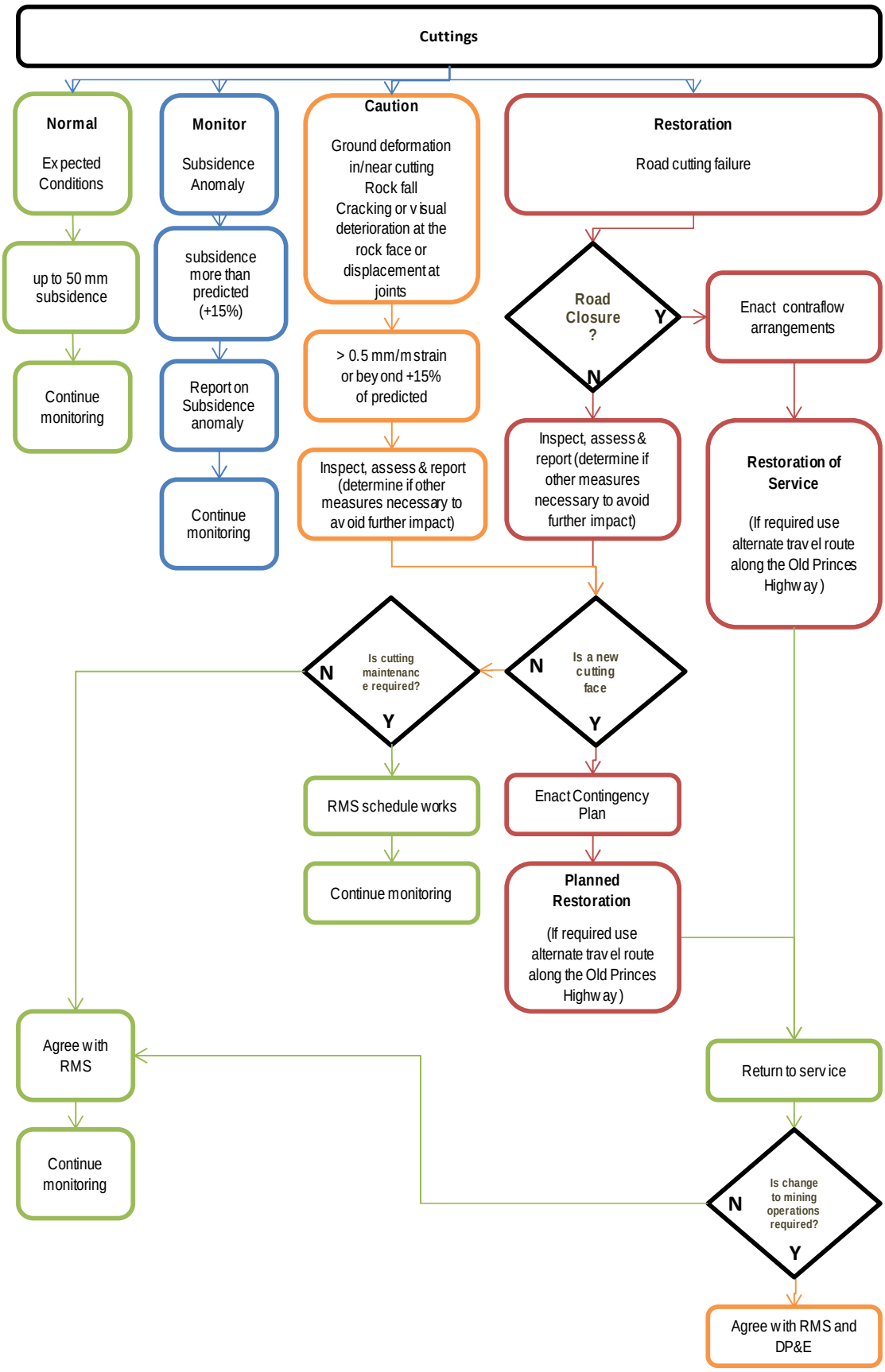
APPENDIX 7

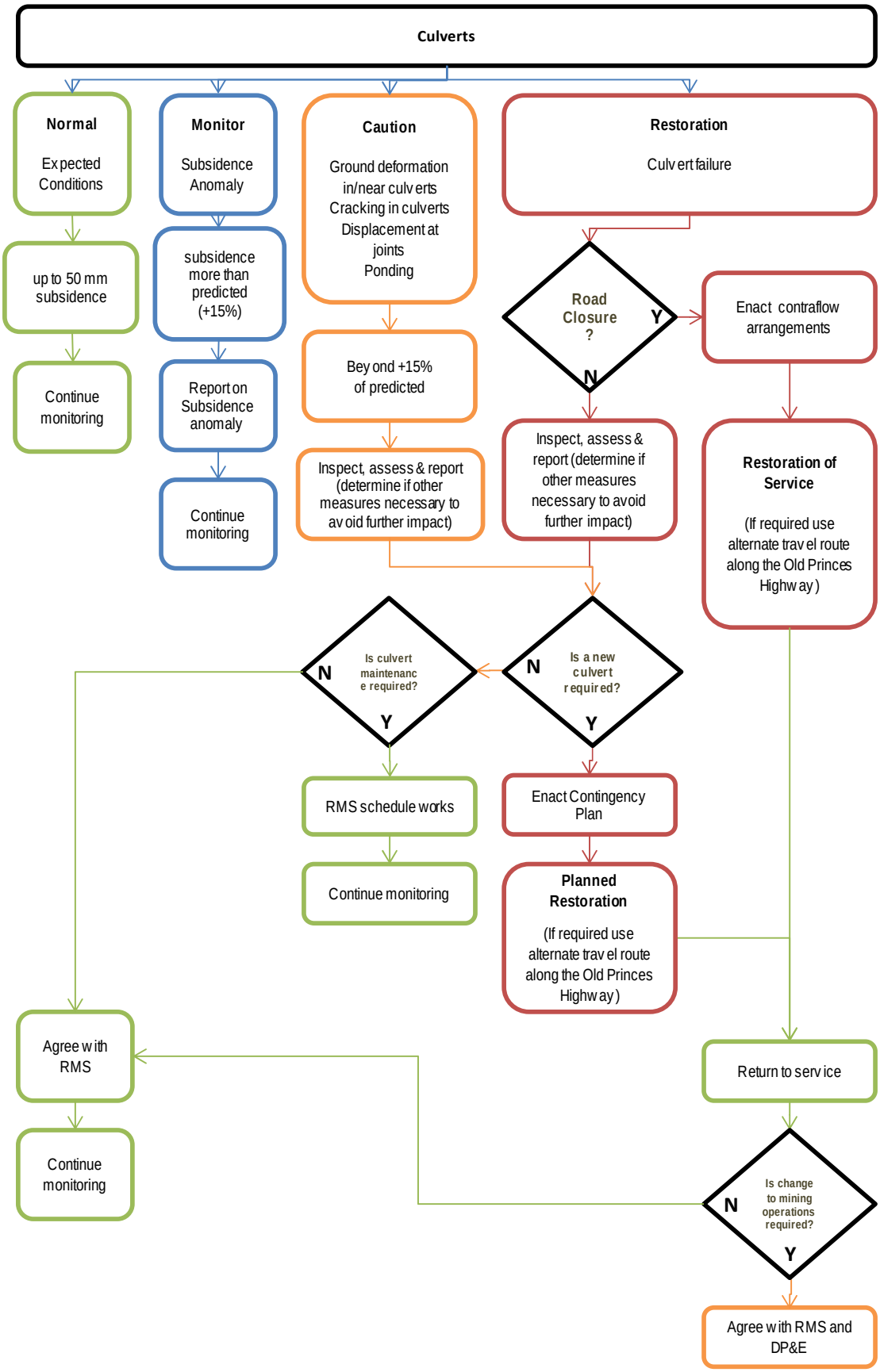
CONTINGENCY PLAN PROCEDURE AND DECISION TREES


Subsidence Impact
Exceeds performance indicator
Notify Technical Services Manager within 24hrs
Public safety risk?
N
Y
Implement public safety measures in accordance with Public Safety Management Plan
Record - Subsidence Impact Register
Report Exceedance to RMS and DP&E
Investigate contributing factors
Develop proposed course of action with asset owner, submit to DP&E for approval
RMS - see decision trees
Action approved?
N
Y
Implement course of action


Bridge 2 (Old Princes Highway Underpass) and Cawley Road Overpass
Normal
Expected Conditions
Monitor
Subsidence Anomaly
Caution
Anomalous differential bridge movement
Ground deformation at bridge
Indication of impact at bridge
Restoration
Bridge Failure
Cracking >1.0mm
Subsidence exceeds 1 in 2000 probability values
Subsidence less than 1 in 20 probability
Incremental Relative Movement
Bridge 2 <8mm
Cawley <5mm
Subsidence Greater 1:20 but Less than 1:100 probability values
Cracking less than 0.1mm
Subsidence exceeds 1 in 100 probability values
Structural cracking 0.1mm to 1.0mm
Road Closure?
Y
N
Enact contraflow arrangements
Continue monitoring
Weekly monitoring commences at >30mm absolute horizontal movement or FBG >2.0mm
Report on Subsidence anomaly
Continue monitoring
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Asses Public Safety
Inspect, assess & report
Restoration of Service
(If required use alternate travel route along the Old Princes Highway)
Is subsidence expected to reach a 1 in 2000 probability?
N
Y
Is a new bridge required?
N
Y
Enact Contingency Plan
Planned Restoration Works
Return to service
Is bridge maintenance required?
N
Y
Is change to mining operations required?
N
Y
Agree with RMS
RMS schedule works
Agree with RMS and DP&E
Continue monitoring


Road Pavement
Normal
Expected Conditions
up to 50 mm subsidence
Continue monitoring
Monitor
Subsidence Anomaly
subsidence more than predicted (+15%)
Report on Subsidence anomaly
Continue monitoring
Caution
Ground deformation in/near pavement
Pavement cracking
Deterioration in ride quality or defects in minor structures
> 0.5 mm/m strain or beyond +15% of predicted
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration
Road pavement failure
Road Closure ?
Y
N
Enact contraflow arrangements
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration of Service
(If required use alternate travel route along the Old Princes Highway)
Is a new pavement required?
N
Y
Is road pavement maintenance required?
N
Y
RMS schedule works
Continue monitoring
Enact Contingency Plan
Planned Restoration
(If required use alternate travel route along the Old Princes Highway)
Agree with RMS
Continue monitoring
Return to service
Is change to mining operations required?
N
Y
Agree with RMS and DP&E


Cuttings
Normal
Expected Conditions
up to 50 mm subsidence
Continue monitoring
Monitor
Subsidence Anomaly
subsidence more than predicted (+15%)
Report on Subsidence anomaly
Continue monitoring
Caution
Ground deformation in/near cutting
Rock fall
Cracking or visual deterioration at the rock face or displacement at joints
> 0.5 mm/m strain or beyond +15% of predicted
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration
Road cutting failure
Road Closure ?
Y
N
Enact contraflow arrangements
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration of Service
(If required use alternate travel route along the Old Princes Highway)
Is cutting maintenance required?
N
Y
Is a new cutting face
N
Y
RMS schedule works
Continue monitoring
Enact Contingency Plan
Planned Restoration
(If required use alternate travel route along the Old Princes Highway)
Agree with RMS
Continue monitoring
Return to service
Is change to mining operations required?
N
Y
Agree with RMS and DP&E


Culverts
Normal
Expected Conditions
Monitor
Subsidence Anomaly
Caution
Ground deformation in/near culverts
Cracking in culverts
Displacement at joints
Ponding
Restoration
Culvert failure
up to 50 mm subsidence
subsidence more than predicted (+15%)
Beyond +15% of predicted
Road Closure ?
Y
N
Enact contraflow arrangements
Continue monitoring
Report on Subsidence anomaly
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration of Service
(If required use alternate travel route along the Old Princes Highway)
Continue monitoring
Is culvert maintenance required?
Is a new culvert required?
RMS schedule works
Enact Contingency Plan
Continue monitoring
Planned Restoration
(If required use alternate travel route along the Old Princes Highway)
Agree with RMS
Return to service
Continue monitoring
Is change to mining operations required?
Agree with RMS and DP&E

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BUILT FEATURES MANAGEMENT PLAN
WOLLONGONG CITY COUNCIL
[OLD PRINCES HIGHWAY]

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&E Approval Date
All	LW301-303 BFMP_WCC-R01-A	Original – Draft for Consultation	WCC, DRG and DP&E	-
Tables 3 & 4, Section 6 and Figure 4	LW301-303 BFMP_WCC-R01-B	Revised – Incorporating WCC Comments (15 September 2016) and updates	WCC, DRG and DP&E	11 May 2017*
Tables 2, 3, 5, 7 & 8 and Appendix 4	LW301-303 BFMP_WCC-R01-C	Revised – Addressing DP&E and DRG requirements	WCC, DRG and DP&E	-
All	LW301-303 BFMP_WCC-R01-D	Revised TARP. Revised for LW303	WCC and DRG	8 November 2018#
All	BFMP_WCC-R01-E	Inclusion of Longwall 304 into BFMP	WCC	-

* The approval allows for the extraction of Longwalls 301 and 302 only.

Approval for the extraction of Longwall 303.

April 2019

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Appendix 2 MSEC (2019) Metropolitan Colliery – Proposed Longwall 304 – Subsidence Predictions and Impact Assessments for the Wollongong City Council Infrastructure
Appendix 3 Built Features Management Plan – Subsidence Impact Register
Appendix 4 Contingency Plan Procedure and Decision Tree

1 INTRODUCTION

Metropolitan Coal is a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under section 75J of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com).

The Project comprises the continuation, upgrade and extension of underground coal mining operations and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1. Following the completion of Longwall 27 in 2017, Longwalls 301, 302, 303 and 304 define the next mining sub-domain within the Project underground mining area (Figures 1 to 3).

1.1 PURPOSE AND SCOPE

In accordance with Condition 6(f), Schedule 3 of the Project Approval, this Built Features Management Plan – Wollongong City Council (BFMP-WCC) has been developed to manage the potential consequences of longwall extraction on the Wollongong City Council assets.

The relationship of this BFMP-WCC to the Metropolitan Coal Environmental Management Structure is shown on Figure 4.

In accordance with Condition 6, Schedule 3 of the Project Approval, the suitably qualified and experienced experts that have prepared this BFMP-WCC, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and Metropolitan Coal were endorsed by the Director-General (now Secretary) of the Department of Planning and Environment (DP&E). This BFMP-WCC has been prepared in consultation with Wollongong City Council, including consideration of prior consultation during the development of the previously approved Built Features Management Plans.

1.2 STRUCTURE OF THE BFMP-WCC

The remainder of the BFMP-WCC is structured as follows:

Section 2: Describes the review and update of the BFMP-WCC.

Section 3: Outlines the statutory requirements applicable to the BFMP-WCC.

Section 4: Provides a revised assessment of the potential subsidence impacts and environmental consequences for Longwalls 301-304.

Section 5: Details the performance measures and indicators that will be used to assess the Project.

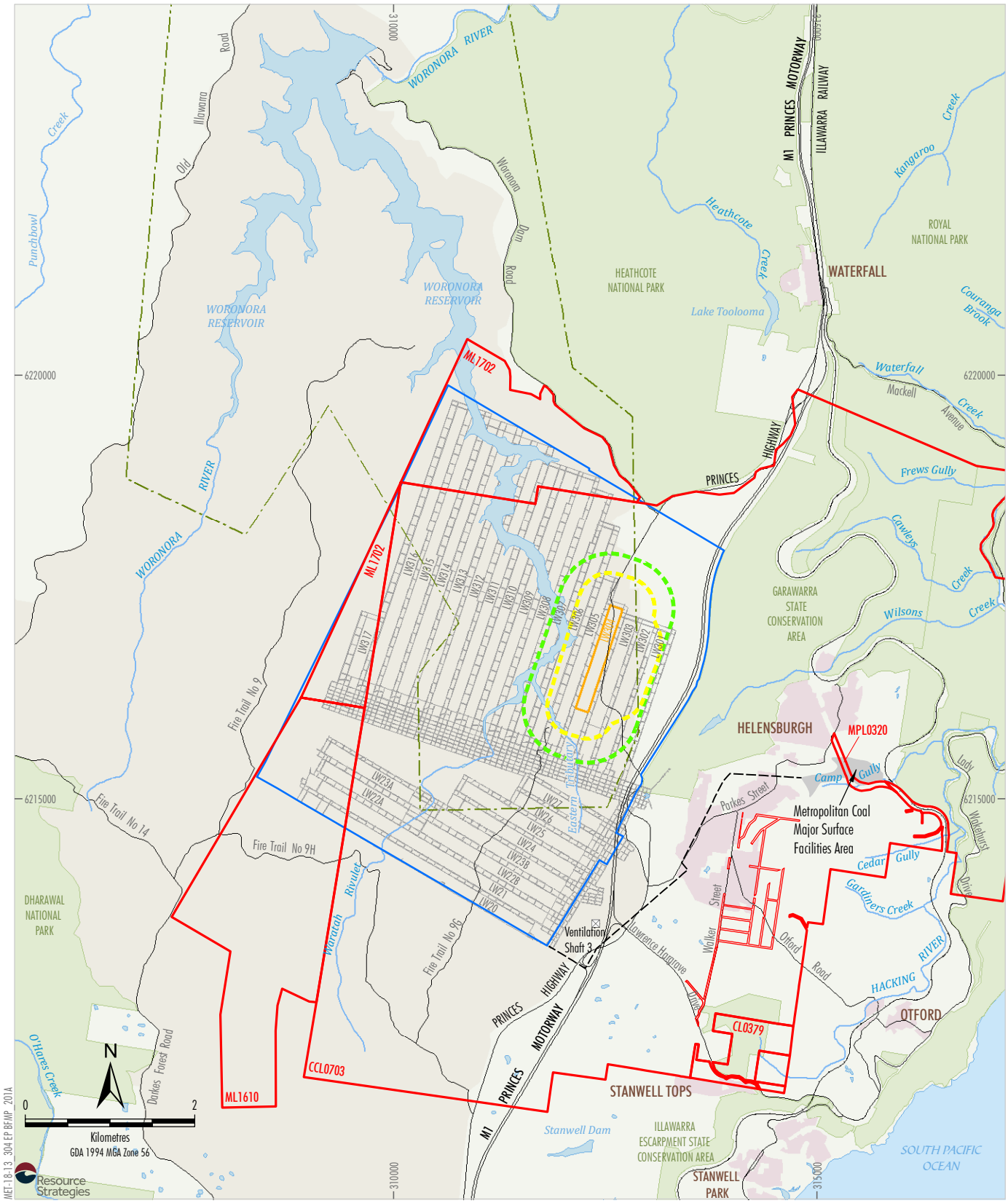
Section 6: Provides the detailed baseline data.

Section 7: Describes the monitoring program.

Section 8: Describes the management measures that will be implemented.

Section 9: Provides a contingency plan to manage any unpredicted impacts and their consequences.

Section 10: Describes the Trigger Action Response Plan (TARP) management tool.



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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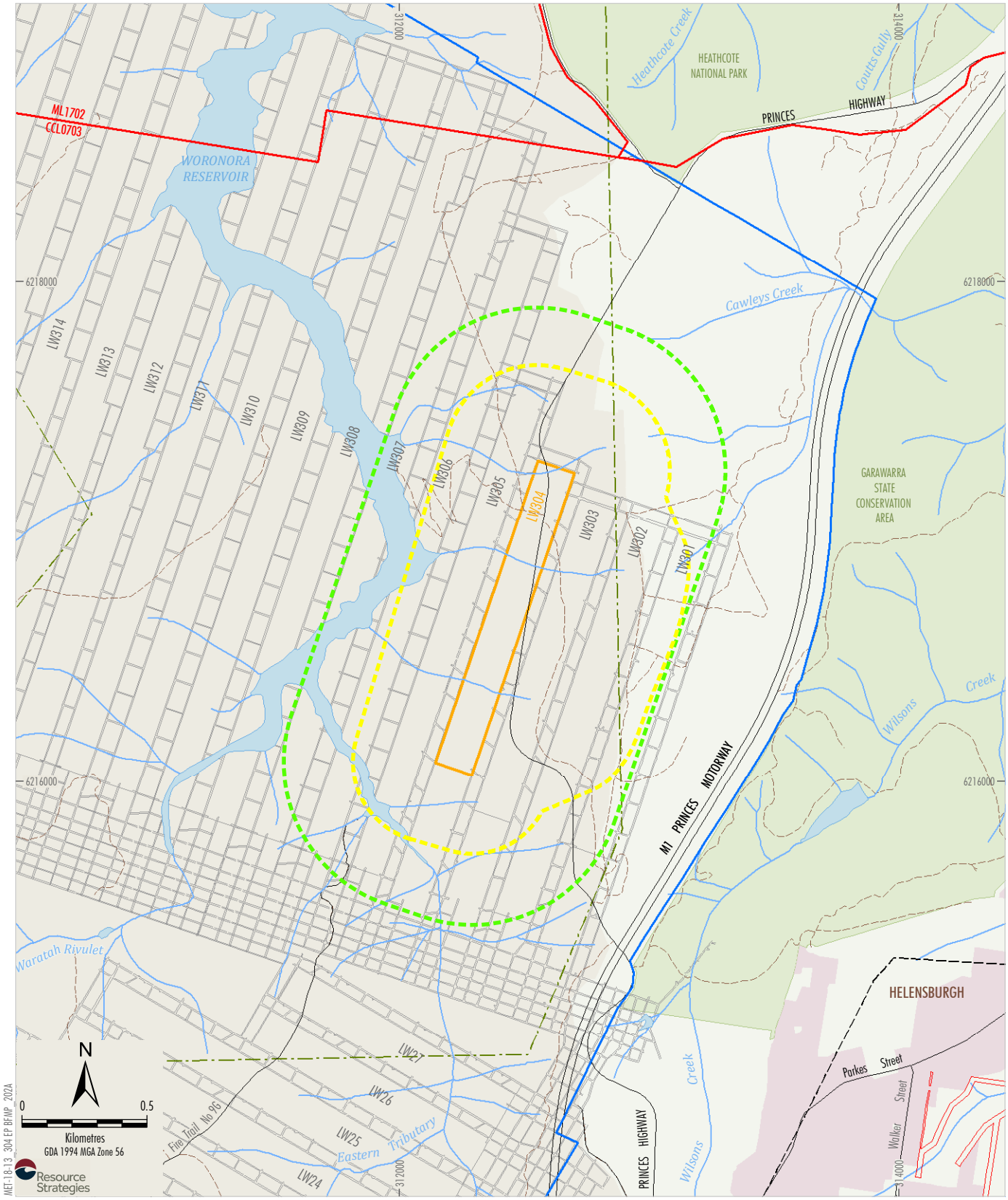
Longwalls 20-27 and Longwalls 301-317 Layout

Figure 1



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)
- Vehicular Track

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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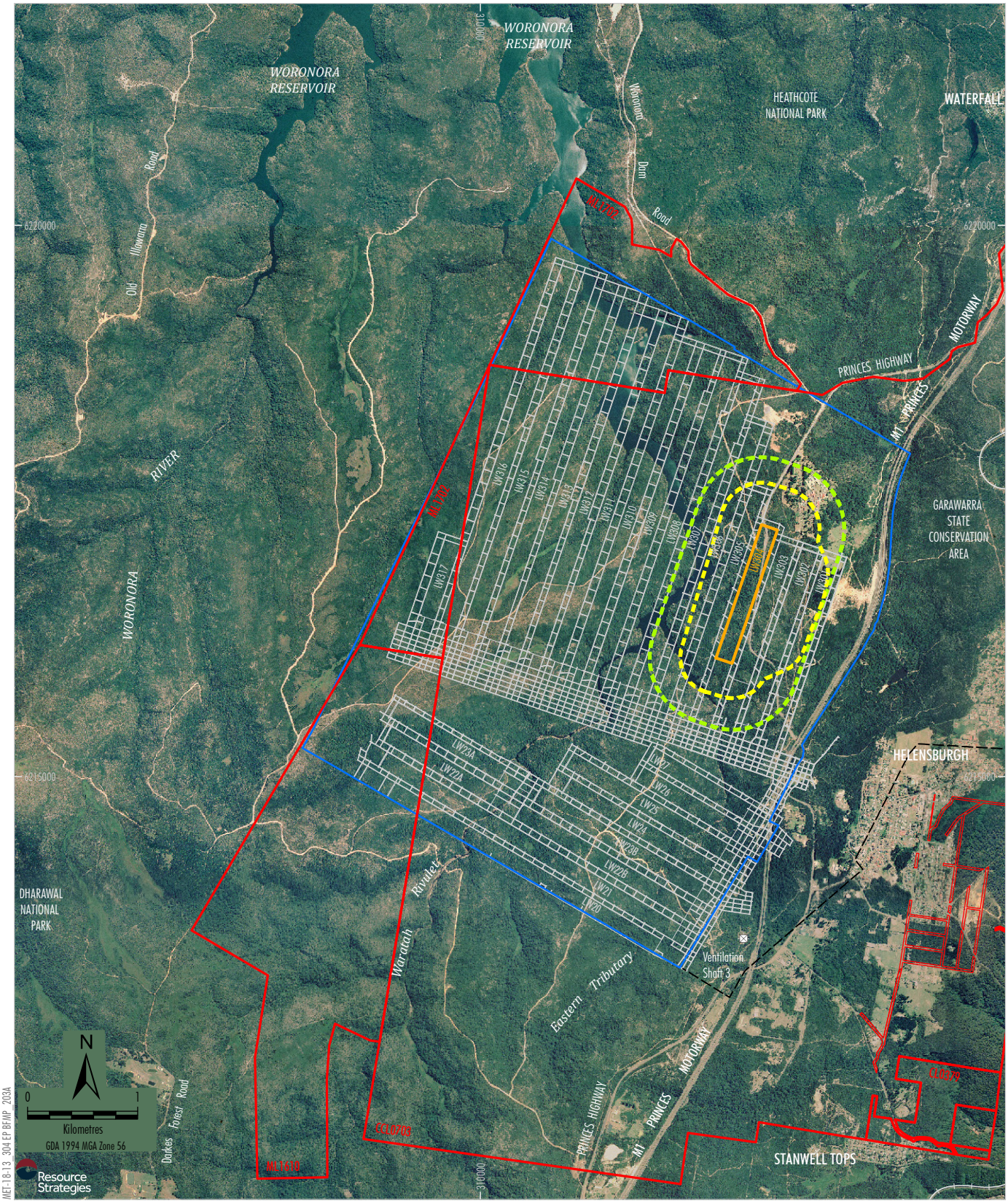
Longwalls 301-304 Layout

Figure 2



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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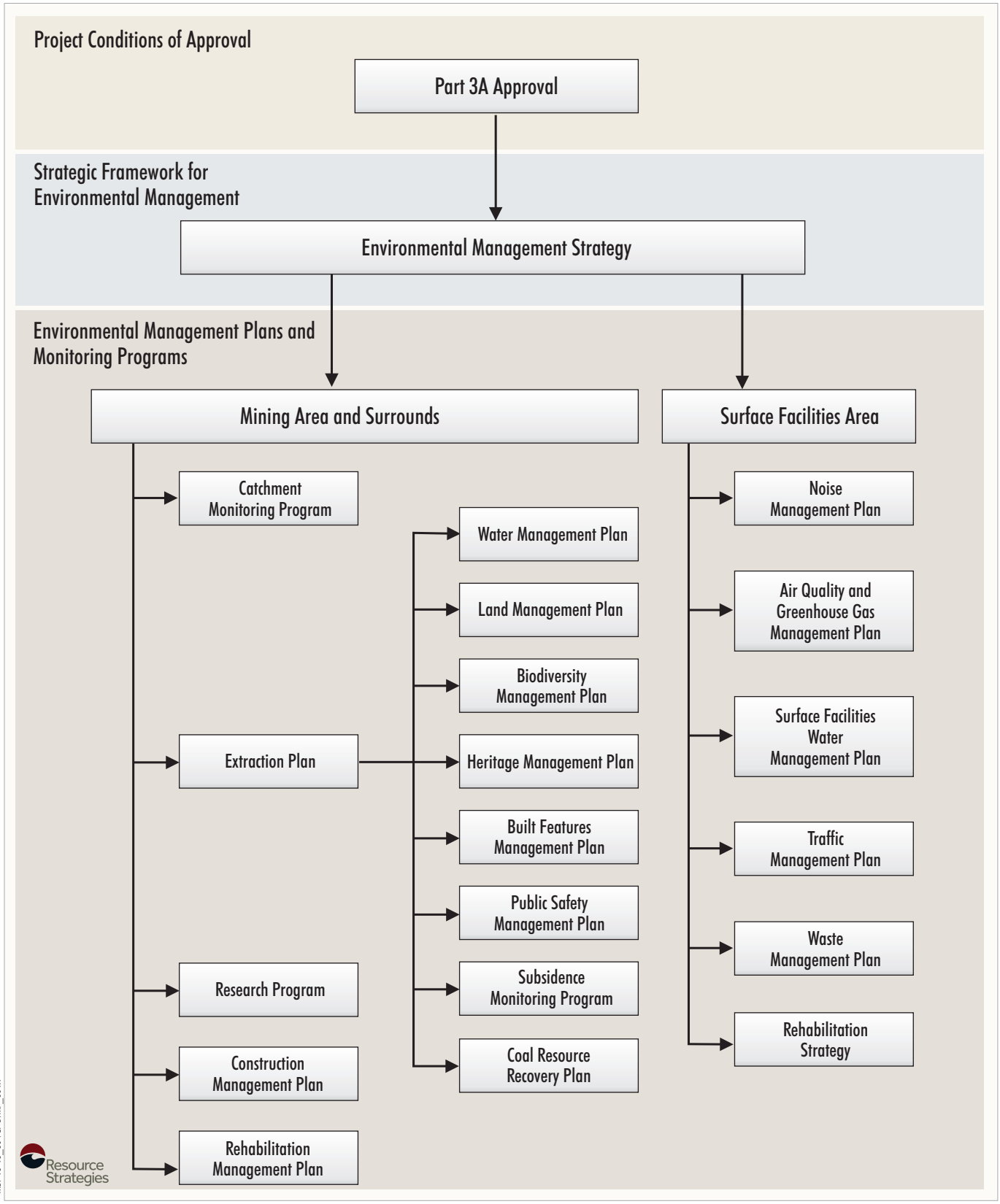
Longwalls 20-27 and Longwalls 301-317 Layout - Aerial Photograph

Figure 3



MET-18-13_304 EP BHMP_001A

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Environmental Management Structure

Figure 4

Section 11: Describes the program to collect sufficient baseline data for future Extraction Plans.

Section 12: Describes the annual review and improvement of environmental performance.

Section 13: Outlines the management and reporting of incidents.

Section 14: Outlines the management and reporting of complaints.

Section 15: Outlines the management and reporting of non-compliances with statutory requirements.

Section 16: Lists the references cited in this BFMP-WCC.

2 BFMP-WCC REVIEW AND UPDATE

In accordance with Condition 4, Schedule 7 of the Project Approval, this BFMP-WCC will be reviewed within three months of the submission of:

- an audit under Condition 8 of Schedule 7;
- an incident report under Condition 6 of Schedule 7;
- an annual review under Condition 3 of Schedule 7; and

if necessary, revised to the satisfaction of the Director-General (now Secretary) of DP&E, to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

This BFMP-WCC will also be reviewed within three months of approval of any Project modification and if necessary, revised to the satisfaction of the DP&E.

The revision status of this plan is indicated on the title page of each copy of the BFMP-WCC. The distribution register for controlled copies of the BFMP-WCC is described in Section 2.1.

Revisions to any documents listed within this BFMP-WCC will not necessarily constitute a revision of this document.

2.1 DISTRIBUTION REGISTER

In accordance with Condition 10, Schedule 7 'Access to Information', Metropolitan Coal will make the BFMP-WCC publicly available on the Peabody website. A hard copy of the BFMP-WCC will also be maintained at the Metropolitan Coal site.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format. An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom the Metropolitan Coal plans and programs, such as the BFMP-WCC, will be distributed;
- the format (i.e. electronic or hard copy) of distribution; and
- the format of revision notification.

Metropolitan Coal will make the Distribution Register publicly available on the Peabody website.

Metropolitan Coal will be responsible for maintaining the Distribution Register and for ensuring that the notification of revisions is sent by email or post as appropriate.

In addition, Metropolitan Coal employees with local computer network access will be able to view the controlled electronic version of this BFMP-WCC on the Metropolitan Coal local area network. Metropolitan Coal will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on Metropolitan Coal's computer system and the Peabody website.

3 STATUTORY REQUIREMENTS

Metropolitan Coal's statutory obligations are contained in:

(i) the conditions of the Project Approval;

(ii) relevant licences and permits, including conditions attached to mining leases; and

(iii) other relevant legislation.

These are described below.

3.1 EP&A ACT APPROVAL

Condition 6(f), Schedule 3 of the Project Approval requires the preparation of a BFMP as a component of Extraction Plan(s) for second workings. Project Approval Condition 6(f), Schedule 3 states:

> ***SECOND WORKINGS***
>
> ***Extraction Plan***
>
> *6. The Proponent shall prepare and implement an Extraction Plan for all second workings in the mining area to the satisfaction of the Director-General. This plan must:*
>
> *…*
>
> *(f) include a:*
>
> *…*
>
> - *Built Features Management Plan, which has been prepared in consultation with the owner of the relevant feature, to manage the potential environmental consequences of the Extraction Plan on any built features;*

In addition, Condition 2, Schedule 7 and Condition 7, Schedule 3 of the Project Approval outline management plan requirements that are applicable to the preparation of the BFMP-WCC. Table 1 indicates where each component of the conditions is addressed within this BFMP-WCC.

Table 1
Management Plan Requirements

Project Approval Condition	BFMP-WCC Section
Condition 2 of Schedule 7	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Section 6
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 3
• any relevant limits or performance measures/criteria;	Section 5
• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 5
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Sections 7, 8, 9 and 10
d) a program to monitor and report on the:	Sections 7, 8 and 12
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 9 and Appendix 4
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Sections 7 and 12
g) a protocol for managing and reporting any;	
• incidents;	Section 13
• complaints;	Section 14
• non-compliances with statutory requirements; and	Section 15
• exceedances of the impact assessment criteria and/or performance criteria; and	Section 9 and Appendix 4
h) a protocol for periodic review of the plan.	Section 2
Condition 7 of Schedule 3	
7. In addition to the standard requirements for management plans (see condition 2 of schedule 7), the Proponent shall ensure that the management plans required under condition 6(f) above include:	
a) a program to collect sufficient baseline data for future Extraction Plans;	Section 11
b) a revised assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval;	Section 4
c) a detailed description of the measures that would be implemented to remediate predicted impacts; and	Section 8
d) a contingency plan that expressly provides for adaptive management.	Section 9 and Appendix 4

3.2 LICENCES, PERMITS AND LEASES

In addition to the Project Approval, all activities at or in association with the Metropolitan Coal Mine will be undertaken in accordance with the following licences, permits and leases which have been issued or are pending issue:

- The conditions of mining leases issued by the NSW Division of Resources and Geoscience (DRG), under the NSW *Mining Act, 1992* (e.g. Consolidated Coal Lease [CCL] 703, Mining Lease [ML] 1610, ML 1702, Coal Lease [CL] 379 and Mining Purpose Lease [MPL] 320).

- The Metropolitan Coal Mining Operations Plan 1 October 2012 to 30 September 2019 approved by the DRG.
- The conditions of Environment Protection Licence (EPL) No. 767 issued by the NSW Environment Protection Authority (EPA) under the NSW *Protection of the Environment Operations Act, 1997*. Revision of the EPL will be required prior to the commencement of Metropolitan Coal activities that differ from those currently licensed.
- The prescribed conditions of specific surface access leases within CCL 703 for the installation of surface facilities as required.
- Water Access Licences (WALs) issued by the NSW Department of Primary Industries – Water (now the Department of Industry – Water) under the NSW *Water Management Act, 2000*, including WAL 36475 under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* and WAL 25410 under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*.
- Mining and workplace health and safety related approvals granted by the NSW Resources Regulator and WorkCover NSW.
- Supplementary approvals obtained from WaterNSW for surface activities within the Woronora Special Area (e.g. fire road maintenance activities).

3.3 OTHER LEGISLATION

Metropolitan Coal will conduct the Project consistent with the Project Approval and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to the conduct of the Project (Helensburgh Coal Pty Ltd [HCPL], 2008)[1]:

- *Biodiversity Conservation Act, 2016;*
- *Biosecurity Act, 2015;*
- *Contaminated Land Management Act, 1997;*
- *Crown Land Management Act, 2016;*
- *Dams Safety Act, 2015;*
- *Dangerous Goods (Road and Rail Transport) Act, 2008;*
- *Energy and Utilities Administration Act, 1987;*
- *Fisheries Management Act, 1994;*
- *Mining Act, 1992;*
- *Protection of the Environment Operations Act, 1997;*
- *Rail Safety (Adoption of National Law) Act, 2012;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Water NSW Act, 2014;*

[1] The list of potentially applicable Acts has been updated to reflect changes to the Acts that were in force at the time of submission of the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008).

- *Work Health and Safety Act, 2011; and*
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

Relevant licences or approvals required under these Acts will be obtained as required.

4 REVISED ASSESSMENT OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

4.1 EXTRACTION LAYOUT

Longwalls 301-304 and the area of land within 600 metres (m) of Longwall 304 secondary extraction are shown on Figures 2 and 3. Longwall extraction occurs from north to south. The longwall layouts include 163 m panel widths (void) with 45 m pillars (solid).

The provisional extraction schedule for Longwalls 301-304 is provided in Table 2.

Table 2
Provisional Extraction Schedule

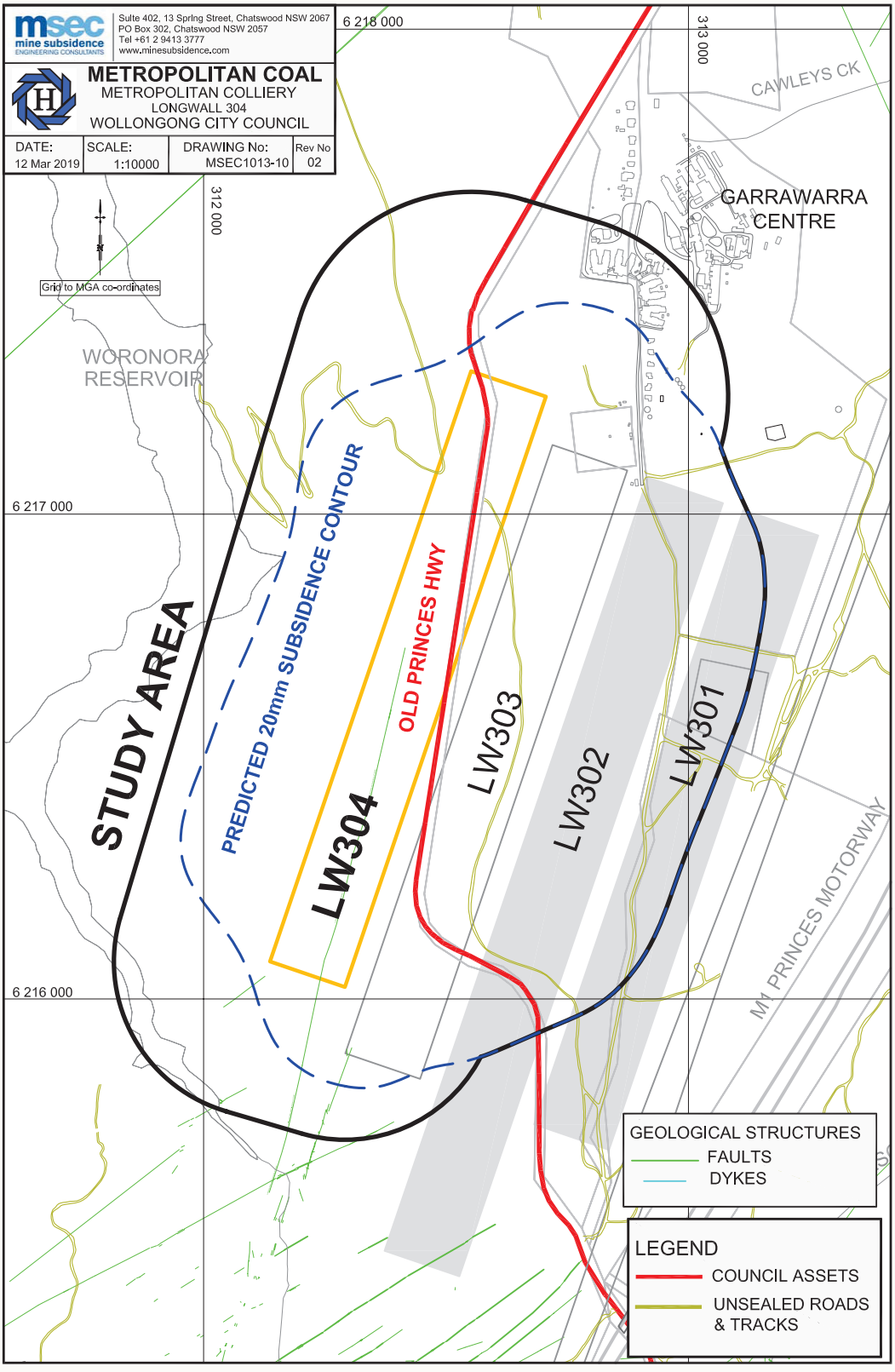
Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
301	June 2017	6 months	February 2018
302	March 2018	7 months	October 2018
303	November 2018	7 months	May 2019
304	July 2019	6 months	December 2019

The future Extraction Plans will consider the cumulative subsidence effects, subsidence impacts and/or environmental consequences. Note that the total cumulative predicted subsidence effects, subsidence impacts and/or environmental consequences at the completion of the Project are considered in the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008) and the Preferred Project Report (HCPL, 2009).

4.1.1 Wollongong City Council Assets

Figure 5 illustrates the Wollongong City Council assets in relation to Longwalls 301-304 extraction. The assets include:

- Old Princes Highway, including
  - pavement;
  - drainage structures (e.g. pipes, culverts); and
  - guard rails, marker posts and signage.



MET-18-13_304 EP BFMP_010A

Source: MSEC (2019)

Peabody

METROPOLITAN COAL

Wollongong City Council Assets
(Old Princes Highway)

Figure 5

4.2 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

4.2.1 Revised Subsidence Predictions

Subsidence predictions for Longwalls 20-44 in relation to the Wollongong City Council assets was conducted by MSEC (2008) as part of the Metropolitan Coal Project EA. MSEC (2008) includes a table summarising the incremental systematic subsidence parameters for the extraction of each longwall from Longwalls 20-44. These include:

- maximum predicted incremental subsidence (vertical movement);
- maximum predicted incremental tilt along alignment;
- maximum predicted incremental tilt across alignment;
- maximum predicted incremental tensile strain; and
- maximum predicted incremental compressive strain.

Revised subsidence and impact predictions for the extraction of Longwalls 301-303 and Longwall 304 on Wollongong City Council assets were conducted by MSEC and reported in MSEC (2016) and MSEC (2019) (Appendices 1 and 2), respectively.

In relation to subsidence predictions for Longwalls 301-303, MSEC (2016) make the following conclusions:

- The section of the Old Princes Highway comprises a single carriageway with a flexible asphalt pavement and grass verges.
- The maximum predicted conventional tilt for the Old Princes Highway is 4.0 mm/m (i.e. 0.4%) and is unlikely to result in adverse impacts on the serviceability or surface water drainage. If additional localised ponding or changes in surface water drainage were to occur, the drainage could be repaired using normal road maintenance techniques.
- The predicted curvatures and strains for the Old Princes Highway are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar asphaltic and bitumen pavements.
- The Old Princes Highway Underpass (beneath Bridge 2[2]) and Cawleys Road Overpass[2] are located at distances of 330 m and 1.43 km, respectively from the longwalls extracted, and could experience low level far-field horizontal movements (i.e. very small differential horizontal movements in the order of 4 mm and less than those that normally occur due to thermal expansion).
- Local roads and bridges are located outside the 20 mm subsidence contour and therefore unlikely to experience adverse impacts.
- With the implementation of suitable monitoring (e.g. visual and/or ground survey lines) and management strategies (e.g. repair of highway using normal road maintenance techniques), it is expected that the Old Princes Highway can be maintained in safe and serviceable conditions during and after mining.

[2] Monitoring and management of the bridge structures (M1 Princes Motorway - Bridge 2 and Cawleys Road Overpass) is addressed separately in the BFMP-RMS (Roads and Maritime Services).

It is important to note that the above predictions and conclusions are for total subsidence after extraction of the three Longwalls 301, 302 and 303. Subsidence effects predicted for the Old Princes Highway during initial mining of Longwall 301 alone are minimal to nil as the subsidence profile does not begin to develop until the finishing end of Longwall 301 and the total subsidence profile does not develop until during extraction of Longwall 302 and Longwall 303.

In relation to subsidence predictions for Longwall 304, MSEC (2019) make the following conclusions:

- The maximum predicted conventional tilt for the Old Princes Highway is 2.5 mm/m (i.e. 0.25%) and is unlikely to result in adverse impacts on the serviceability or surface water drainage. If additional localised ponding or changes in surface water drainage were to occur, the drainage could be repaired using normal road maintenance techniques.
- The predicted curvatures and strains for the Old Princes Highway are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar asphaltic and bitumen pavements.
- The potential impacts on the Old Princes Highway are being managed using monitoring (visual and/or ground survey lines) and impacts can be remediated during active subsidence using normal road maintenance techniques. The final repair of the highway would be undertaken at the completion of the longwalls. No impacts or anomalous movements have been identified along the Old Princes Highway during the extraction of Longwalls 301 and 302.
- It is expected that the highway can be maintained in safe and serviceable conditions with the implementation of the appropriate monitoring and management strategies.

4.2.2 Risk Assessment Meeting

In accordance with the *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) a risk assessment meeting was held for Longwalls 301-303 on 15 August 2016. Attendees at the risk assessment meeting included representatives from Metropolitan Coal, Wollongong City Council, MSEC, Resource Strategies and Axys Consulting (risk assessment facilitator).

The investigation and analysis methods used during the risk assessment included:

- preliminary identification of Wollongong City Council assets[3];
- review of the revised subsidence predictions and potential impacts on Wollongong City Council assets (including consideration of past experience in the Southern Coalfield); and
- development of a preliminary monitoring plan.

A number of risk control measures and procedures were identified during the risk assessment which considered the extraction of coal beneath the Wollongong City Council assets, and are summarised as follows:

Baseline Data / Validation

1. Confirm the make-up of the roadway structure of the Old Princes Highway (i.e. flexible asphalt) with Wollongong City Council.
2. Carry out a visual audit of the Old Princes Highway (and associated infrastructure) within the Study area.

[3] During the risk assessment meeting, Metropolitan Coal confirmed that the Waterfall General (Garrawarra) Cemetery would be managed separately with Wollongong City Council in the Waterfall General (Garrawarra) Cemetery BFMP (BFMP-CEM).

3. Metropolitan Coal to obtain a copy of the visual audit of the Old Princes Highway (and associated infrastructure) once carried out, and other available baseline records (e.g. deflectograph survey, video, etc.).
4. Metropolitan Coal to engage a third party to conduct a dilapidation survey of the road pavement, guard rails, marker posts and signage in the Study area.

Management / Monitoring / Response Measures

5. Establish a key contacts list between Peabody and Wollongong City Council to provide a regular update of status of mining activities, and for consultation if any repair works were required to be carried out.
6. Include in the BFMP a schedule of times/frequency of communication with Wollongong City Council for the status of mining of Longwalls 301-303.
7. Develop a Trigger Action Response Plan (TARP) and include a trigger for roadway, pipes/culverts and other furniture conditions that may need to be actioned by Wollongong City Council.
8. Include a monitoring plan in the BFMP to implement visual inspections of the roadway, pipes/culverts and other furniture during active subsidence associated with Longwalls 301-303.
9. Include a schedule for pre and post audits to record conditions of the roadway, pipes/culverts, guard rails, marker posts and signage in the Study area.

Metropolitan Coal considers all risk control measures and procedures to be feasible to manage all identified risks.

The risk control measures and procedures have been incorporated where relevant in this BFMP and the program for implementation is summarised in Table 3.

Table 3
Program for Implementation of Proposed Risk Control Measures and Procedures

	Risk Control Measure / Procedure	BFMP Section	Timing
Baseline Data / Validation			
1	Confirm the make-up of the roadway structure of the Old Princes Highway (i.e. flexible) with Wollongong City Council	Section 4.2.1	Complete
2	Carry out a visual audit of the Old Princes Highway (and associated infrastructure) in the Study area	Section 6	Complete
3	Obtain a copy of the visual audit of the Old Princes Highway (and associated infrastructure) once carried out, and other available baseline records (e.g. deflectograph survey, video)	Section 6	
4	Engage a third party to conduct a dilapidation survey of the road pavement, guard rails, marker posts and signage in the Study area	Section 6	
Management / Monitoring / Response Measures			
5	Establish a key contacts list in the BFMP	Section 6.3 / Table 4	Complete
6	Include a schedule of times/frequency of communication with Wollongong City Council for the status of mining of Longwalls 301-303 in the BFMP	Sections 7 and 10 / Table 2	Complete
7	Include in the TARP a trigger to roadway, pipes/culverts and other furniture conditions that may need to be actioned by Wollongong City Council	Section 10 / Table 7	Complete
8	Include a monitoring plan in the BFMP to implement visual inspections of the roadway, pipes/culverts and other furniture during active subsidence associated with Longwalls 301-303	Table 5	Complete
9	Include a schedule for pre and post audits to record conditions of the roadway, pipes/culverts, guard rails, marker posts and signage in the Study area	Section 7.2	Complete

The risk control measures and procedures identified during the risk assessment for Longwalls 301-303 will be implemented for the extraction of Longwall 304.

5 PERFORMANCE MEASURES AND INDICATORS

The Project Approval requires Metropolitan Coal not to exceed the subsidence impact performance measures outlined in Table 1 of Condition 1, Schedule 3. The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

> *Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.*

The performance indicators proposed to ensure that the above performance measure is achieved include:

- no pavement cracking exceeding 5 mm, or other defects of the road pavement resulting in deterioration of ride quality;
- no ponding of water on the road surface as a result of changes in grade from subsidence associated with Longwalls 301-304;
- no joint displacement or cracking or other defects of the drainage structure (e.g. pipes/culverts) in excess of 5 mm; and
- serviceability of guard rails, marker posts and signage is maintained.

Section 7 of this BFMP-WCC describes the monitoring that will be conducted to assess the Project against the above performance indicators and performance measure. Sections 8 and 9 of this BFMP-WCC provides management measures and a Contingency Plan in the event the performance measure is exceeded.

6 BASELINE DATA

The Old Princes Highway is shown on Plate 1.

Plate 1 – Old Princes Highway (Source: MSEC, 2016)

A visual audit of the Old Princes Highway and drainage structure (e.g. pipes/culverts) will occur prior to the longwall face approaching within 400 m of the Old Princes Highway (or as otherwise agreed with Wollongong City Council) to establish the condition of the roadway and pipes/culverts. The visual audit will be conducted by representatives of Wollongong City Council and include:

- recording of existing defects using detailed road surface photography (video), i.e. one photograph every 2 m; and
- recording of existing pipe/culvert condition using CCTV video.

A copy of the visual audit record will be provided to Metropolitan Coal on request. Other road pavement baseline records (e.g. deflectograph survey, video) would also be provided to Metropolitan Coal if available.

A third party will be engaged by Metropolitan Coal to conduct a dilapidation survey of the guard rails, marker posts and signage. The dilapidation survey reporting will include photo evidence, in addition to notes.

6.1 KEY CONTACTS LIST

The list of key contacts for Peabody and Wollongong City Council during the development and implementation of this BFMP are provided in Table 4.

Table 4
List of Key Contacts

Company	Position	Contact
Peabody (Metropolitan Coal)	Jon Degotardi Manager – Technical Services	Metropolitan Coal 24hr Control Room 02 4294 7333
Wollongong City Council	Murray Davis Civil Asset Management Unit Leader	Wollongong City Council 24hr Contact Number 02 4227 7111
Wollongong City Council	Peter Tobin Senior Geotechnical Engineer	

7 MONITORING

A monitoring program will be implemented to monitor the impacts of the Project on the Wollongong City Council assets. Table 5 summarises the BFMP-WCC monitoring components.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts for comparison with baseline photographic records.

Wollongong City Council or their delegates will conduct the various visual inspections. Metropolitan Coal will be notified of the timing of inspections and accompany Wollongong City Council or delegates if considered necessary. All personnel will complete necessary inductions or orientation relevant to the tasks required.

Table 5
BFMP-WCC Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Baseline	Ground	Survey	Adjacent Old Princes Highway subsidence line points at approximately 20 m spacing	Establish base conditions	Prior to Longwalls 301 and 304 extraction	Twice
	Pavement	Photography and other available baseline information		Establish base condition	Prior to longwall face approaching within 400 m of the Old Princes Highway	Once
	Drainage Structures (Pipes/ Culverts) and Other Furniture	CCTV, visual inspection, dilapidation survey of the guard rails, marker posts and signage		Establish base condition	Prior to longwall face approaching within 400 m of the Old Princes Highway	Once
During Mining	Ground	Survey	Adjacent Old Princes Highway subsidence line points at approximately 20 m spacing	Monitor subsidence effects during mining (subsidence, tilt, tensile strain, compressive strain)	At the completion of each longwall	Once per Longwalls 301, 302, 303 & 304
					Weekly when the active longwall face is within 400 m of passing under Old Princes Highway until subsidence reduces to less than survey accuracy.	
	Pavement	Visual inspection (Metropolitan Coal)		To identify development of, or changes in existing pavement including cracks, buckling and stepping.	Weekly when the active longwall face is within 400 m of passing under Old Princes Highway	
		Visual inspection (WCC routine inspections)			During the extraction of Longwalls 301, 302, 303 and 304	Quarterly
	Drainage Structures (Pipes/ Culverts) and Other Furniture	Visual inspection (Metropolitan Coal)		To identify changes to the visible surfaces of the structures including cracking, buckling, shearing, and collapse, and impacts to furniture	Weekly when the active longwall face is within 400 m of passing under Old Princes Highway	
		Visual inspection (WCC routine inspections)			During the extraction of Longwalls 301, 302, 303 and 304	Quarterly

Table 5 (Continued)
BFMP-WCC Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Post Mining	Pavement	Condition (video photography)		Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 302, 303 and 304 (or as otherwise agreed with WCC subject to future longwall extraction)	Three times
		Visual inspection (WCC routine inspections)		Validation	Next scheduled post mining	Once
	Drainage Structures (Pipes/ Culverts) and Other Furniture	Condition Report (CCTV, visual inspection and dilapidation survey)		Determine level of impact of mining (if any)	Within 3 months of the completion Longwalls 302, 303 and 304 (or as otherwise agreed with WCC subject to future longwall extraction)	Three times
		Visual inspection (WCC routine inspections)		Validation	Next scheduled post mining	Once

The frequency of monitoring will be reviewed either:

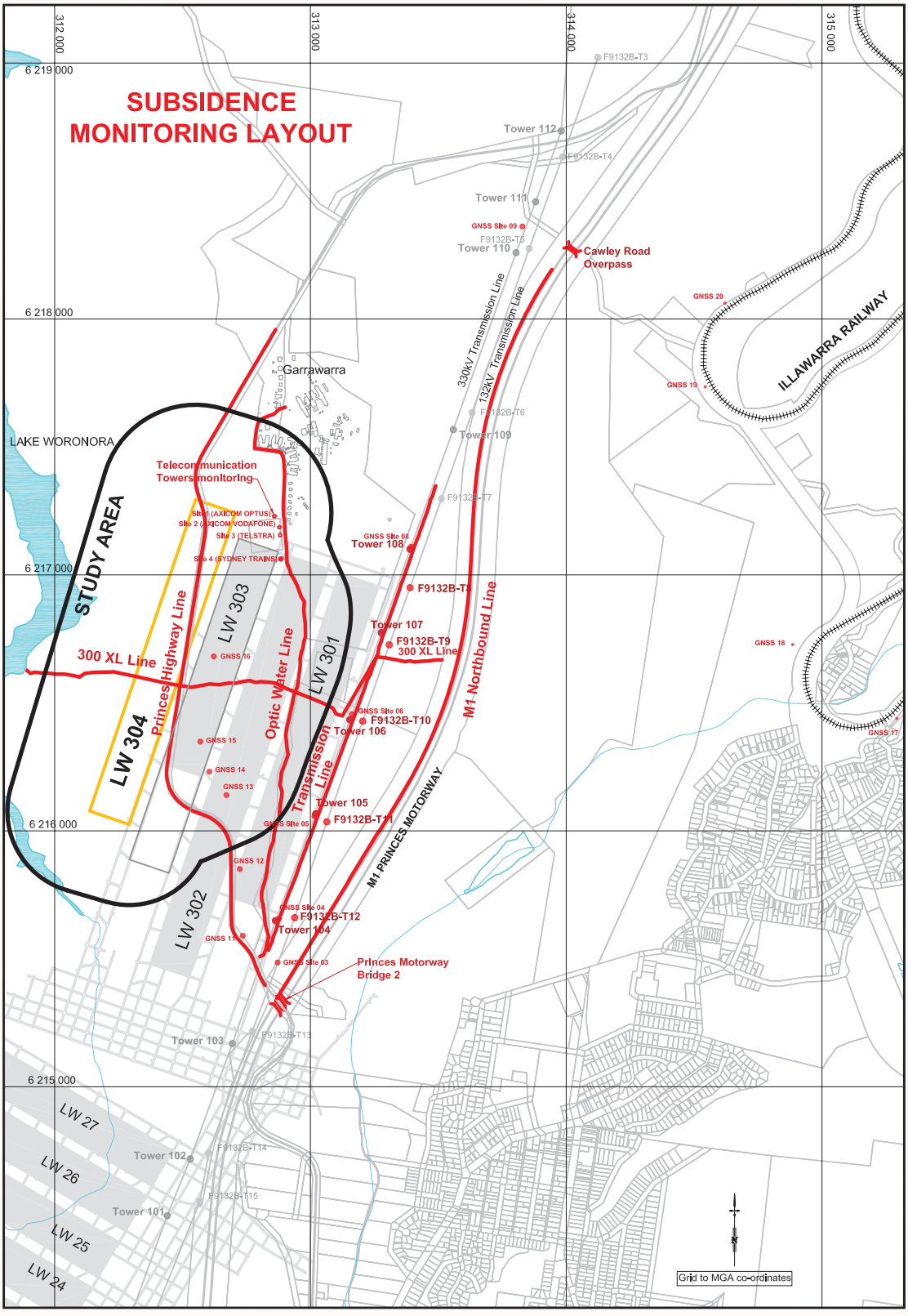
- in accordance with the Annual Review outlined in Section 12; or
- if triggered as a component of the Contingency Plan as outlined in Section 9 of this BFMP-WCC.

7.1 SUBSIDENCE PARAMETERS

Subsidence parameters (i.e. subsidence, tilt, tensile strain, compressive strain, absolute horizontal translation, and differential leg movement) associated with mining will be measured in accordance with the Longwall 304 Subsidence Monitoring Program (Figure 6).

In summary, surveys will be conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence movements (i.e. subsidence, tilt, tensile strain and compressive strain) will be measured along subsidence lines that have been positioned across the general landscape.

Monitoring of subsidence parameters specific to the Wollongong City Council assets include the survey line along the Old Princes Highway. These surveys will monitor the general movement about the longwalls and the data will allow evaluation of the likely ground movements about the Old Princes Highway (by comparison between measured and predicted movements).



MET-18-13_304 EP BFMP_017A

Source: MSEC (2019)

Peabody

METROPOLITAN COAL

Subsidence Monitoring Layout

Figure 6

7.2 SUBSIDENCE IMPACTS

7.2.1 Pavement

Road pavement subsidence impacts will be monitored along the pavement using video photography provided by Wollongong City Council. Metropolitan Coal will provide additional monitoring with weekly visual inspections when the longwall is operating within 400m of passing under the Princes Highway.

Subsidence impacts will be monitored extending from the Old Princes Highway Underpass (Bridge 2) to the entrance to the Garrawarra Centre Complex. Subsidence monitoring will increase to weekly as the longwall face approaches within 400m of passing under the Princes Highway.

An inspection of the pavement will occur prior to the longwall face approaching within 400 m of the Old Princes Highway (or as otherwise agreed with Wollongong City Council) and within three months of the completion of Longwalls 301-304. Progress monitoring (visual inspections) will occur as the longwall face approaches within 400 m of passing under the asset to establish more frequent communications with Wollongong City Council. Additional observations of subsidence impacts will be conducted during routine works and WCC's routine (quarterly) road condition inspections.

Specific details that will be noted and/or photographed include:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- assessment against the performance indicators and performance measure;
- whether any actions are required (e.g. initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The information will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 3) and reported in accordance with the Project Approval conditions.

7.2.2 Drainage Structures (Pipes/Culverts)

Inspection of the drainage structures (e.g. pipes/culverts) within the Study area will be carried out to provide an assessment of the baseline condition of these features prior to the longwall face approaching within 400 m of the Old Princes Highway (or as otherwise agreed with Wollongong City Council). The inspection will include:

- recording of existing cracks; and
- recording of other defects such as joint displacement and general condition.

A site inspection of the pipes/culverts will also occur following the completion of Longwalls 301-304. The visual assessment will be carried out by representative(s) from the Wollongong City Council and will assess changes to the pipes/culverts from the baseline condition as a result of the extraction of Longwalls 301-304.

The information will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 3) and reported in accordance with the Project Approval conditions.

7.2.3 Guard Rails, Marker Posts and Signage

Pre and post audits of guard rails, marker posts and signage will be conducted using the results of the dilapidation survey described in Section 6 and recorded following the completion of Longwalls 301-304 to assess changes from the baseline condition.

7.3 ENVIRONMENTAL CONSEQUENCES

Metropolitan Coal and Wollongong City Council will compare the results of the subsidence impact monitoring against the built features performance measure and performance indicators. In the event the observed subsidence impacts exceed the performance measure or performance indicators, Metropolitan Coal and Wollongong City Council will assess the consequences of the exceedance in accordance with the Contingency Plan described in Section 9.

8 MANAGEMENT MEASURES

A number of potential management measures in relation to pavement, drainage structures and other furniture are considered to be applicable and are described below.

Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.

Management measures will be reported in the Annual Review (Section 12).

8.1 ROAD PAVEMENTS

The potential management measures in relation to the Old Princes Highway pavement include:

- mill and/or replace pavement layers; and
- crack sealing/repair.

In the event that repairs are required, traffic control measures such as contra-flow of traffic or partial carriageway closures may be used to divert traffic off one carriageway, lane or shoulder. Repairs would be carried out as soon as practicable in consultation with the Wollongong City Council.

8.2 DRAINAGE STRUCTURES (PIPES/CULVERTS)

The potential management measures in relation to drainage structures (pipes/culverts) include:

- point repairs;
- replace sections of pipe/culvert; and
- grouting/sealing of cracks.

In the event that repairs are required, traffic control measures such as contra-flow of traffic or partial carriageway closures may be used to divert traffic off one carriageway, lane or shoulder. Repairs would be carried out as soon as practicable in consultation with the Wollongong City Council.

8.3 GUARD RAILS, MARKER POSTS AND SIGNAGE

The potential management measures in relation to guard rails, marker posts and signage include repairs and/or replacement of furniture.

In the event that repairs are required, traffic control measures such as contra-flow of traffic or partial carriageway closures may be used to divert traffic off one carriageway, lane or shoulder. Repairs would be carried out as soon as practicable in consultation with the Wollongong City Council.

9 CONTINGENCY PLAN

In the event the subsidence impacts observed exceed the performance measure or performance indicators detailed in Section 5 of this BFMP-WCC, Metropolitan Coal will implement the following Contingency Plan (Appendix 4):

- The observation will be reported to the Manager - Technical Services within 24 hours.
- The observation will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 3) consistent with the monitoring program described in Section 7 of this BFMP-WCC.
- Metropolitan Coal will report any exceedance of the performance measure or performance indicators to the DP&E and Wollongong City Council as soon as practicable after Metropolitan Coal becomes aware of the exceedance.
- Metropolitan Coal will assess public safety and where appropriate implement safety measures in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan.
- Metropolitan Coal will conduct an investigation to evaluate the potential contributing factors. The investigation will:
  - include the re-survey of relevant subsidence monitoring lines;
  - compare and critically analyse measured versus predicted subsidence parameters;
  - review measured subsidence parameters against the observed impact; and
  - review the subsidence monitoring program and update the program where appropriate.
- The course of action with respect to the identified impact(s), in consultation with specialists and relevant agencies, will include:
  - a program to review the effectiveness of the contingency measures; and
  - consideration of adaptive management.

  Contingency measures are provided in Section 9.1.
- Metropolitan Coal will submit the proposed course of action to the DP&E for approval.
- Metropolitan Coal will implement the approved course of action to the satisfaction of the DP&E.

In accordance with Condition 6, Schedule 6 of the Project Approval, Metropolitan Coal will provide a suitable offset to compensate for the impact to the satisfaction of the Director-General (now Secretary) of DP&E if either the contingency measures implemented by Metropolitan Coal have failed to remediate the impact or the Director-General (now Secretary) determines that it is not reasonable or feasible to remediate the impact.

Metropolitan Coal will comply with the NSW *Coal Mine Subsidence Compensation Act, 2017* in the event that property damages occur as a result of mining Longwalls 301-304.

9.1 CONTINGENCY MEASURES

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of environmental consequences).

Contingency measures that could be considered in the event the performance measure for the Old Princes Highway is exceeded are summarised in Table 6. The decision trees for the contingency measures are shown in Appendix 4.

Table 6
Contingency Measures – Old Princes Highway

Environmental Consequence	Contingency Measures	
	Measure	**Description**
Impact on:		
Pavement	Rebuild road.	• Temporary closure of the road and reconstruction of pavement.
Pipes/Culverts	Replace pipe. Rebuild culvert.	• Construction of temporary drainage pipe/culvert and reconstruction or replacement of original pipe/culvert.
Other Furniture (Guard Rail, Marker Posts, Signage)	Replace furniture.	• Replace section of guard rail, marker post or signage.

Temporary road closure procedures would be developed and carried out in consultation with the Wollongong City Council.

10 TARP – MANAGEMENT TOOL

The framework for the various components of the BFMP-WCC are summarised in the BFMP-WCC TARP shown in Table 7. The BFMP-WCC TARP illustrate how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

The TARP comprises:

- baseline conditions;
- predicted subsidence impacts;
- trigger levels from monitoring to assess performance; and
- triggers that flag implementation of contingency measures.

The TARP system provides a simple and transparent snapshot of the monitoring of environmental performance and the implementation of management and/or contingency measures.

Table 7
Trigger Action Response Plan – Old Princes Highway

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
Safe, serviceable and repairable	Subsidence parameters. The structural integrity of the pavement and drainage structures (pipes, culverts and other furniture).	Old Princes Hwy	Subsidence Tilt Tensile strain Compressive strain Direct signs of movement, about the pavement of drainage structures	After each longwall When LW is within 400m of the asset After each longwall	Comparison between predicted and measured subsidence Video photography Visual inspection	Subsidence measurement accuracy.	Pre-mining audit conducted prior to commencement of LW 301.	Level 1	**LW 301-302** Subsidence <675 mm Tilt < 4.0 mm/m Tensile strain < 0.9 mm/m Compressive strain <1.6 mm/m **LW 303** Subsidence < 900 mm Tilt < 3.5 mm/m Tensile strain < 0.9 mm/m Compressive strain <1.6 mm/m **LW 304** Subsidence < 1000 mm Tilt < 3.5 mm/m Tensile strain < 0.9 mm/m Compressive strain <1.6 mm/m (i.e. measured subsidence parameters generally in accordance with predicted). Negligible visible impact to road pavement or drainage structures.	Continue monitoring.
								Level 2	Subsidence effects up to 15% more than predicted. **LW 301-302** Subsidence between 675 and 775 mm Strain between 1.6 and 1.8 mm/m **LW 303** Subsidence between 900 and 1035 mm Strain between 1.6 and 1.8 mm/m **LW 304** Subsidence between 1000 and 1150 mm Strain between 1.6 and 1.8 mm/m Negligible visible impact to pavement or drainage structures.	Report subsidence anomaly. Immediately resurvey subsidence line to confirm results. Engage subsidence expert to assess results. Confirm results are consistent with other subsidence lines. Compare and critically analyse measured versus predicted subsidence. Inform and provide report to WCC of subsidence results. Collaboratively share information with WCC to monitor situation. **<u>WCC</u>** Assess information provided by Metropolitan Coal.

Table 7
Trigger Action Response Plan – Old Princes Highway

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
								Level 3	Anomalous subsidence effects >15% predicted. For LW 301-302 Subsidence > 775 mm Strain > 1.8 mm/m For LW 303 Subsidence > 1035 mm Strain > 1.8 mm/m For LW 304 Subsidence > 1150 mm Strain > 1.8 mm/m Visible impact to the pavement, i.e. cracking > 5mm, ponding, cracking or opening of drainage structures > 5mm Defects to guard railing, marker posts, or signage.	Inform WCC and NSW Principal Subsidence Engineer of subsidence results (immediately following awareness of trigger). Increase frequency of subsidence line surveys to weekly in affected area. Report monitoring data to NSW Principal Subsidence Engineer In conjunction with WCC identify impact location and have WCC assess asset condition. Review the subsidence monitoring program and update the program where appropriate. Provide report on issue to both WCC and DP&E. **WCC** In conjunction with Metropolitan Coal identify impact location, inspect road pavement, assess condition and determine appropriate response (e.g. greater monitoring data or frequency, or schedule maintenance on the road pavement/structure). Make determination if other measures necessary to avoid further impact (e.g. deployment of emergency structures).
								Level 4	Impact Occurs	Implement Contingency Plan as per BFMP Section 9. Implement appropriate safety controls General Manager in all decision-making processes. Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwall 304 Public Safety Management Plan. Report exceedance of the performance measure or indicators to the DP&E as soon as practicable. Update the 'Built Features Management Plan – Subsidence Impact Register'. **WCC** WCC to enact contra-flow of traffic or partial carriageway closure. Complete restoration works. Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures
	The serviceability of the access roads and tracks are maintained.	Access roads and tracks in the vicinity of the WCC assets.	Cracking about access road/tracks.	After LW 301, 302, and 303	Visual Inspection. Visual observations of access roads/tracks will also be conducted by Metropolitan Coal as part of routine works and inspections within 600 m of Longwalls 301-304 secondary extraction as described in the Metropolitan Coal Longwall 304 Land Management Plan (Longwall 304 LMP).		Pre-mining audit conducted prior to commencement of LW 301.	Level 1	Minor cracking.	**Continue monitoring.** Consider whether any actions are required (e.g. implementation of management measures as outlined in the Longwall 304 LMP, initiation of the Contingency Plan as outlined in the Longwall 304 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.).
								Level 2	Moderate cracking (ie cracking that requires implementation of management measures).	Implement management measures as outlined in the Longwall 304 LMP.
								Level 3	Greater than moderate cracking.	Implement contingency measures as outlined in the Longwall 304 LMP.

11 FUTURE EXTRACTION PLANS

In accordance with Condition 7, Schedule 3 of the Project Approval, Metropolitan Coal will collect baseline data for the next Extraction Plan (i.e. Longwalls 305-310). The collection of baseline data will be consistent with the baseline data collected for Longwalls 301-304. However, for the Old Princes Highway, the baseline (and post-mining) data collected for Longwalls 301-304 will be used as baseline for Longwalls 305 onward.

In addition to the baseline data collection, consideration of the environmental performance and management measures in accordance with the review(s) conducted as part of this BFMP-WCC will inform the appropriate type and frequency of monitoring of the assets relevant to the next Extraction Plan.

12 ANNUAL REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

In accordance with Condition 3, Schedule 7 of the Project Approval, Metropolitan Coal will conduct an Annual Review of the environmental performance of the Project by the end of March each year.

The Annual Review will:

- describe the works carried out in the past year, and the works proposed to be carried out over the next year;
- include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the EA, Preferred Project Report and Extraction Plan;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

As described in Section 2, the BFMP-WCC will be reviewed within three months of the submission of an Annual Review, and revised where appropriate.

13 INCIDENTS

An incident is defined as a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval.

The reporting of incidents will be conducted in accordance with Condition 6, Schedule 7 of the Project Approval. Metropolitan Coal will notify the Director-General (now Secretary) of DP&E and any other relevant agencies of any incident associated with the Project as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of DP&E and any relevant agencies with a detailed report on the incident.

Wollongong City Council will be notified within 24 hours of any access limitations or restrictions.

14 COMPLAINTS

A protocol for the managing and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

The Environment & Community Superintendent is responsible for maintaining a system for recording complaints.

Metropolitan Coal will maintain public signage advertising the telephone number on which environmental complaints can be made. The Environment & Community Superintendent is responsible for ensuring that the currency and effectiveness of the service is maintained. Notifications of complaints received are to be provided as quickly as practicable to the Environment & Community Superintendent.

Complaints and enquiries do not have to be received via the telephone line and may be received in any other form. Any complaint or enquiry relating to environmental management or performance is to be relayed to the Environment & Community Superintendent as soon as practicable. All employees are responsible for ensuring the prompt relaying of complaints. All complaints will be recorded in a complaints register.

For each complaint, the following information will be recorded in the complaints register:

- date and time of complaint;
- method by which the complaint was made;
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- nature of the complaint;
- the action(s) taken by Metropolitan Coal in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken by Metropolitan Coal, the reason why no action was taken.

The Environment & Community Superintendent is responsible for ensuring that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary.

In accordance with Condition 10, Schedule 7 of the Project Approval, the complaints register will be made publicly available on the website and updated on a monthly basis. A summary of complaints received, and actions taken will be presented to the Community Consultative Committee as part of the operational performance review.

15 NON-COMPLIANCES WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with Metropolitan Coal, and will be developed through promotion of Metropolitan Coal ownership under the direction of the General Manager.

The Manager - Technical Services and/or Environment & Community Superintendent will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 13, Metropolitan Coal will notify the Director-General (now Secretary) of the DP&E and any other relevant agencies of any incident associated with Metropolitan Coal as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of the DP&E and any relevant agencies with a detailed report on the incident.

A review of Metropolitan Coal's compliance with all conditions of the Project Approval, mining leases and all other approvals and licenses will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the Peabody website.

Additionally, in accordance with Condition 8, Schedule 7 of the Project Approval, an independent environmental audit was undertaken by the end of December 2011, and is undertaken a minimum of once every three years thereafter. A copy of the audit report will be submitted to the Director-General (now Secretary) of the DP&E and made publicly available on the Peabody website. The independent audit will be undertaken by an appropriately qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General (now Secretary) of the DP&E.

16 REFERENCES

Department of Planning & Environment and Division of Resources and Energy (2015) *Guidelines for the Preparation of Extraction Plans*. Draft.

Helensburgh Coal Pty Ltd [HCPL] (2008) *Metropolitan Coal Project Environmental Assessment*.

Helensburgh Coal Pty Ltd [HCPL] (2009) *Metropolitan Coal Project Preferred Project Report.*

Mine Subsidence Engineering Consultants (2008) *Subsidence Assessment Report on the Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Surface Infrastructure Resulting from the Proposed Extraction of Longwalls 20 to 44 at Metropolitan Colliery in Support of a Part 3A Application.*

Mine Subsidence Engineering Consultants (2016) *Metropolitan Colliery – Subsidence Predictions and Impact Assessments from Proposed Longwalls 301 to 303 for the Wollongong City Council Infrastructure, 8 September 2016.*

Mine Subsidence Engineering Consultants (2019) *Metropolitan Colliery – Subsidence Predictions and Impact Assessments from Proposed Longwall 304 for the Wollongong City Council Infrastructure.*

APPENDIX 1

MSEC (2016) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 301 TO 303 – SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE WOLLONGONG CITY COUNCIL INFRASTRUCTURE, DATED 8 SEPTEMBER 2016

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

8th September 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-10

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Wollongong City Council Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Wollongong City Council (WCC) infrastructure resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery.

The locations of the WCC infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC844-10. The Old Princes Highway crosses directly above Longwalls 301 to 303. This section of the highway comprises a single carriageway with a flexible asphalt pavement and grass verges. A photograph of the Old Princes Highway is provided in Figure 1.

Figure 1 Old Princes Highway

There are also local roads and bridges located outside and in the vicinity of the Study Area, within the township of Helensburgh to the south-east of the longwalls and to the north-east of the longwalls. These local roads are located at a minimum distance of 0.9 kilometres from the longwalls. The Princes Highway Underpass and the Cawleys Road Overpass are located at distances of 330 metres and 1.43 kilometres, respectively, from the longwalls.

The predictions and impact assessments for the WCC infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the WCC Infrastructure

The following provides summaries of the maximum predicted conventional movements for the WCC infrastructure resulting from the extraction of Longwalls 301 to 303. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

The predicted profiles of incremental and total conventional subsidence, tilt and curvature along the alignment of the Old Princes Highway, resulting from the extraction of Longwalls 301 to 303, are shown in the attached Fig. A.1. The black dashed lines are the incremental profiles that represent the additional movements due to each of the longwalls. The solid blue lines represent the total or accumulated movements after the completion of each longwall. The range of predicted curvatures in any direction at any time during or after the extraction of the longwalls is shown by the grey shading.

A summary of the maximum predicted values of incremental subsidence, tilt and curvature for the Old Princes Highway, due to the extraction of each of the Longwalls 301 to 303, is provided in Table 1. The values are the maxima anywhere along the highway at any time during or after the extraction of each longwall.

Table 1 Maximum Predicted Incremental Subsidence, Tilt and Curvature for the Old Princes Highway Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
Due To LW301	40	< 0.5	< 0.01	< 0.01
Due To LW302	625	4.0	0.05	0.06
Due To LW303	650	3.0	0.05	0.06

The maximum predicted incremental subsidence for the Old Princes Highway, due to the extraction of each of the Longwalls 301 to 303, varies between 40 mm to 650 mm.

A summary of the maximum predicted values of total subsidence, tilt and curvature for the Old Princes Highway, resulting from the extraction of Longwalls 301 to 303, is provided in Table 2. The values are the maxima anywhere along the highway at any time during or after the extraction of the longwalls.

Table 2 Maximum Predicted Total Subsidence, Tilt and Curvature for the Old Princes Highway Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	40	< 0.5	< 0.01	< 0.01
After LW302	675	4.0	0.05	0.06
After LW303	900	3.5	0.05	0.06

The maximum predicted total subsidence for the Old Princes Highway, resulting from the extraction of Longwalls 301 to 303, is 900 mm. The maximum predicted conventional tilt for the highway is 4.0 mm/m (i.e. 0.4 %, or 1 in 250). It is noted, that the maximum tilt occurs after the extraction of Longwall 302 and reduces slightly after the extraction of Longwall 303. The maximum predicted conventional curvatures are 0.05 km^{-1} hogging and 0.06 km^{-1} sagging, which equate to minimum radii of curvature of 20 kilometres and 17 kilometres, respectively.

The local roads and bridges are located outside the predicted 20 mm subsidence contour. It is unlikely that the features would experience measurable vertical subsidence, tilt, curvatures or strains. These features could experience low level far-field horizontal movement. The far-field horizontal movements are expected to be similar to those observed for previous longwall mining in the Southern Coalfield.

The observed incremental far-field horizontal movements, resulting from the extraction of longwalls in the Southern Coalfield, are provided in Figure 2. The data are based on survey marks located outside of the mining area (i.e. above solid coal).

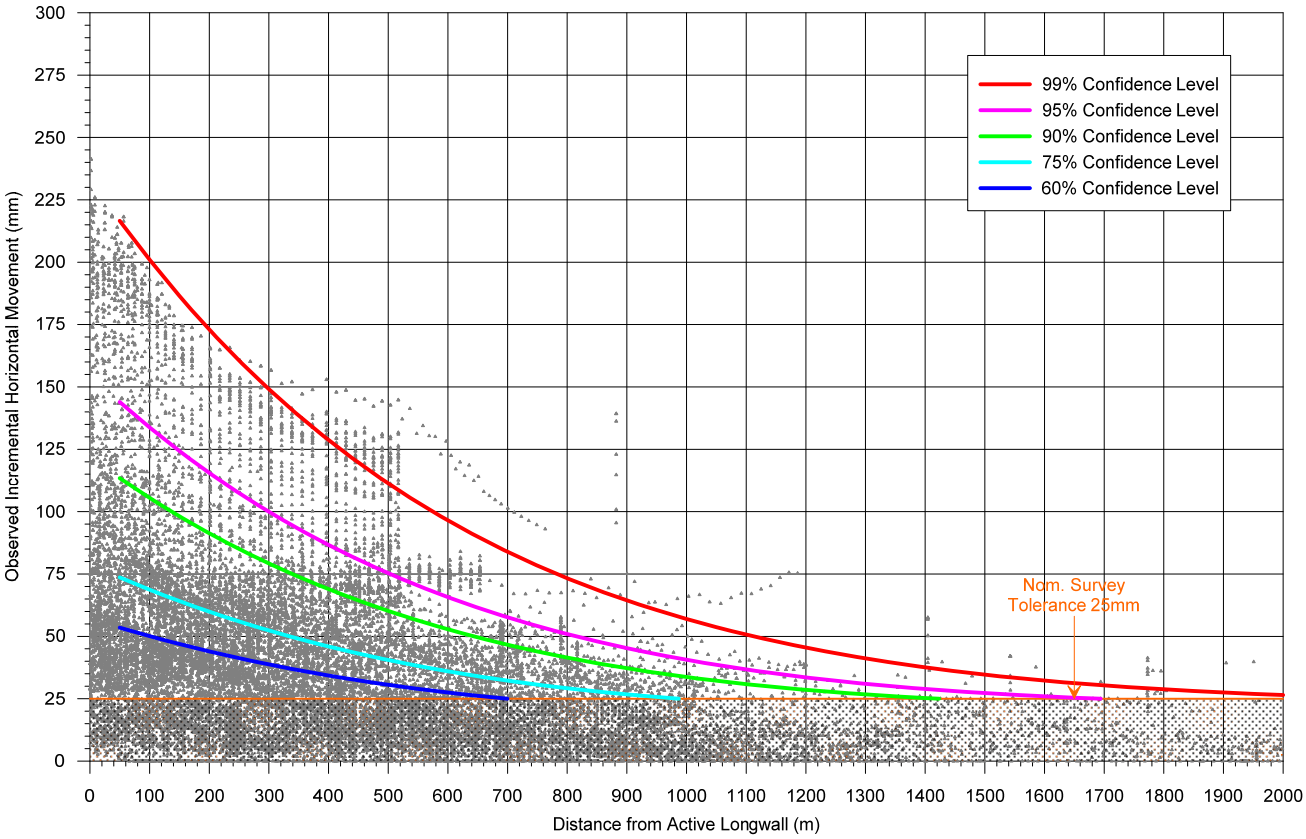


Figure 2 Observed Incremental Far-field Horizontal Movements from the Southern Coalfield (Solid Coal)

The absolute horizontal movements measured at distances greater than 0.9 kilometres from mining are in the order of 40 mm based on the 95 % confidence level. These low level movements comprise a large proportion of survey tolerance. Far-field horizontal movements tend to be bodily movements orientated towards the mining area. The strains associated with these low level horizontal movement are not expected to be measurable.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the WCC infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The Old Princes Highway is partially located above Longwalls 301 to 303. A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 3. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

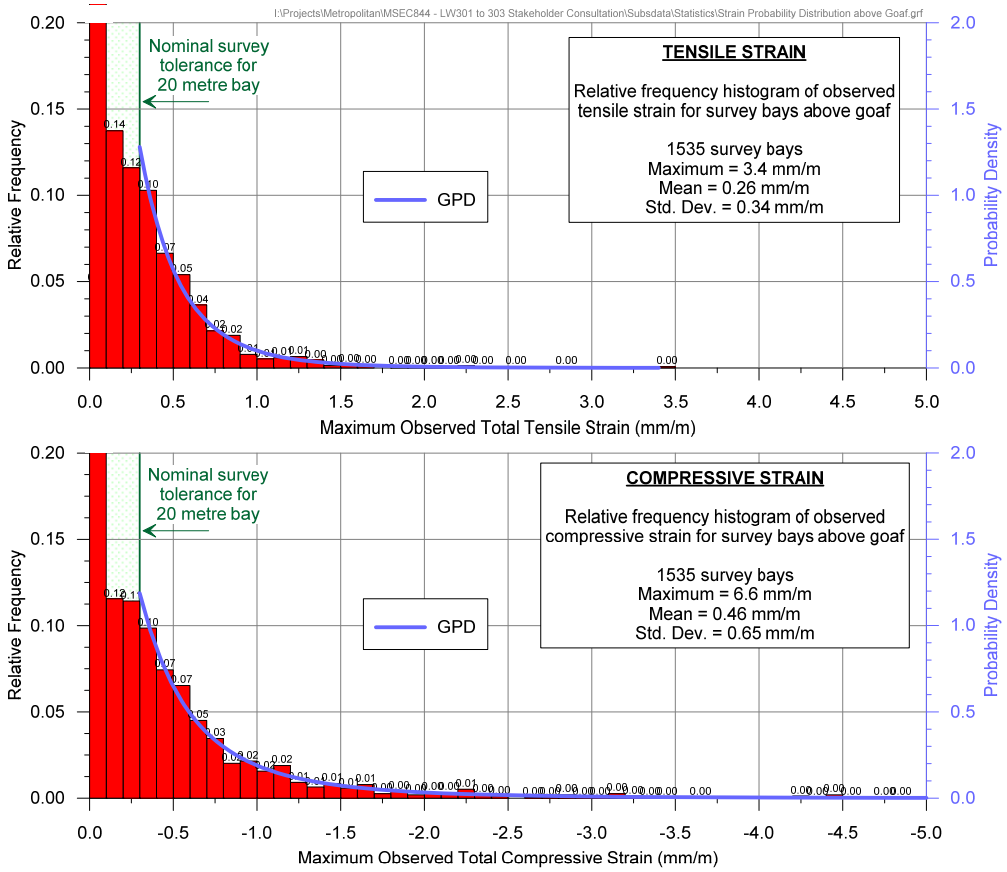


Figure 3 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based on the fitted GPDs, is provided in Table 3.

Table 3 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures and the streams are shown in Drawing No. MSEC844-10.

There are no mapped faults located within the extents of Longwalls 301 to 303. It is possible that the infrastructure located above the longwalls could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The Old Princes Highway does not cross any major streams within the Study Area. The highway, therefore, is not expected to experience any measurable valley closure effects.

Impact Assessments for the Old Princes Highway

The maximum predicted conventional tilt for the Old Princes Highway is 4.0 mm/m (i.e. 0.4 %, or 1 in 250). The predicted changes in grade are small, less than 1 %, and therefore are unlikely to result in adverse impacts on the serviceability or surface water drainage for the highway. If additional localised ponding or adverse changes in surface water drainage were to occur as the result of mining, the highway could be repaired using normal road maintenance techniques.

The maximum predicted conventional curvatures for the highway are 0.05 km^{-1} hogging and 0.06 km^{-1} sagging, which equate to minimum radii of curvature of 20 kilometres and 17 kilometres, respectively. The predicted strains are 0.9 mm/m tensile and 1.6 mm/m compressive based on the 95 % confidence level and 1.5 mm/m tensile and 3.2 mm/m compressive based on the 99 % confidence level.

The maximum predicted curvatures and the range of potential strains for the Old Princes Highway are similar to those typically experienced elsewhere in the Southern Coalfield. Longwalls in the Southern Coalfield have been successfully mined directly beneath roads with bitumen and asphaltic pavements.

For example, at Tahmoor Colliery, Longwalls 22 to 27 have mined beneath approximately 24.5 kilometres of local roads. A total of 46 impact sites have been observed and, therefore, this equates to an average of one impact for

every 533 metres of pavement. The impacts were minor and did not present a public safety risk. The potential impacts due to conventional subsidence movements include minor cracking, rippling, bumps and stepping in the road surface. The nature of potential impacts to the pavement are also affected by the type of construction of the road pavement.

The potential impacts on the Old Princes Highway could be managed using monitoring (visual and/or ground survey lines) and remediation of adverse impacts during active subsidence using normal road maintenance techniques. The final repair of the highway would be undertaken at the completion of the longwalls.

It is recommended that monitoring and management strategies are developed, in consultation with WCC, to manage the potential impacts on the Old Princes Highway. It is expected that the highway can be maintained in safe and serviceable conditions with the implementation of the appropriate monitoring and management strategies.

Impact Assessments for the Local Roads and Bridges

The local roads are located outside of the predicted 20 mm subsidence contour. It is unlikely therefore that these roads would experience adverse impacts as a result of Longwalls 301 to 303.

The Princes Highway Underpass and the Cawleys Road Overpass are located at distances of 330 metres and 1.43 kilometres, respectively, from the longwalls. These bridges could experience low level far-field horizontal movements and could be sensitive to these movements. The Princes Highway Underpass and Cawleys Road Overpass are maintained by Roads and Maritime Services (RMS) and therefore the assessments for these bridges are provided in the Report No. MSEC844-08. The monitoring and management of the Princes Highway Underpass and the Cawleys Road Overpass will be incorporated in the Built Features Management Plan for RMS the infrastructure.

Summary

The Old Princes Highway crosses directly above Longwalls 301 to 303. The previous experience from the Southern Coalfield has found that the potential impacts on bitumen seal and asphaltic pavements can be managed with the implementation of suitable monitoring and management strategies.

It is recommended that monitoring and management strategies are developed, in consultation with WCC, to manage the potential impacts on the Old Princes Highway. It is expected that the highway can be maintained in safe and serviceable conditions with the implementation of the appropriate monitoring and management strategies.

The other local roads and bridges are located outside the predicted 20 mm subsidence contour. Whilst these features could experience low level far-field horizontal movements, they are not expected to experience measurable strains or differential horizontal movements. It is unlikely therefore that these features would experience adverse impacts as a result of Longwalls 301 to 303.

Yours sincerely

Peter DeBono

Attachments:

Drawing No. MSEC844-10 – Longwalls 301 to 303 – WCC Infrastructure

Fig. A.1 Predicted Profiles of Conventional Subsidence, Tilt and Curvature for the Old Princes Highway due to LW301 to LW303

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COAL

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
WOLLONGONG CITY COUNCIL

DATE:	SCALE:	DRAWING No:	Rev No
30-Aug-2016	1:12500	MSEC844-10	D

313 000 314 000 312 000
6 218 000 6 217 000 6 216 000 6 215 000

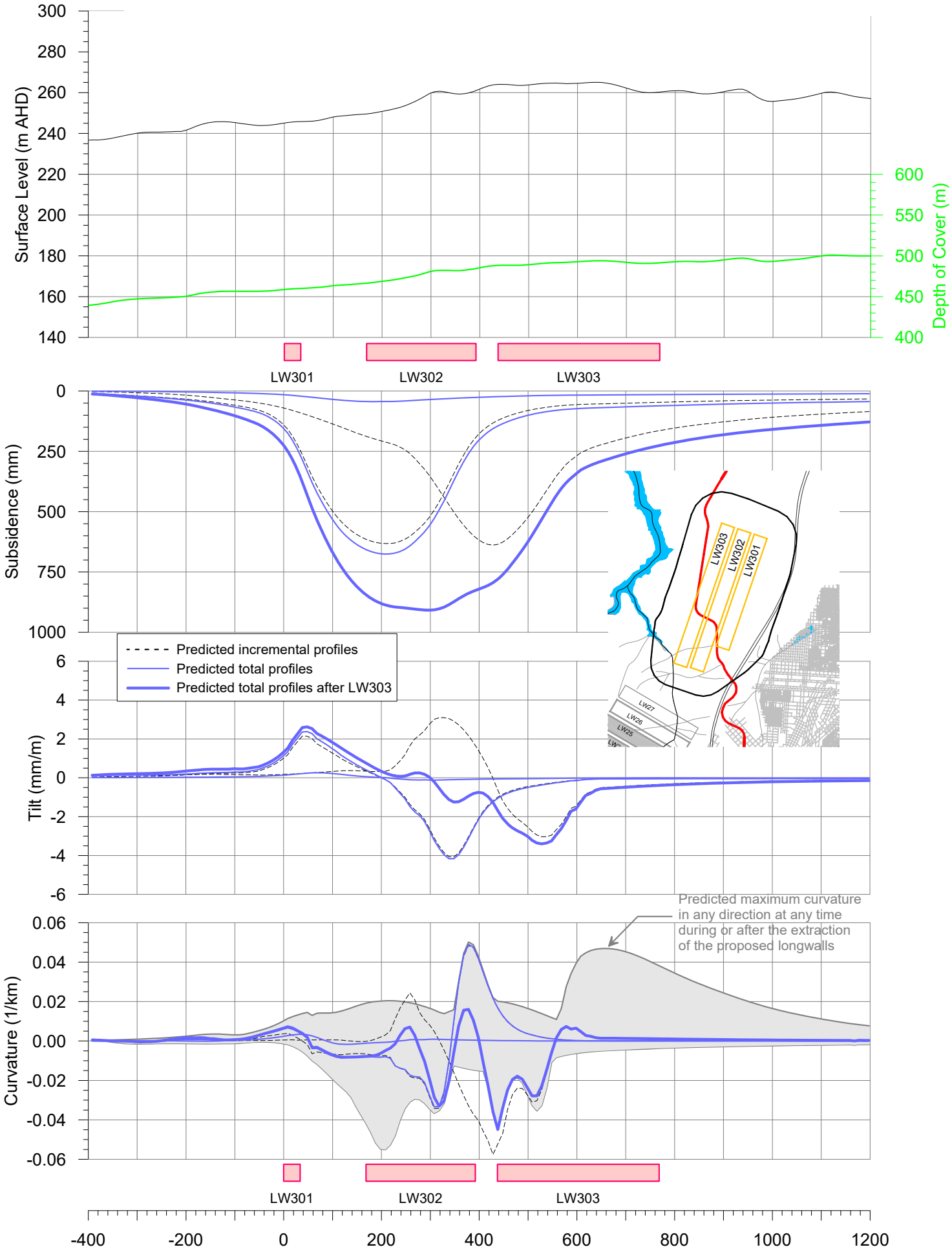
Grid to MGA co-ordinates

FORMER QUARRY SITE
CAWLEYS ROAD OVERPASS
CAWLEYS CK
M1 PRINCES MOTORWAY
STUDY AREA
GARRAWARRA CENTRE
METROPOLITAN FAULT
WORONORA RESERVOIR
PREDICTED 20mm SUBSIDENCE CONTOUR
20
OLD PRINCES HWY
LW302
LW301
LW303
WILSONS CK
PRINCES HIGHWAY UNDERPASS 2
MAIN WEST FAULT
POWELL FAULT
FAULT

GEOLOGICAL STRUCTURES
FAULTS
DYKES

LEGEND
COUNCIL ASSETS
UNSEALED ROADS & TRACKS

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along the Old Princes Highway due to LW301 to LW303



msec

Fig. A.1

APPENDIX 2

MSEC (2019) METROPOLITAN COLLIERY – PROPOSED LONGWALL 304 – SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE WOLLONGONG CITY COUNCIL INFRASTRUCTURE

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

15th March 2019

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC1013-10

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Wollongong City Council Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Wollongong City Council (WCC) infrastructure resulting from the extraction of the proposed Longwall 304 at Metropolitan Colliery.

The locations of the WCC infrastructure and the proposed Longwall 304 are shown in the attached Drawing No. MSEC1013-10. A Study Area is shown in Drawing No. MSEC1013-10 and is based on the outer limits of a 35° angle of draw line from Longwall 304 and the predicted 20mm subsidence contour for Longwall 304. The Old Princes Highway crosses directly above the proposed Longwall 304 and previous Longwalls 301 to 303. This section of the highway comprises a single carriageway with a flexible asphalt pavement and grass verges. A photograph of the Old Princes Highway is provided in Figure 1.

Figure 1 Old Princes Highway

There are also local roads and bridges located outside of, but in the vicinity of the Study Area, within the township of Helensburgh to the south-east of the longwalls and to the north-east of the longwalls. These local roads are located

at a minimum distance of 1.5 kilometres from Longwall 304. It is unlikely therefore that these roads would experience adverse impacts as a result of the proposed Longwall 304. A bridge is located above the Princes Highway at the crossing with the M1 Princes Motorway, at 880 m from Longwall 304. The bridge is maintained by Roads and Maritime Services (RMS) and therefore the assessments and management for the bridge are outlined in reports for the RMS infrastructure.

The predictions and impact assessments for the WCC infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the WCC Infrastructure

The following provides summaries of the maximum predicted conventional movements for the WCC infrastructure following the extraction of Longwall 303 and after the extraction of Longwall 304. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

The predicted profiles of total conventional subsidence, tilt and curvature along the alignment of the Old Princes Highway, following the extraction of Longwall 303 and after the extraction of Longwall 304, are shown in the attached Fig. A.1. The solid blue lines represent the total or accumulated movements after the completion of each longwall. The range of predicted curvatures in any direction at any time during or after the extraction of the longwalls is shown by the grey shading.

A summary of the maximum predicted values of total subsidence, tilt and curvature for the Old Princes Highway, following the extraction of Longwall 303 and after the extraction of Longwall 304, is provided in Table 1. The values are the maxima anywhere along the highway at any time during or after the extraction of the longwalls.

Table 1 Maximum Predicted Total Subsidence, Tilt and Curvature for the Old Princes Highway after from the Extraction of Longwalls 303 and 304

Longwall	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})
After LW303	950	3.0	0.05	0.05
After LW304	1,000	2.5	0.05	0.05

The maximum predicted total subsidence for the Old Princes Highway, following the extraction of Longwall 303 and after the extraction of Longwall 304, is 1,000 mm. The maximum predicted conventional tilt for the highway after the extraction of Longwall 304 is 2.5 mm/m (i.e. 0.25 %, or 1 in 400). It is noted, that the maximum tilt after the extraction of Longwall 304 and reduces slightly compared to the tilt after Longwall 303. The maximum predicted conventional curvatures are 0.05 km^{-1} hogging and sagging, which equate to minimum radii of curvature of 20 km.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the WCC infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The Old Princes Highway is partially located above the proposed Longwall 304 and this road also crosses Longwalls 301 to 303. A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 2. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

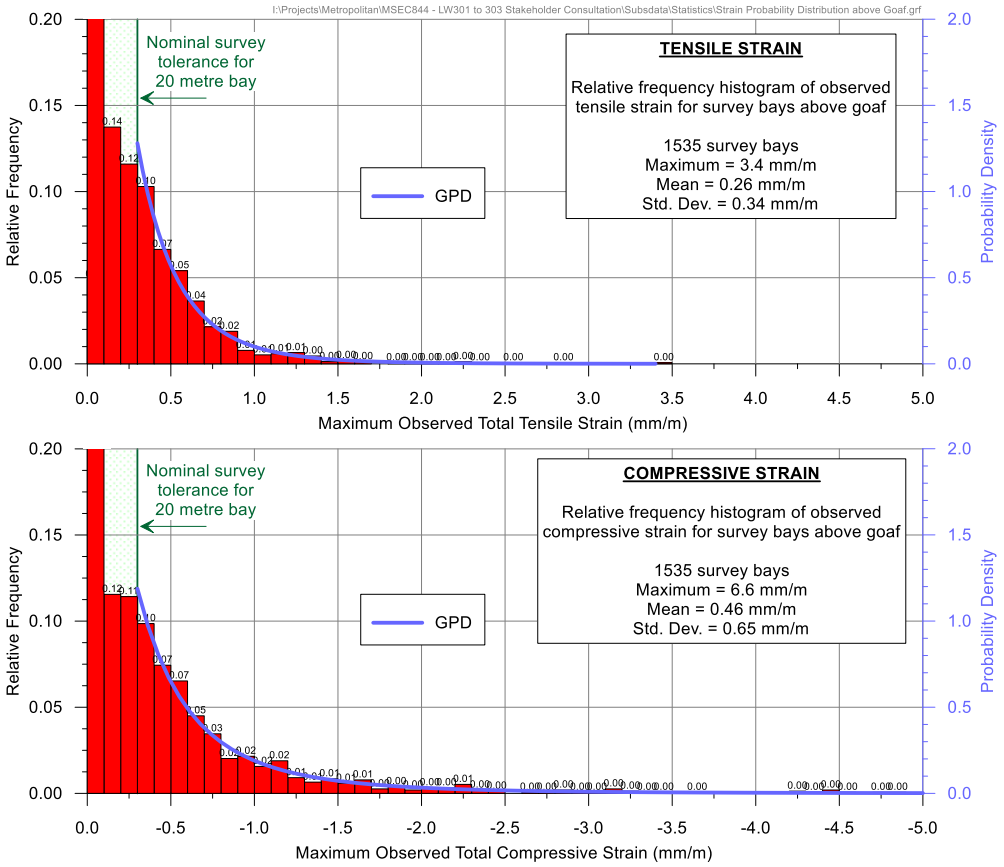


Figure 2 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based on the fitted GPDs, is provided in Table 2.

Table 2 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures at seam level and the major streams are shown in Drawing No. MSEC1013-10. There are no mapped faults located within the Study Area that extend beneath the Old Princes Highway. It is possible that the Old Princes Highway could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). Non-conventional or anomalous movements have not been identified during the extraction of Longwalls 301 and 302 and part extraction of Longwall 303. The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The Old Princes Highway does not cross any major streams within the Study Area. The highway, therefore, is not expected to experience any measurable valley closure effects.

Impact Assessments for the Old Princes Highway

The maximum predicted conventional tilt for the Old Princes Highway after the extraction of Longwall 304 is 2.5 mm/m (i.e. 0.25 %, or 1 in 400). The predicted changes in grade are small, less than 1 %, and therefore are unlikely to result in adverse impacts on the serviceability or surface water drainage for the highway. If additional localised ponding or adverse changes in surface water drainage were to occur as the result of mining, the highway could be repaired using normal road maintenance techniques.

The maximum predicted conventional curvatures for the highway are 0.05 km^{-1} hogging and sagging, which equate to minimum radii of curvature of 20 km. The predicted strains are 0.9 mm/m tensile and 1.6 mm/m compressive based on the 95 % confidence level and 1.5 mm/m tensile and 3.2 mm/m compressive based on the 99 % confidence level.

The maximum predicted curvatures and the range of potential strains for the Old Princes Highway are similar to those typically experienced elsewhere in the Southern Coalfield. Longwalls in the Southern Coalfield have been successfully mined directly beneath roads with bitumen and asphaltic pavements.

For example, at Tahmoor Colliery, Longwalls 22 to 27 have mined beneath approximately 24.5 kilometres of local roads. A total of 46 impact sites have been observed and, therefore, this equates to an average of one impact for every 533 metres of pavement. The impacts were minor and did not present a public safety risk. The potential impacts due to conventional subsidence movements include minor cracking, rippling, bumps and stepping in the

road surface. The nature of potential impacts to the pavement are also affected by the type of construction of the road pavement.

The potential impacts on the Old Princes Highway are being managed using monitoring (visual and/or ground survey lines) and impacts can be remediated during active subsidence using normal road maintenance techniques. The final repair of the highway would be undertaken at the completion of the longwalls. No impacts or anomalous movements have been identified along the Old Princes Highway during the extraction of Longwalls 301 and 302.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301 to 303 are updated and continued, in consultation with Wollongong City Council, to manage the potential impacts on the Old Princes Highway. It is expected that the highway can be maintained in safe and serviceable conditions with the implementation of the appropriate monitoring and management strategies.

Summary

The Old Princes Highway crosses directly above proposed Longwall 304 and this road also crosses Longwalls 301 to 303. The previous experience from the Southern Coalfield has found that the potential impacts on bitumen seal and asphaltic pavements can be managed with the implementation of suitable monitoring and management strategies.

It is expected that the highway can be maintained in safe and serviceable conditions with the implementation of the appropriate monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:

Drawing No. MSEC1013-10 – Longwall 304 – WCC Infrastructure

Fig. A.1 Predicted Profiles of Conventional Subsidence, Tilt and Curvature for the Old Princes Highway after LW303 and after LW304

I:\Projects\Metropolitan\MSEC1013 - LW304 Stakeholders Consultation\AcadData\MSEC1013-10 Wollongong City Council.dwg

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COAL

METROPOLITAN COLLIERY
LONGWALL 304
WOLLONGONG CITY COUNCIL

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	1:10000	MSEC1013-10	02

6 218 000
313 000
312 000
6 217 000
6 216 000

CAWLEYS CK
GARRAWARRA CENTRE
WORONORA RESERVOIR
M1 PRINCES MOTORWAY

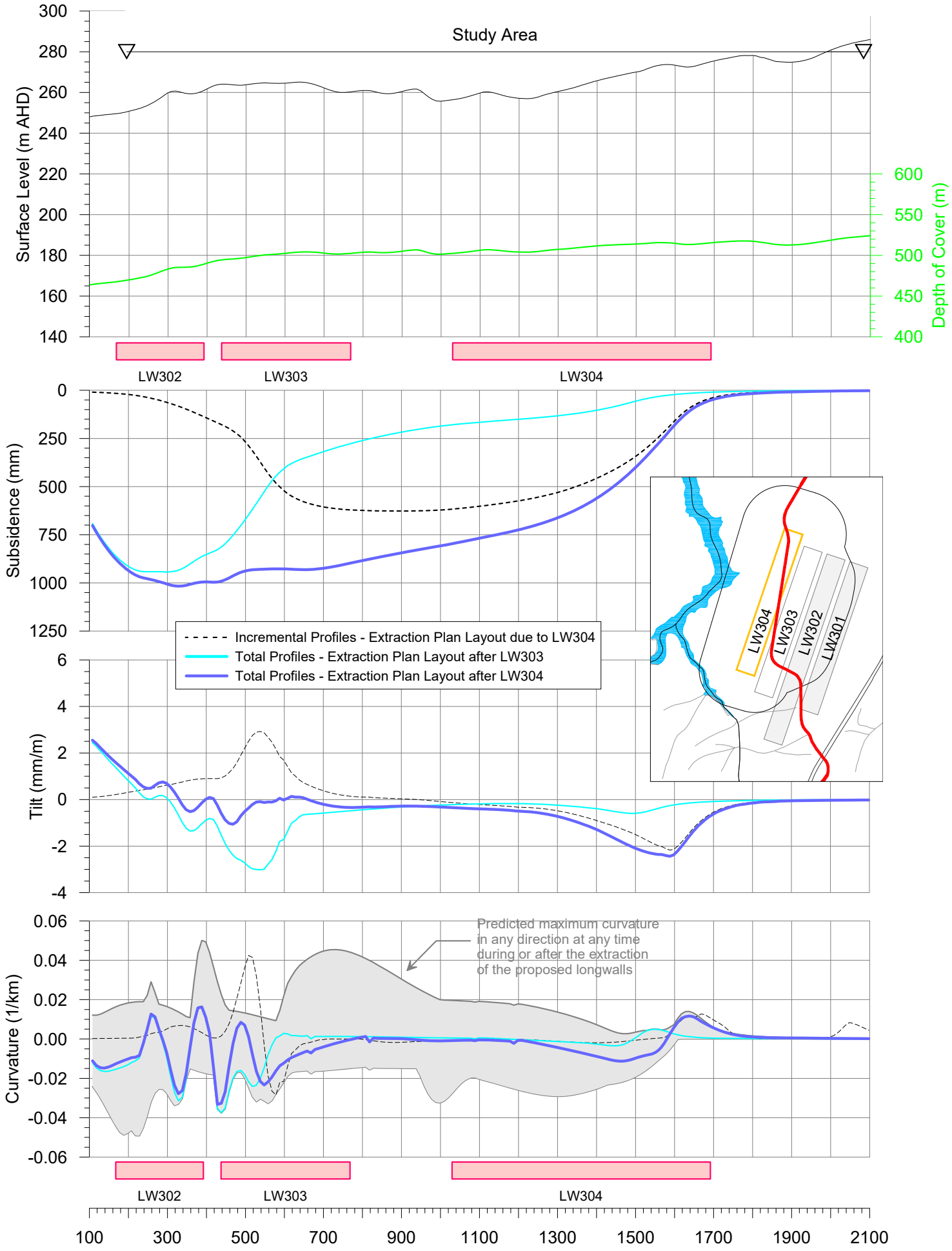
Grid to MGA co-ordinates

STUDY AREA
PREDICTED 20mm SUBSIDENCE CONTOUR
LW304
OLD PRINCES HWY
LW303
LW302
LW301

GEOLOGICAL STRUCTURES
FAULTS
DYKES

LEGEND
COUNCIL ASSETS
UNSEALED ROADS & TRACKS

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along the Old Princes Highway due to LW304



msec

Fig. A.01

APPENDIX 3

BUILT FEATURES MANAGEMENT PLAN – SUBSIDENCE IMPACT REGISTER

Built Features Management Plan - Subsidence Impact Register

Impact Register Number[1]	Built Feature[2]	Impact Description	Does Impact Exceed the Built Feature Performance Measure/Indicators? (Yes/No)	Management Measures Implemented	Were Management Measures Effective? (Yes/No)

Notes:

1: Fill out all details in the Assessment Form and record the register number here.

2: Built feature (e.g. road pavement, guard rail, etc.).

Built Feature Management Plan – Subsidence Impact Register
Assessment Form

Date:

Observer (Name and position):

Register Number (i.e. Number 1, 2, etc.):

Longwall Number and Chainage:

Location of Observed Impact:

(Examples: location of culvert, include GPS co-ordinates and a sketch)

Description of Observed Impact:

(Examples: nature and extent of impact - cracks in road etc any relevant information, attach photographs)

Person Notified:	Manager - Technical Services	☐

Description of Photographs:

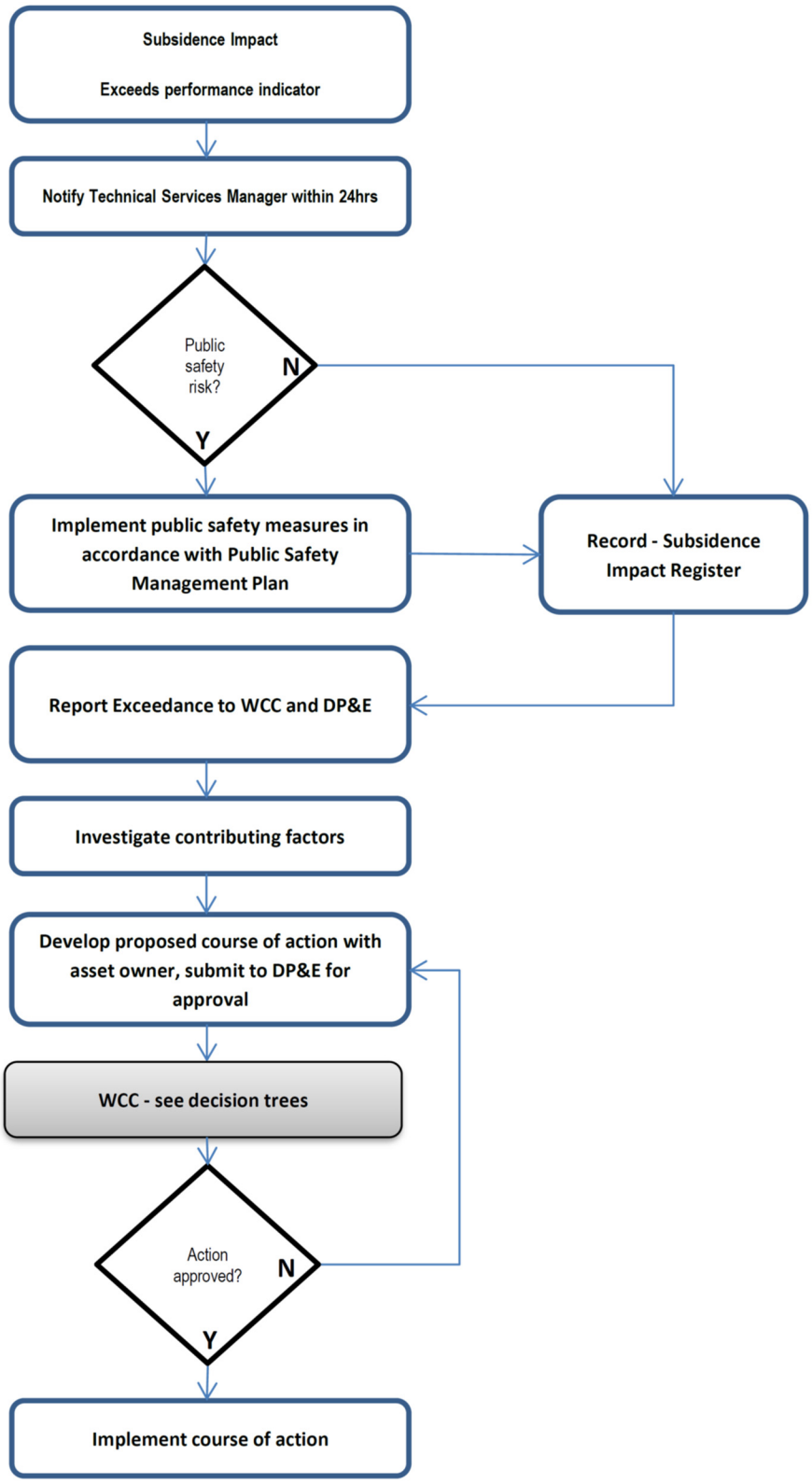
Actions Required:	Contingency Plan Initiated	☐
	Incident Notification	☐
	Safety Measures/Public Safety Management Plan Requirements	☐

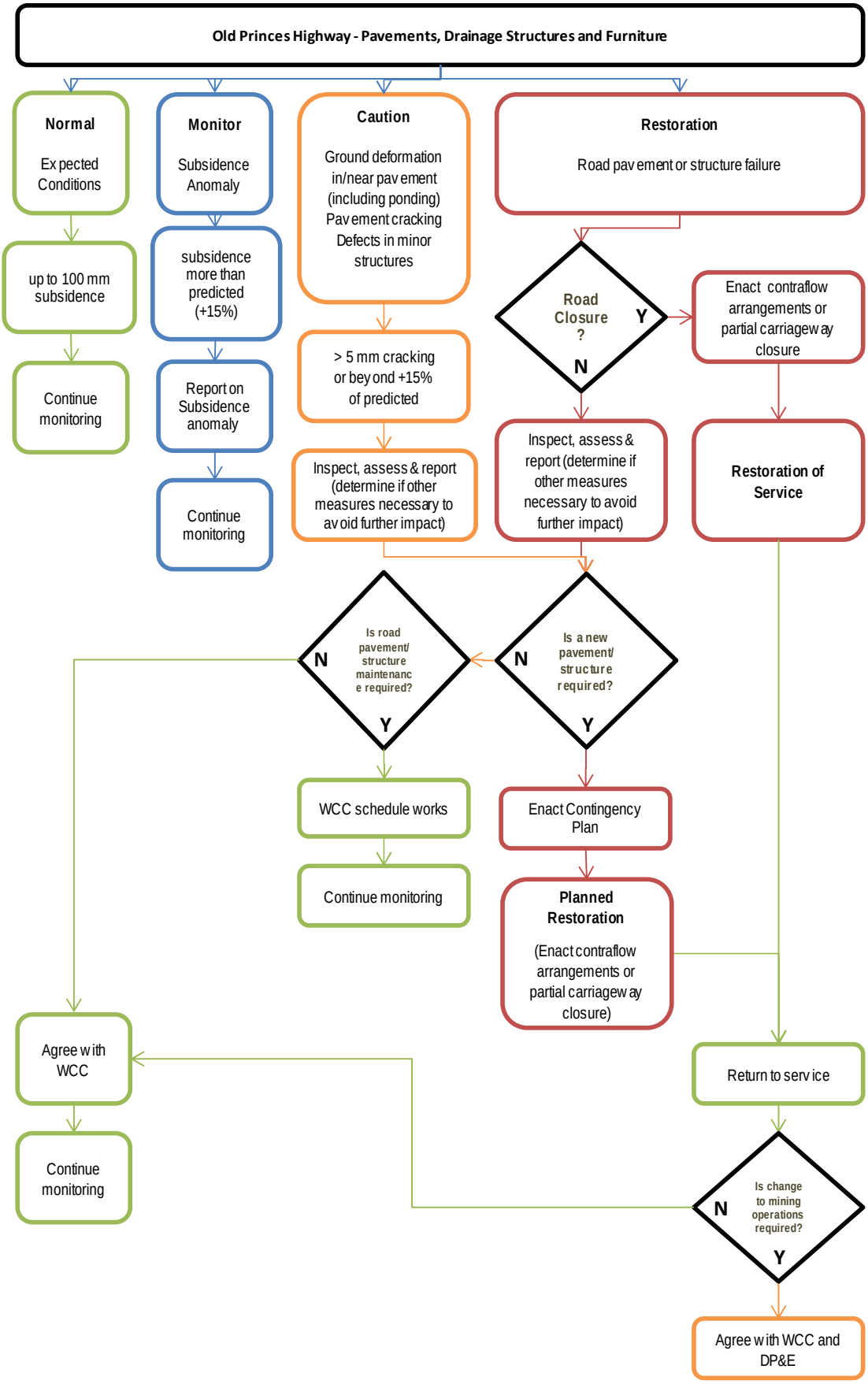
Management or Contingency Measures Implemented:

Effectiveness of Management or Contingency Measures:

APPENDIX 4

CONTINGENCY PLAN PROCEDURE AND DECISION TREE


Subsidence Impact
Exceeds performance indicator
Notify Technical Services Manager within 24hrs
Public safety risk?
N
Y
Implement public safety measures in accordance with Public Safety Management Plan
Record - Subsidence Impact Register
Report Exceedance to WCC and DP&E
Investigate contributing factors
Develop proposed course of action with asset owner, submit to DP&E for approval
WCC - see decision trees
Action approved?
N
Y
Implement course of action


Old Princes Highway - Pavements, Drainage Structures and Furniture
Normal
Expected Conditions
up to 100 mm subsidence
Continue monitoring
Monitor
Subsidence Anomaly
subsidence more than predicted (+15%)
Report on Subsidence anomaly
Continue monitoring
Caution
Ground deformation in/near pavement (including ponding) Pavement cracking Defects in minor structures
> 5 mm cracking or beyond +15% of predicted
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration
Road pavement or structure failure
Road Closure ?
Y
N
Enact contraflow arrangements or partial carriageway closure
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration of Service
Is road pavement/ structure maintenance required?
N
Y
Is a new pavement/ structure required?
N
Y
WCC schedule works
Continue monitoring
Enact Contingency Plan
Planned Restoration
(Enact contraflow arrangements or partial carriageway closure)
Agree with WCC
Continue monitoring
Return to service
Is change to mining operations required?
N
Y
Agree with WCC and DP&E

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BUILT FEATURES MANAGEMENT PLAN
WATERFALL GENERAL [GARRAWARRA] CEMETERY

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&E Approval Date
All	LW301-303 BFMP_CEM-R01-A	Original – Draft for Consultation	Wollongong City Council, DRG and DP&E	-
Tables 3 & 5, Figure 4	LW301-303 BFMP_CEM-R01-B	Revised – Incorporating updates	Wollongong City Council, DRG and DP&E	11 May 2017*
Tables 2, 3, 5 & 6 and Appendix 3	LW301-303 BFMP_CEM-R01-C	Revised – Addressing DP&E and DRG requirements	Wollongong City Council, DRG and DP&E	-
All	LW301-303 BFMP_CEM-R01-D	Minor amendments. Revised TARP format and inclusion of LW303 in monitoring program	Wollongong City Council and DRG	-
Table 4 and Section 9.1.1	LW301-303 BFMP_CEM-R01-E	Minor amendments to address Wollongong City Council comments	Wollongong City Council	8 November 2018#
All	BFMP_CEM-R01-F	Inclusion of Longwall 304 into BFMP	Wollongong City Council	-

* The approval allows for the extraction of Longwalls 301 and 302 only.

Approval for the extraction of Longwall 303.

April 2019

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Appendix 2 MSEC (2019) Metropolitan Colliery – Proposed Longwall 304 – Subsidence Predictions and Impact Assessments for the Waterfall General [Garrawarra] Cemetery – Wollongong City Council

Appendix 3 Built Features Management Plan – Subsidence Impact Register

Appendix 4 Contingency Plan Procedure and Decision Tree

1 INTRODUCTION

Metropolitan Coal is a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under section 75J of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com).

The Project comprises the continuation, upgrade and extension of underground coal mining operations (Longwalls 20-27 and Longwalls 301-317) and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1. Following the completion of Longwall 27 in 2017, Longwalls 301, 302, 303 and 304 define the next mining sub-domains within the Project underground mining area (Figures 1 to 3).

1.1 PURPOSE AND SCOPE

In accordance with Condition 6(f), Schedule 3 of the Project Approval, this Built Features Management Plan – Cemetery (BFMP-CEM) has been developed to manage the potential consequences of longwall extraction on the Waterfall General [Garrawarra] Cemetery.

The relationship of this BFMP-CEM to the Metropolitan Coal Environmental Management Structure is shown on Figure 4.

In accordance with Condition 6 of Schedule 3, the suitably qualified and experienced experts that have prepared this BFMP-CEM, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and Metropolitan Coal were endorsed by the Secretary of the NSW Department of Planning and Environment (DP&E). This BFMP-CEM has been prepared in consultation with Wollongong City Council.

1.2 STRUCTURE OF THE BFMP-CEM

The remainder of the BFMP-CEM is structured as follows:

Section 2: Describes the review and update of the BFMP-CEM.

Section 3: Outlines the statutory requirements applicable to the Plan.

Section 4: Provides a revised assessment of the potential subsidence impacts and environmental consequences for Longwalls 301-304.

Section 5: Details the performance measures and indicators that will be used to assess the Project.

Section 6: Provides the detailed baseline data.

Section 7: Describes the monitoring program.

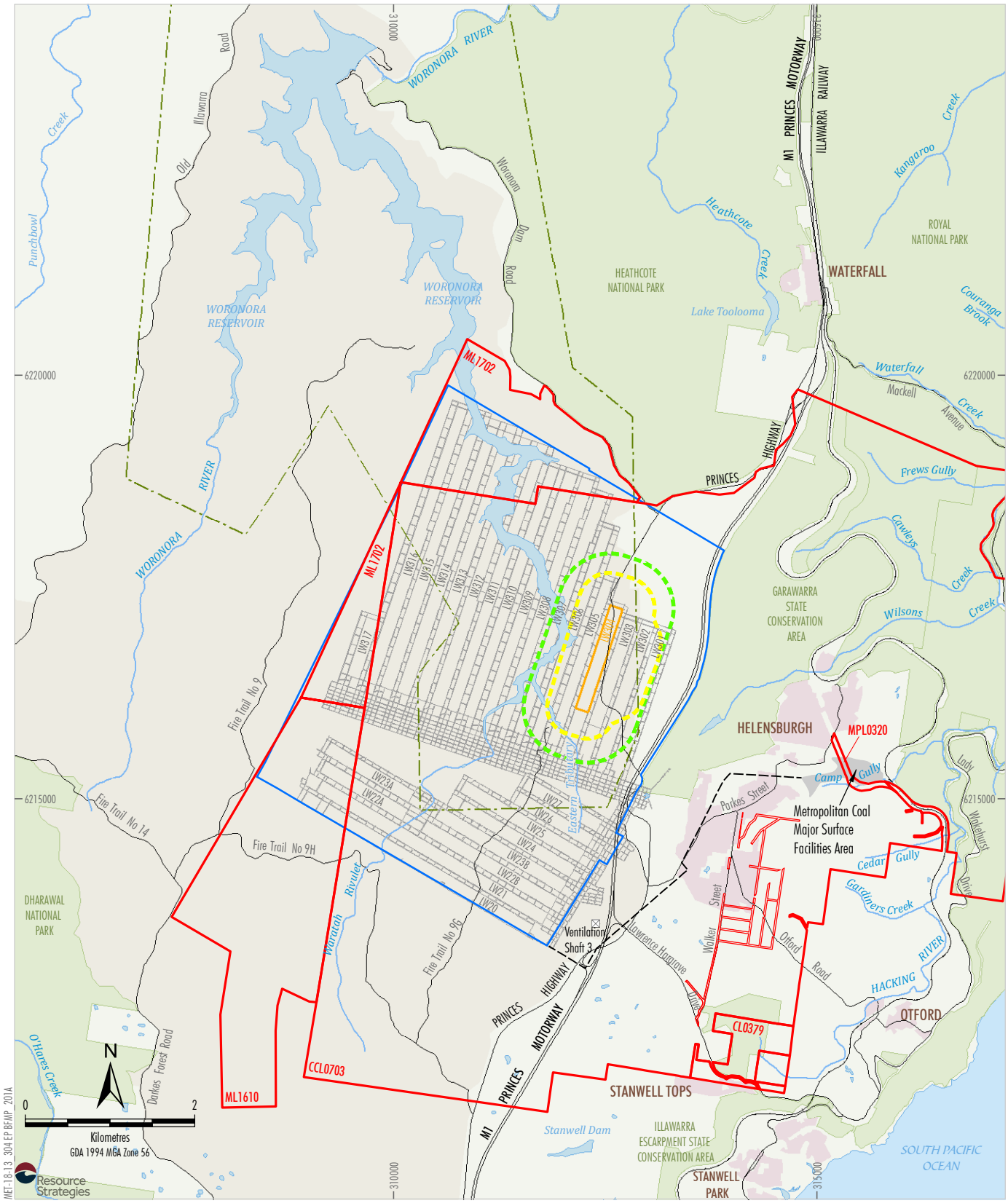
Section 8: Describes the management measures that will be implemented.

Section 9: Provides a contingency plan to manage any unpredicted impacts and their consequences.

Section 10: Describes the Trigger Action Response Plan (TARP) management tool.

Section 11: Describes the program to collect sufficient baseline data for future Extraction Plans.

Section 12: Describes the annual review and improvement of environmental performance.



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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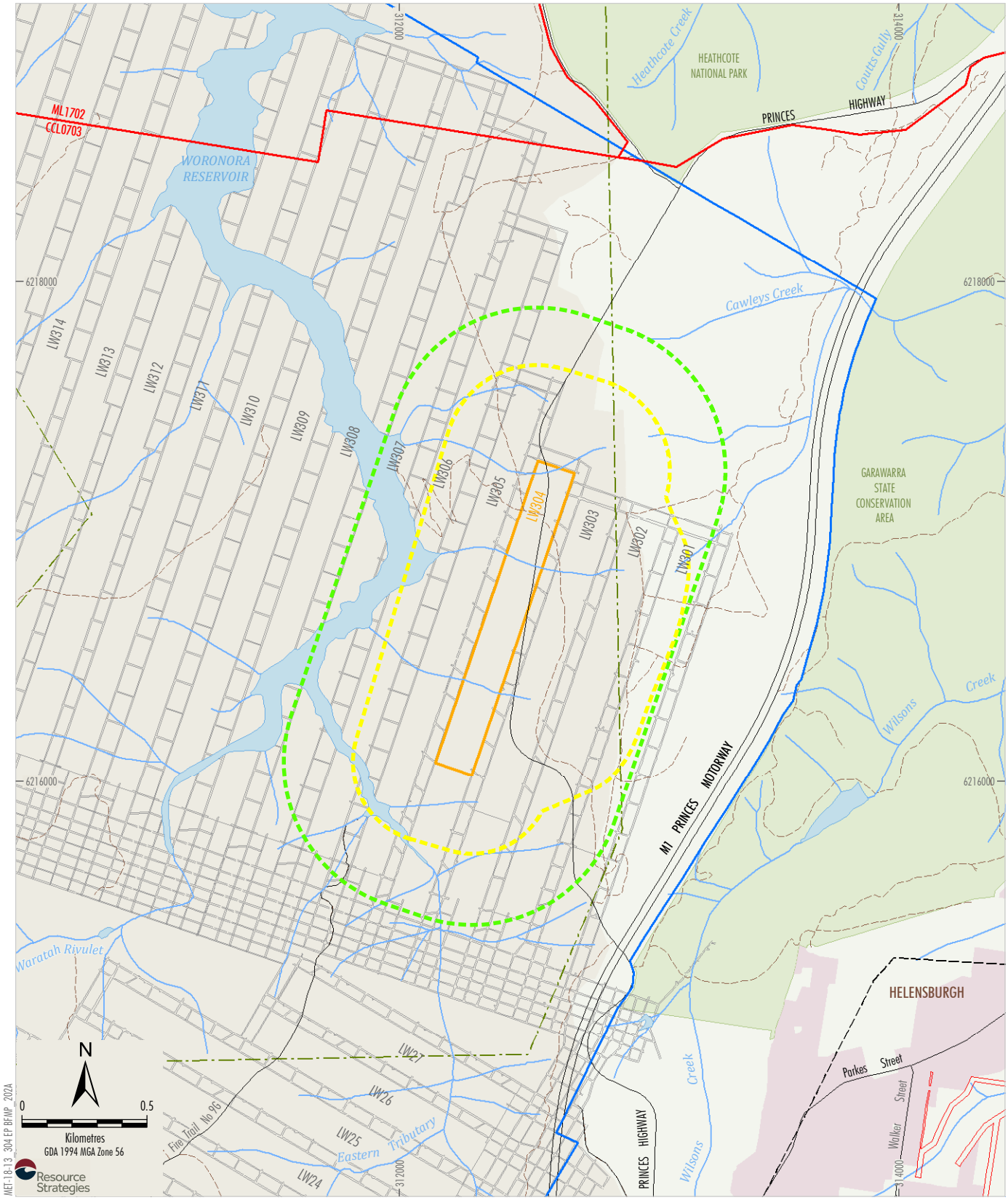
Longwalls 20-27 and Longwalls 301-317 Layout

Figure 1



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)
- Vehicular Track

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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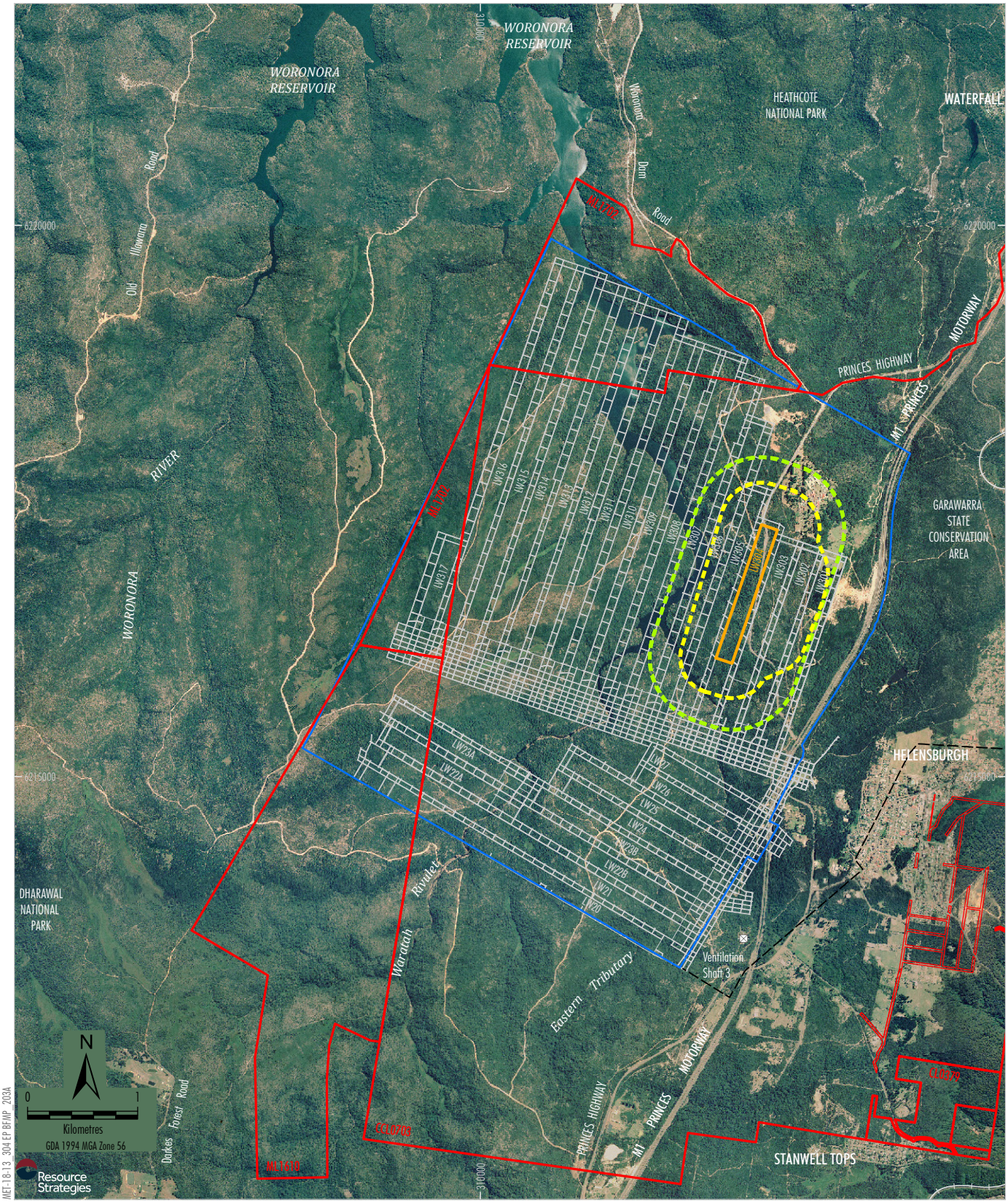
Longwalls 301-304 Layout

Figure 2



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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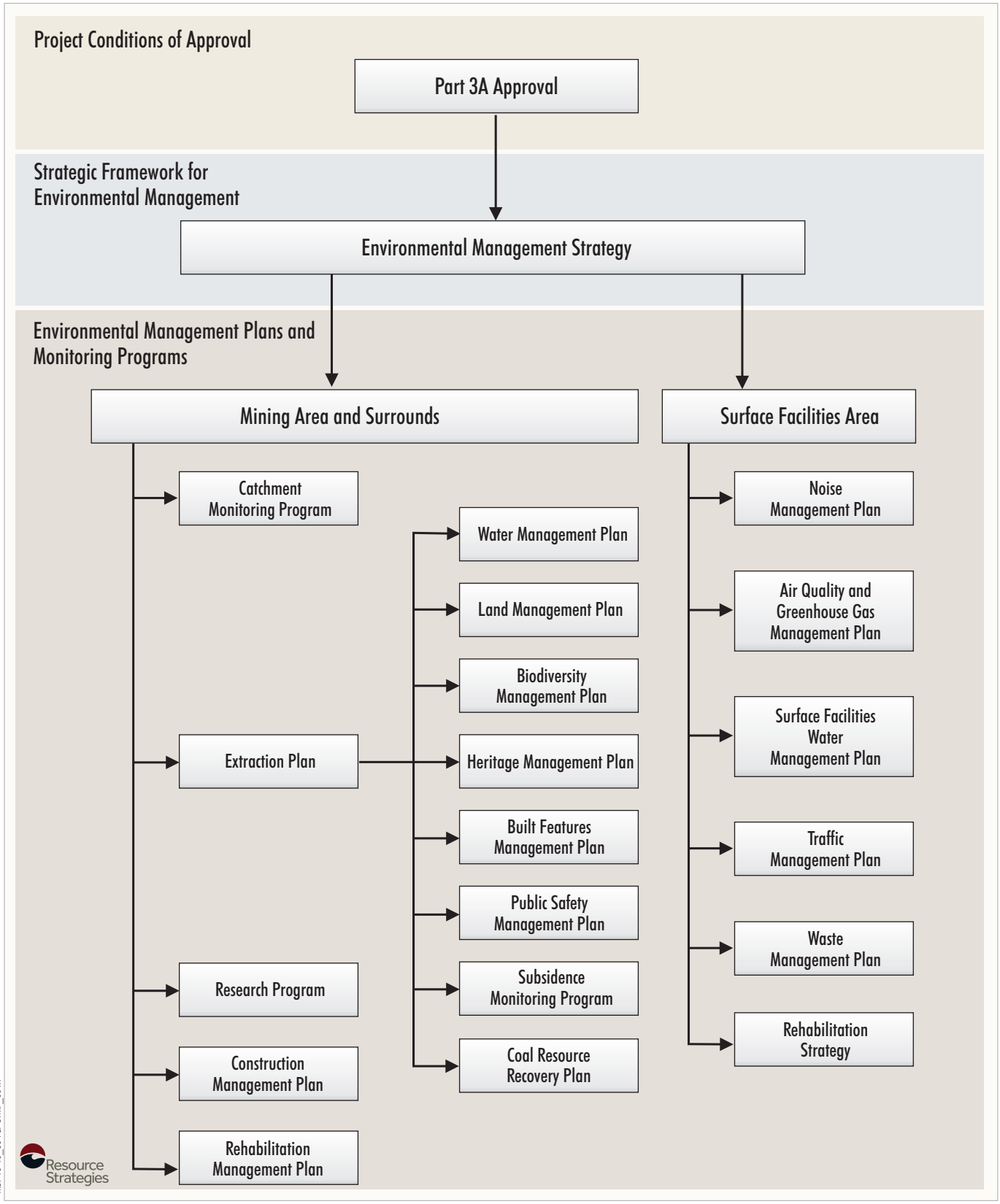
Longwalls 20-27 and Longwalls 301-317 Layout - Aerial Photograph

Figure 3



MET-18-13_304 EP BHMP_001A

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Environmental Management Structure

Figure 4

Section 13: Outlines the management and reporting of incidents.

Section 14: Outlines the management and reporting of complaints.

Section 15: Outlines the management and reporting of non-compliances with statutory requirements.

Section 16: Lists the references cited in this BFMP-CEM.

2 BFMP-CEM REVIEW AND UPDATE

In accordance with Condition 4, Schedule 7 of the Project Approval, this BFMP-CEM will be reviewed within three months of the submission of:

- an audit under Condition 8 of Schedule 7;
- an incident report under Condition 6 of Schedule 7;
- an annual review under Condition 3 of Schedule 7; and

if necessary, revised to the satisfaction of the Director-General (now Secretary) of DP&E, to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

This BFMP will also be reviewed within three months of approval of any Project modification and if necessary, revised to the satisfaction of the DP&E.

The revision status of this plan is indicated on the title page of each copy of the BFMP-CEM. The distribution register for controlled copies of the BFMP-CEM is described in Section 2.1.

Revisions to any documents listed within this BFMP-CEM will not necessarily constitute a revision of this document.

2.1 DISTRIBUTION REGISTER

In accordance with Condition 10, Schedule 7 'Access to Information', Metropolitan Coal will make the BFMP-CEM publicly available on the Peabody website. A hard copy of the BFMP-CEM will also be maintained at the Metropolitan Coal site.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format. An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom the Metropolitan Coal plans and programs, such as the BFMP-CEM, will be distributed;
- the format (i.e. electronic or hard copy) of distribution; and
- the format of revision notification.

Metropolitan Coal will make the Distribution Register publicly available on the Peabody website.

Metropolitan Coal will be responsible for maintaining the Distribution Register and for ensuring that the notification of revisions is sent by email or post as appropriate.

In addition, Metropolitan Coal employees with local computer network access will be able to view the controlled electronic version of this BFMP-CEM on the Metropolitan Coal local area network. Metropolitan Coal will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on Metropolitan Coal's computer system and the Peabody website.

3 STATUTORY REQUIREMENTS

Metropolitan Coal's statutory obligations are contained in:

(i) the conditions of the Project Approval;

(ii) relevant licences and permits, including conditions attached to mining leases; and

(iii) other relevant legislation.

These are described below.

3.1 EP&A ACT APPROVAL

Condition 6(f), Schedule 3 of the Project Approval requires the preparation of a BFMP as a component of Extraction Plan(s) for second workings. Project Approval Condition 6(f), Schedule 3 states:

> ***SECOND WORKINGS***
>
> ***Extraction Plan***
>
> *6. The Proponent shall prepare and implement an Extraction Plan for all second workings in the mining area to the satisfaction of the Director-General. This plan must:*
>
> *…*
>
> *(f) include a:*
>
> *…*
>
> - *Built Features Management Plan, which has been prepared in consultation with the owner of the relevant feature, to manage the potential environmental consequences of the Extraction Plan on any built features;*
>
> *…*

In addition, Condition 2, Schedule 7 and Condition 7, Schedule 3 of the Project Approval outline management plan requirements that are applicable to the preparation of the BFMP-CEM. Table 1 indicates where each component of the conditions is addressed within this BFMP-CEM.

Table 1
Management Plan Requirements

Project Approval Condition	BFMP-CEM Section
Condition 2 of Schedule 7	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Section 6
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 3
• any relevant limits or performance measures/criteria;	Section 5
• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 5
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Sections 7, 8, 9 and 10
d) a program to monitor and report on the:	Sections 7, 8 and 12
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 9 and Appendix 4
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Sections 7 and 12
g) a protocol for managing and reporting any;	
• incidents;	Section 13
• complaints;	Section 14
• non-compliances with statutory requirements; and	Section 15
• exceedances of the impact assessment criteria and/or performance criteria; and	Section 9 and Appendix 4
h) a protocol for periodic review of the plan.	Section 2
Condition 7 of Schedule 3	
7. In addition to the standard requirements for management plans (see condition 2 of schedule 7), the Proponent shall ensure that the management plans required under condition 6(f) above include:	
a) a program to collect sufficient baseline data for future Extraction Plans;	Section 11
b) a revised assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval;	Section 4
c) a detailed description of the measures that would be implemented to remediate predicted impacts; and	Section 8
d) a contingency plan that expressly provides for adaptive management.	Section 9 and Appendix 4

3.2 LICENCES, PERMITS AND LEASES

In addition to the Project Approval, all activities at or in association with Metropolitan Coal will be undertaken in accordance with the following licences, permits and leases which have been issued or are pending issue:

- The conditions of mining leases issued by the NSW Division of Resources and Geoscience under the NSW Mining Act, 1992 (e.g. Consolidated Coal Lease [CCL] 703, Mining Lease [ML] 1610, ML 1702, Coal Lease [CL] 379 and Mining Purpose Lease [MPL] 320).

- The Metropolitan Coal Mining Operations Plan 1 October 2012 to 30 September 2019 approved by the DRG.
- The conditions of Environment Protection Licence (EPL) No. 767 issued by the NSW Environment Protection Authority (EPA) under the NSW *Protection of the Environment Operations Act, 1997*. Revision of the EPL will be required prior to the commencement of Metropolitan Coal activities that differ from those currently licensed.
- The prescribed conditions of specific surface access leases within CCL 703 for the installation of surface facilities as required.
- Water Access Licences (WALs) issued by the NSW Department of Primary Industries – Water (DPI Water) (now the Department of Industry –Water) under the NSW *Water Management Act, 2000*, including WAL 36475 under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* and WAL 25410 under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*.
- Mining and workplace health and safety related approvals granted by the NSW Resources Regulator and WorkCover NSW.
- Supplementary approvals obtained from WaterNSW for surface activities within the Woronora Special Area (e.g. fire road maintenance activities).

3.3 OTHER LEGISLATION

Metropolitan Coal will conduct the Project consistent with the Project Approval and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to the conduct of the Project (Helensburgh Coal Pty Ltd [HCPL], 2008)[1]:

- *Biodiversity Conservation Act, 2016;*
- *Biosecurity Act, 2015;*
- *Contaminated Land Management Act, 1997;*
- *Crown Land Management Act, 2016;*
- *Dams Safety Act, 2015;*
- *Dangerous Goods (Road and Rail Transport) Act, 2008;*
- *Energy and Utilities Administration Act, 1987;*
- *Fisheries Management Act, 1994;*
- *Mining Act, 1992;*
- *Protection of the Environment Operations Act, 1997;*
- *Rail Safety (Adoption of National Law) Act, 2012;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Water NSW Act, 2014;*

[1] The list of potentially applicable Acts has been updated to reflect changes to the Acts that were in force at the time of submission of the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008).

- *Work Health and Safety Act, 2011; and*
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

Relevant licences or approvals required under these Acts will be obtained as required.

4 REVISED ASSESSMENT OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

4.1 EXTRACTION LAYOUT

Longwalls 301-304 and the area of land within 600 metres (m) of Longwall 304 secondary extraction are shown on Figures 2 and 3. Longwall extraction occurs from north to south. The longwall layouts include 163 m panel widths (void) with 45 m pillars (solid).

The provisional extraction schedule for Longwalls 301-304 is provided in Table 2.

Table 2
Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
301	June 2017	6 months	February 2018
302	March 2018	7 months	October 2018
303	November 2018	7 months	May 2019
304	July 2019	6 months	December 2019

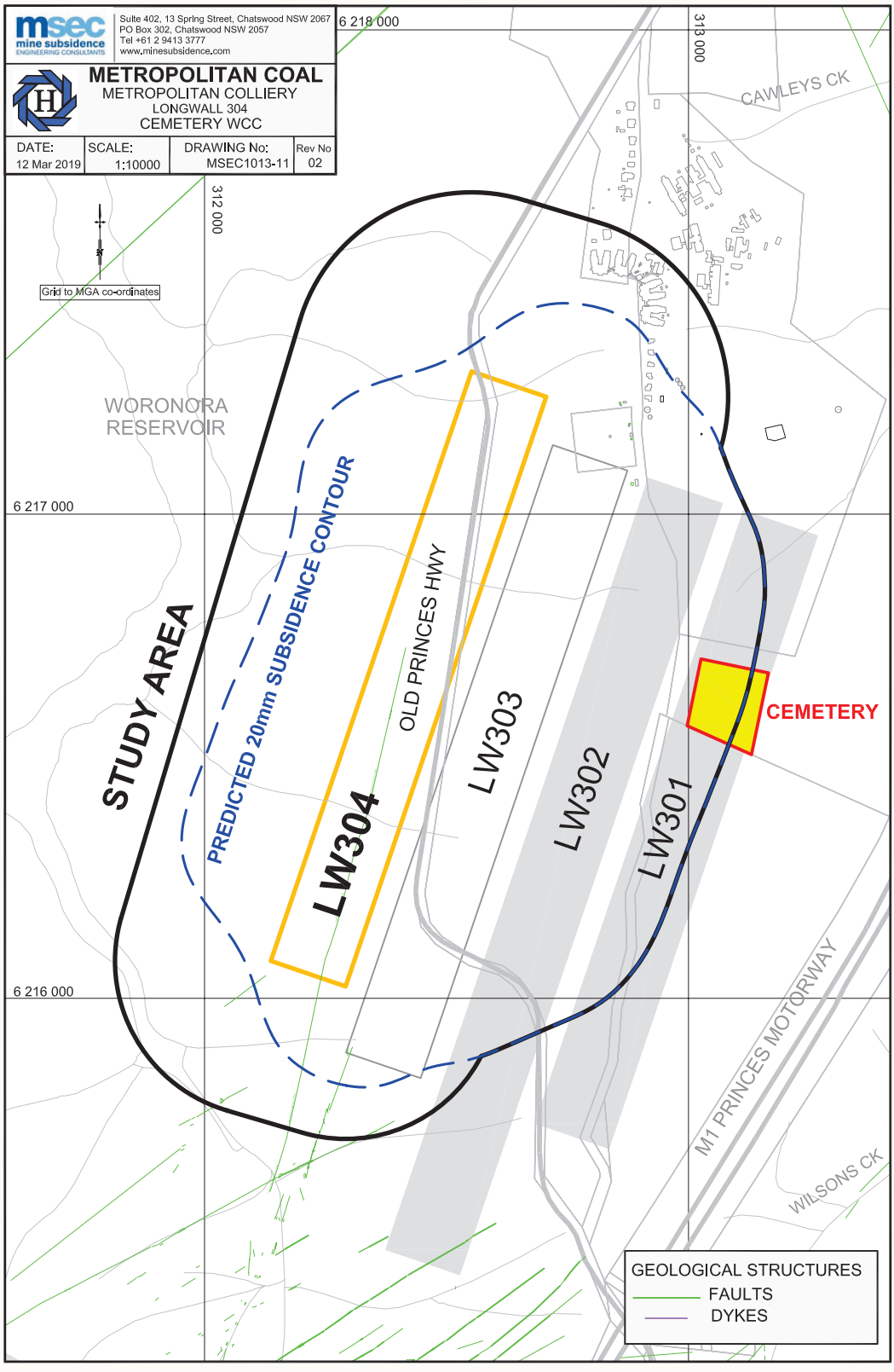
The future Extraction Plans will consider the cumulative subsidence effects, subsidence impacts and/or environmental consequences. Note that the total cumulative predicted subsidence effects, subsidence impacts and/or environmental consequences at the completion of the Project are considered in the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008) and the Preferred Project Report (HCPL, 2009).

4.1.1 Waterfall General [Garrawarra] Cemetery

The Waterfall General [Garrawarra] Cemetery, also referred as the Garrawarra Hospital Cemetery or Waterfall Cemetery, is currently listed as an item of local significance under the *Wollongong Local Environmental Plan, 2009* (item 61028). The location of the Waterfall Cemetery is shown on Figure 5.

The Subsidence Assessment prepared by MSEC in 2008 (Appendix A to the Metropolitan Coal Project EA) included an assessment of impacts on the Waterfall Cemetery, and noted that:

> *It is unlikely that existing headstones or fencing, if any, would be affected by the predicted maximum tilt of 5.3 mm/m.*
>
> *It is possible that some minor cracking of the surface soils in the cemetery could occur as a result of the extraction of the proposed Longwalls 20 to 44, but it is unlikely that surface cracks in the soil would exceed 20 mm in width... If these cracks eventuate they can be identified by regular survey inspections and surface cracking can be readily overcome by infilling with soil or other suitable materials, or by locally regrading and compacting the surface.*



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Source: MSEC (2019)

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Waterfall General (Garrawarra) Cemetery

Figure 5

The Waterfall Cemetery site is under the management of the Wollongong City Council. A photographic index of identifiable graves was produced by the Wollongong City Council in September 2013 (Wollongong City Council, 2013). A Conservation Management Plan was developed and endorsed by the Wollongong City Council on 14 July 2014.

A draft Planning Proposal was also exhibited from 24 August 2015 to 11 September 2015 to amend the property description and expand the conservation area boundary of Garrawarra Hospital Heritage Conservation Area (item 61028) to include the Waterfall General [Garrawarra] Cemetery.

4.2 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

4.2.1 Revised Subsidence Predictions

Subsidence predictions for Longwalls 20-44 in relation to the Waterfall Cemetery was conducted by MSEC (2008) as part of the Metropolitan Coal Project EA. MSEC (2008) includes a table summarising the incremental systematic subsidence parameters for the extraction of each longwall from Longwalls 20-44. These include:

- maximum predicted incremental subsidence (vertical movement);
- maximum predicted incremental tilt along alignment;
- maximum predicted incremental tilt across alignment;
- maximum predicted incremental tensile strain; and
- maximum predicted incremental compressive strain.

Revised subsidence and impact predictions for the extraction of Longwalls 301-303 and Longwall 304 on the Waterfall Cemetery were conducted by MSEC and reported in MSEC (2016) and MSEC (2019) (Appendices 1 and 2), respectively.

In relation to subsidence predictions for Longwalls 301-303, MSEC (2016) make the following conclusions:

- The Waterfall Cemetery site is located directly above Longwall 301 in an area of relatively flat topography at a topographical high point.
- The maximum predicted incremental subsidence (600 mm) for the Waterfall Cemetery site however occurs due to the extraction of Longwall 302.
- The maximum predicted total subsidence for the Waterfall Cemetery site resulting from the extraction of Longwalls 301-303 is 800 mm.
- The maximum predicted conventional tilt for the Waterfall Cemetery site is 5.0 mm/m, which is a very small change in grade (i.e. 0.5%) and therefore is unlikely to result in adverse impacts on any features including headstones or fencing.
- The maximum predicted curvatures and the range of potential strains for the Waterfall Cemetery site are similar to those typically experienced elsewhere in the Southern Coalfield directly above extracted longwalls.
- It is possible that some minor cracking of the surface soils or exposed bedrock in the Waterfall Cemetery could occur as a result of the extraction of Longwalls 301-303, however identification may be difficult given the overgrown nature of the site (refer Section 6).
- If minor surface cracks eventuate, and can be identified, they can be readily repaired by infilling with soil or other suitable materials.

In relation to subsidence predictions for Longwall 304, MSEC (2019) make the following conclusions:

- A portion of the Waterfall Cemetery site is located within the Longwall 304 study area.
- The maximum predicted total subsidence for the Waterfall Cemetery site is 800 mm following the extraction of Longwall 304.
- The maximum predicted conventional tilt for the Waterfall Cemetery site is 5.0 mm/m, which is a very small change in grade (i.e. 0.5%) and therefore is unlikely to result in adverse impacts on any features including headstones or fencing.
- The maximum predicted curvatures and the range of potential strains for the Waterfall Cemetery site are similar to those typically experienced elsewhere in the Southern Coalfield.
- It is possible that some minor cracking of the surface soils or exposed bedrock in the Waterfall Cemetery could occur as a result of the extraction of Longwall 304.
- The likelihood of impact to the cemetery due to the extraction of Longwall 304 is considered to be low.

4.2.2 Risk Assessment Meeting

In accordance with the *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) a risk assessment meeting was held on 15 August 2016. Attendees at the risk assessment meeting included representatives from Metropolitan Coal, Wollongong City Council, MSEC, Resource Strategies and Axys Consulting (risk assessment facilitator).

The investigation and analysis methods used during the risk assessment included:

- identification of the asset managed by Wollongong City Council (i.e. Waterfall General [Garrawarra] Cemetery), including recognition of the Conservation Management Plan and draft Planning Proposal for the site;
- review of the revised subsidence predictions and potential impacts on Wollongong City Council assets (including consideration of past experience in the Southern Coalfield); and
- development of a preliminary monitoring plan.

A number of risk control measures and procedures were identified during the risk assessment which considered the extraction of coal beneath the Waterfall Cemetery, and are summarised as follows:

Baseline Data / Validation

1. Prepare a pre-mining audit of all marked grave sites to document a baseline of the condition of each grave site. The pre-mining audit to include photographs and commentary.

Management / Monitoring / Response Measures

2. Establish a key contacts list between Peabody and Wollongong City Council to provide a regular update of status of mining activities, and for consultation if any repair works were required to be carried out (refer Point 4 below).
3. Prepare a post mining audit of all marked grave sites to report on any changes or impacts to the graves sites from the mining of Longwalls 301 to 303.

Contingency Planning

4. Develop a rectification plan/protocol to describe how potentially affected grave sites can be repaired and returned to the pre-audit report condition taking into account the Wollongong City Council endorsed Conservation Management Plan.
5. Establish mechanisms to address a possible change in the classification of the cemetery from current local listing to a state listed heritage site.

Metropolitan Coal considers all risk control measures and procedures to be feasible to manage all identified risks.

The proposed risk control measures and procedures have been incorporated where relevant in this BFMP and the program for implementation is summarised in Table 3.

Table 3
Program for Implementation of Proposed Risk Control Measures and Procedures

Risk Control Measure / Procedure		BFMP Section	Timing
Baseline Data / Validation			
1	Pre-mining audit of all marked grave sites	Section 6.1	Complete
Management / Monitoring / Response Measures			
2	Establish key contacts list in the BFMP	Section 6.3	Complete
3	Prepare a post mining audit of all marked grave sites	Section 7.2.1	Post LW301-LW303
Contingency Planning			
4	Develop a rectification plan/protocol	Section 9.1	Complete
5	Establish mechanisms for possible changes to the heritage listing classification	Section 9.2	Complete

The risk control measures and procedures identified during the risk assessment for Longwalls 301-303 will be implemented for the extraction of Longwall 304.

5 PERFORMANCE MEASURES AND INDICATORS

The Project Approval requires Metropolitan Coal not to exceed the subsidence impact performance measures outlined in Table 1 of Condition 1, Schedule 3. The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

> *Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.*

The performance indicators proposed to ensure that the above performance measure is achieved include:

- no defects to the structural integrity of headstones or fencing (beyond the baseline [pre-mining] conditions – refer Section 6); and
- the land in general is expected to experience minor cracking consistent with that observed during the extraction of previous longwalls at Metropolitan Coal (i.e. no more than minor cracking).

Section 7 of this BFMP-CEM describes the monitoring that will be conducted to assess the Project against the above performance measure. Section 9 of this BFMP-CEM provides a Contingency Plan in the event the performance measure is exceeded.

6 BASELINE DATA

The Waterfall Cemetery is understood to have received some 2,000 burials between 1909 and the 1950s. The Waterfall Cemetery was closed when the Waterfall State Sanatorium was closed in 1957 (which is now the Garrawarra Centre Complex). In 1967, the Wollongong City Council was handed responsibility to manage the Waterfall Cemetery site.

The Waterfall Cemetery site is described in the *Conservation Plan for the Garrawarra Centre for Aged Care* (Howard Tanner & Associates, 1993) as:

> *"Mounds in ground, some broken pieces of marble. Overgrown with Eucalyptus haemastoma, ...and other indigenous vegetation. ...*
>
> [Condition is] *poor – little remains to identify this area as the Cemetery"*

A summary of the notes reported following an inspection of the Waterfall Cemetery site by the Wollongong City Council in March 2012 and referred in the minutes of the Wollongong City Council ordinary meeting held on 27 August 2012 is provided below:

- Little maintenance has occurred at the site since hand over to Wollongong City Council in 1967.
- Surrounding bush has encroached onto the site making it unrecognisable as a cemetery.
- Many graves were damaged by overgrown vegetation, vandalism and grave subsidence.
- Bushfires are believed to have resulted in the loss of much of the evidence of the cemetery including timber grave markers.
- More than 40 graves were identifiable during the inspection[2].
- Evidence of fencing, roadways and entry gates remain.

6.1 STATE OF ASSET BEFORE MINING

A pre-mining audit (including photographic record and commentary) was completed by Metropolitan Coal to establish the state of the Wollongong City Council asset prior to commencement of Longwall 301. A pre-mining inspection was also conducted prior to the commencement of Longwall 301 by the University of Queensland Culture and Heritage unit.[3]

6.2 KEY CONTACTS LIST

The list of key contacts for Peabody and Wollongong City Council during the development and implementation of this BFMP are provided in Table 4.

[2] A subsequent photographic index of identifiable graves was published in September 2013 (Wollongong City Council, 2013).

[3] Pre-mining audit at Waterfall General (Garrawarra) Cemetery near Helensburgh, NSW. Report 3095-001

Table 4
List of Key Contacts

Company	Position	Contact
Peabody (Metropolitan Coal)	Jon Degotardi Manager – Technical Services	Metropolitan Coal 24 hr Control Room 02 4294 7333
Wollongong City Council	Jenny Towers Commercial Business Manager	Wollongong City Council 24 hr 02 4227 7111
Wollongong City Council	Joel Thompson Coordinator Heritage	

7 MONITORING

A monitoring program has been implemented to monitor the impacts of the Project on the Waterfall Cemetery as determined in consultation with Wollongong City Council.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts for comparison with baseline photographic records.

Wollongong City Council or their delegates may conduct visual inspections. Metropolitan Coal will be notified of the timing of inspections and accompany Wollongong City Council or delegates if considered necessary. All personnel will complete necessary inductions or orientation relevant to the tasks required.

Table 5 summarises the BFMP-CEM monitoring components.

The frequency of monitoring will be further reviewed either:

- in accordance with the Annual Review outlined in Section 12; or
- if triggered as a component of the Contingency Plan as outlined in Section 9 of this BFMP-CEM.

7.1 SUBSIDENCE PARAMETERS

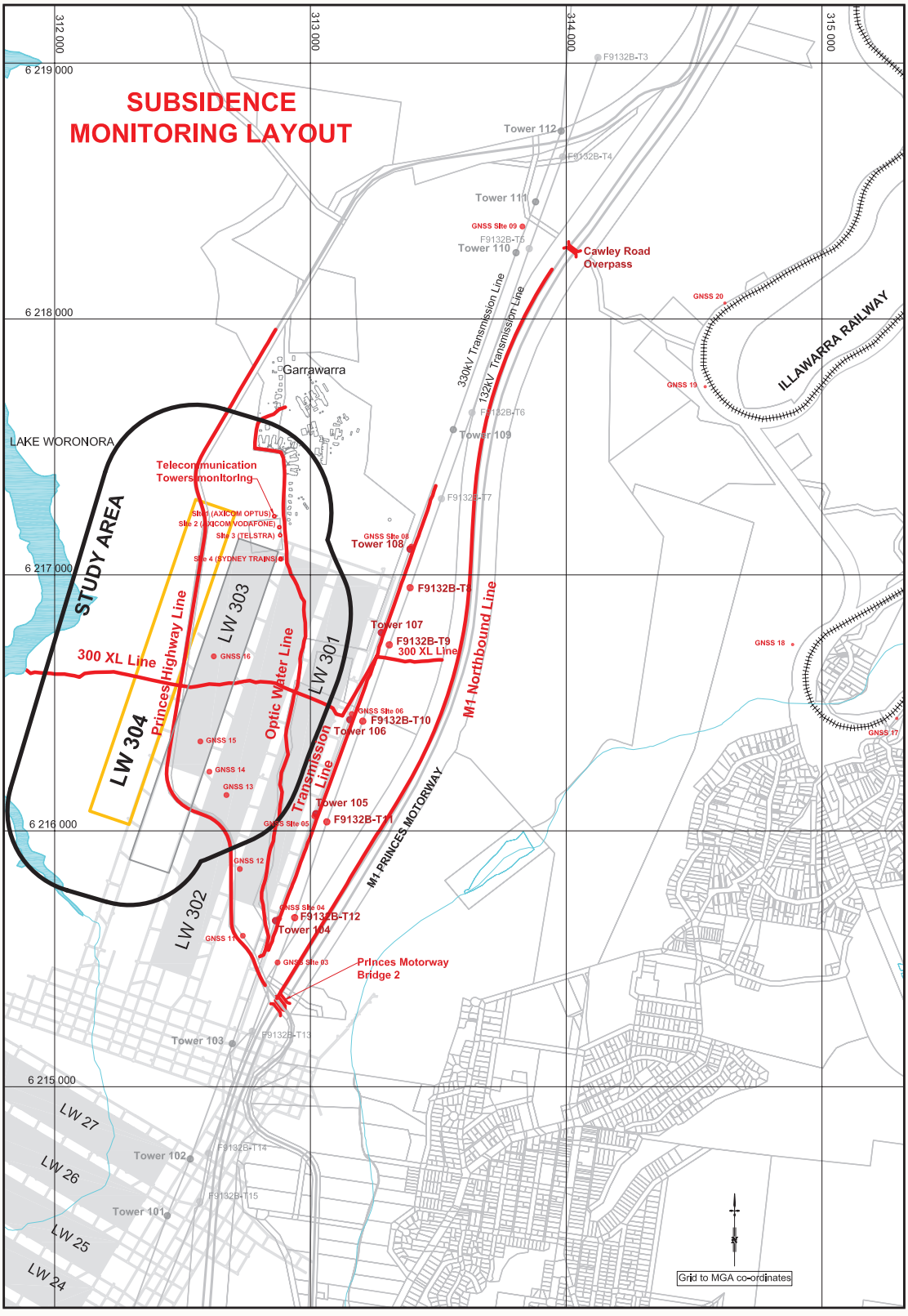
Subsidence parameters (i.e. subsidence, tilt, tensile strain, compressive strain, absolute horizontal translation, and differential leg movement) associated with mining will be measured in accordance with the Longwall 304 Subsidence Monitoring Program (Figure 6).

In summary, surveys will be conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence movements (i.e. subsidence, tilt, tensile strain and compressive strain) will be measured along subsidence lines that have been positioned across the general landscape.

Monitoring of subsidence parameters specific to the Waterfall Cemetery include the survey lines along the adjacent transmission line corridor and the 300 XL subsidence monitoring line (Figure 6). The surveys will monitor the general movement about the longwalls and the data will allow evaluation of the likely ground movements about the site (by comparison between measured and predicted movements).

Table 5
BFMP-CEM Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Baseline	Waterfall Cemetery site	Survey	Adjacent subsidence line (300XL & Transmission Line) points at approximately 20 m spacing	Establish base conditions	Prior to Longwall 301 extraction	Completed
		Condition Report (Pre-Mining Audit)		Establish base condition	Prior to Longwall 301 extraction	Completed
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Establish base condition	Prior to Longwall 301 extraction	Completed
During Mining	Waterfall Cemetery site	Survey (subsidence, tilt, strain)	Adjacent subsidence line (300XL & Transmission Line) points at approximately 20 m spacing	Monitor subsidence effects during mining	At the completion of each longwall	Once per Longwall
		Visual inspection (for evidence of subsidence effects and impacts)		Monitor structural integrity of headstones or fencing and surface cracks, buckling and general safety.	At the completion of each longwall	Once per Longwall
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Monitor for surface cracks, buckling and general safety	At the completion of each longwall	Once per Longwall
					As per Longwall 304 LMP	
Post Mining	Waterfall Cemetery site	Condition Report (Post-Mining Audit)		Determine level of impact of mining (if any)	Within 3 months of the completion of Longwalls 302 and 303. Then 2 calendar years after 303 report.	After LWs 302, 303 and then 2 years post 303 report.
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Determine level of impact of mining (if any)	Within 3 months of the completion Longwalls 302, 303 and 304	Once after LWs 302, 303 and 304



MET-18-13_304 EP BFMP_017A

Source: MSEC (2019)

Peabody

METROPOLITAN COAL

Subsidence Monitoring Layout

Figure 6

7.2 SUBSIDENCE IMPACTS

7.2.1 Waterfall General [Garrawarra] Cemetery

A post mining audit will be conducted following completion of Longwalls 302-303 for comparison with the pre-mining audit records. It is intended that a follow up audit be undertaken two years after the completion of Longwall 303

The information will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 4) and reported in accordance with the Project Approval conditions.

7.2.2 Access Roads/Tracks

Visual inspection of the access roads/tracks occurred prior to the commencement of Longwall 301 and will occur following extraction of Longwalls 304.

Visual observations of access roads/tracks will also be conducted by Metropolitan Coal as part of routine works and inspections within 600 m of Longwalls 301-304 secondary extraction as described in the Metropolitan Coal Longwall 304 Land Management Plan (Longwall 304 LMP).

Specific details that will be noted and/or photographed that are relevant to the Waterfall Cemetery access roads/tracks include:

- the location, approximate dimensions (length, width and depth), and orientation of surface tension cracks;
- the location of the surface tension crack in relation to access road/track to the Waterfall Cemetery;
- whether any actions are required (e.g. implementation of management measures as outlined in the Longwall 304 LMP, initiation of the Contingency Plan as outlined in the Longwall 304 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The date of the observation, details of the observer and the location of longwall extraction will also be documented.

The information obtained will be recorded in the Longwall 304 LMP - Subsidence Impact Register and reported in accordance with the Project Approval conditions.

The information obtained will be used to assess the potential environmental consequences of the subsidence impact (described in the Longwall 304 LMP) and to identify required management measures. Management measures are discussed in the Longwall 304 LMP.

In the event the subsidence impacts are deemed to present a safety hazard (i.e. regardless of the nature or extent of the subsidence impact), actions will be implemented in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan.

7.3 ENVIRONMENTAL CONSEQUENCES

Metropolitan Coal and Wollongong City Council will compare the results of the subsidence impact monitoring against the built features performance indicators and performance measure. In the event the observed subsidence impacts exceed the performance indicators or performance measure, Metropolitan Coal and Wollongong City Council will assess the consequences of the exceedance in accordance with the Contingency Plan described in Section 9.

8 MANAGEMENT MEASURES

A number of potential management measures in relation to the Waterfall Cemetery are considered to be applicable (e.g. if minor surface cracks eventuate, and can be identified, they can be readily repaired by infilling with soil or other suitable materials) and further measures are summarised in the rectification plan/protocol (Section 9.1.1).

Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.

Management measures will be reported in the Annual Review (Section 12).

9 CONTINGENCY PLAN

In the event the subsidence impacts observed exceed the performance measure or indicators detailed in Section 5 of this BFMP, Metropolitan Coal will implement the following Contingency Plan (Appendix 3):

- The observation will be reported to the Manager - Technical Services within 24 hours.
- With the exception of access roads/tracks, the observation will be recorded in the Built Features Management Plan - Subsidence Impact Register (Appendix 3) consistent with the monitoring program described in Section 7 of this BFMP-CEM.
- If relating to an access road/track, the observation will be recorded in the Metropolitan Coal LW304 Land Management Plan – Subsidence Impact Register.
- Metropolitan Coal will report any exceedance of the performance measure or indicators to the DP&E and Wollongong City Council as soon as practicable after Metropolitan Coal becomes aware of the exceedance.
- Metropolitan Coal will assess public safety and where appropriate implement safety measures in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan;
- Metropolitan Coal will conduct an investigation to evaluate the potential contributing factors. The investigation will:
  - include the re-survey of relevant subsidence monitoring lines;
  - compare and critically analyse measured versus predicted subsidence parameters;
  - review measured subsidence parameters against the observed impact; and
  - review the subsidence monitoring program and update the program where appropriate.

- The course of action with respect to the identified impact(s), in consultation with specialists and relevant agencies, will include:
  - a program to review the effectiveness of the contingency measures; and
  - consideration of adaptive management.

  Contingency measures are provided in Section 9.1.
- Metropolitan Coal will submit the proposed course of action to the DP&E for approval.
- Metropolitan Coal will implement the approved course of action to the satisfaction of the DP&E.

In accordance with Condition 6, Schedule 6 of the Project Approval, Metropolitan Coal will provide a suitable offset to compensate for the impact to the satisfaction of the Director-General (now Secretary) of DP&E if either the contingency measures implemented by Metropolitan Coal have failed to remediate the impact or the Director-General (now Secretary) determines that it is not reasonable or feasible to remediate the impact.

Metropolitan Coal will comply with the NSW *Coal Mine Subsidence Compensation Act, 2017* in the event that property damages occur as a result of mining Longwalls 301-304.

9.1 CONTINGENCY MEASURES

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of environmental consequences). The decision tree for the contingency measures are shown in Appendix 3.

A rectification plan/protocol has been developed for the Waterfall General [Garrawarra] Cemetery and is described in Section 9.1.1 below. Possible changes resulting if and when heritage listing of the cemetery was to change from local to state is also detailed below in Section 9.1.2.

9.1.1 Rectification Plan/Protocol

In the event that impacts associated with mining activities are observed at the Waterfall General [Garrawarra] Cemetery (during post-mining audits and subsidence monitoring activities), the following rectification plan/protocol will be implemented:

1. Metropolitan Coal will determine the extent of the impacts to the Waterfall General [Garrawarra] Cemetery, including the nature of the impacts (i.e. cracking of headstones, collapse of grave monuments etc.) and the grave site(s) and/or monument(s) affected.
2. Metropolitan Coal will notify the Wollongong City Council (including the Wollongong Heritage Reference Group if requested by the Wollongong City Council) of the extent and nature of the impacts to the Waterfall General [Garrawarra] Cemetery.
3. Based on the nature and extent of the impacts, Metropolitan Coal (in consultation with a suitably qualified archaeologist) will develop suitable rectification/repair methods for each grave site/monument. In accordance with the *Waterfall General (Garrawarra) Cemetery Conservation Management Plan* (Biosis, 2013) any repairs and/or rectification works will reflect the appearance around the time of active operation of the cemetery (i.e. 1909-1949) where possible.

   The methods proposed may include (but are not limited to) the following:

   - Re-bedding of fallen monuments using porous fill (e.g. light gravel and sand).
   - Re-setting broken portions of gravestone bases (using pinning or epoxy resin adhesive).

- Installation of backing plate (in same material where appropriate) for cracked gravestones or grave monuments.
- Installation of steel fixing pins and epoxy resin adhesive to repair cracked marble headstones and minor cracks in concrete bases/slabs.
- Back filling of any collapsed graves with local ironstone gravel fill (where available).
- Replacement of fallen lettering (e.g. re-hammering by a relevant mason).

4. In the event that impacts to an identified grave site are observed, Metropolitan Coal will (with assistance from the Wollongong City Council and the Wollongong Heritage Reference Group if required) seek to notify and consult with any relatives/descendants in relation to the proposed repair and/or rectification works (as determined in consultation with the Wollongong City Council).
5. In the event impacts are observed at an unidentified grave site, or if the relatives/descendants are unknown, un-contactable or decline to be consulted, the Wollongong City Council will be the relevant party for consultation.
6. Following consultation with the relatives/descendants and Wollongong City Council as described in (4), and prior to the commencement of any repair and/or rectification works, Metropolitan Coal will submit the proposed course of action to the DP&E for approval.
7. Following DP&E approval of the repair and/or rectification works, Metropolitan Coal will engage suitably qualified experts to undertake the works[4].
8. Following completion of the repairs and/or rectification works, Metropolitan Coal will notify the relatives/descendents, Wollongong City Council and the DP&E of the completion of the works.
9. In the event that the damage observed is unable to be repaired and/or restored to a similar condition to that noted in the pre-mining baseline audit, Metropolitan Coal will provide a suitable offset to compensate for the impact to the satisfaction of the Director-General (now Secretary) of DP&E, in accordance with Condition 6, Schedule 6 of the Project Approval.

The above rectification plan/protocol has been developed in consideration of the *Waterfall General (Garrawarra) Cemetery Conservation Management Plan* prepared for the Wollongong City Council (Biosis, 2013).

As described in Section 4.1.1, a draft Planning Proposal has been prepared to amend the property description and expand the conservation area boundary of Garrawarra Hospital Heritage Conservation Area to include the Waterfall General [Garrawarra] Cemetery. In the event that the Conservation Area is amended, the BFMP will be reviewed and if necessary, revised to reflect the expanded boundary.

9.1.2 Possible Changes to Heritage Listing

The *Waterfall General (Garrawarra) Cemetery Conservation Management Plan* prepared for the Wollongong City Council (Biosis, 2013) recommended the Cemetery (and the associated Waterfall State Sanatorium [now the Garrawarra Aged Care Centre]) be nominated to the State Heritage Register for listing as a site of state heritage significance.

In the event the Waterfall General [Garrawarra] Cemetery is listed on the State Heritage Register, additional consultation may also be required with the Heritage Council of NSW and Cemeteries and Crematoria NSW. Should this occur, the above described rectification plan/protocol will be reviewed and revised if necessary.

[4] Note that prior to commencement of any works, NSW Department of Primary Industries – Land and/or WaterNSW will be notified in the event access through Crown Land and/or the Woronora Special Area is required.

10 TARP – MANAGEMENT TOOL

The framework for the various components of the BFMP-CEM are summarised in the BFMP-CEM TARP shown in Table 6. The BFMP-CEM TARP illustrates how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

The TARP comprises:

- baseline conditions;
- predicted subsidence impacts;
- trigger levels from monitoring to assess performance; and
- triggers that flag implementation of contingency measures.

The TARP system provides a simple and transparent snapshot of the monitoring of environmental performance and the implementation of management and/or contingency measures.

Table 6
BFMP-CEM Trigger Action Response Plan

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
Safe, serviceable and repairable	No defects to the structural integrity of headstones or fencing (beyond the baseline [pre-mining] conditions	Survey lines along the adjacent transmission line corridor and the 300 XL subsidence monitoring line.	Subsidence, compressive strain. Visible defect	After LWs 301, 302, 303 and 304.	Evaluation of the likely ground movements about the site by comparison between measured and predicted movements. Visual Inspection.	Subsidence measurement accuracy.	Pre-mining audit conducted prior to commencement of LW 301.	Level 1	After LW 302 Subsidence <650 mm Compressive strain < 1.6 mm/m After LWs 303 and 304 Subsidence <800 mm Compressive strain < 1.6 mm/m (i.e. measured subsidence parameters generally in accordance with predicted). No visible defects to the structural integrity of headstones or fences evident.	Continue monitoring.
								Level 2	After LW 302 Subsidence Between 650 and 750mm Strain Between 1.6 and 2.0 mm/m After LWs 303 and 304 Subsidence Between 800 and 920mm Strain Between 1.6 and 2.0 mm/m (i.e. measured subsidence parameters up to 15% greater than predicted). AND No indication of impact to Waterfall Cemetery Site	**<u>Metropolitan Coal</u>** Report subsidence anomaly. Immediately resurvey subsidence line to confirm results. Engage subsidence expert to assess results. Confirm results are consistent with other subsidence lines. Compare and critically analyse measured versus predicted subsidence. Inform and provide report to WCC of subsidence results. Collaboratively share information with WCC to monitor situation. **<u>WCC</u>** Assess information provided by Metropolitan Coal.
								Level 3	Indication of impact to Waterfall Cemetery Site	**<u>Metropolitan Coal</u>** Steps as per Level 2 event, plus: In conjunction with WCC identify impact location and work with WCC to resolve. Review the subsidence monitoring program and update the program where appropriate. Provide report on issue to both WCC and DP&E. **<u>WCC</u>** In conjunction with Metropolitan Coal identify impact location. Make determination if other measures necessary to avoid further impact (e.g. filling of cracks or fence stabilisation).

Table 6 (Continued)
BFMP-CEM Trigger Action Response Plan

Performance Measure	Performance Indicator	Monitoring Site(s)	Parameters	Frequency/ Sample Size	Analysis Methodology	Error Types	Baseline	Significance Levels/ Triggers		Action/Response
								Level 4	Damage to grave sites and/or monuments beyond baseline condition.	**Implement Contingency Plan** As per BFMP Section 9 and Appendix 4. **Metropolitan Coal** As per Level 3 event, plus: General Manager to be involved in all decision making processes. Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwall 304 Public Safety Management Plan. Report exceedance of the performance measure or indicators to the DP&E and WCC as soon as practicable. Update the 'Built Features Management Plan – Subsidence Impact Register'. Enact rectification plan/protocol, in consultation with WCC, and complete restoration works if required. Investigate circumstances of the damage and determine requirement for adaptive management of mining operations prior to future operations in vicinity of the Waterfall General (Garrawarra) Cemetery. **WCC** As per Level 3 event, plus: Provide input as required in implementing the rectification plan/protocol with Metropolitan Coal. Determine appropriate course of action for restoration and repairs/rectification works. Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.
	The land in general is expected to experience minor cracking consistent with that observed during the extraction of previous longwalls at Metropolitan Coal (i.e. no more than minor cracking).	Access roads and tracks in the vicinity of Waterfall General Cemetery.	The location of any surface tension cracks about access road/track to the Waterfall Cemetery;	After LWs 301, 302, 303 and 304.	Visual Inspection. Visual observations of access roads/tracks will also be conducted by Metropolitan Coal as part of routine works and inspections within 600 m of Longwalls 301-304 secondary extraction as described in the Metropolitan Coal Longwall 304 Land Management Plan.		Pre-mining audit conducted prior to commencement of LW 301.	Level 1	Minor cracking.	**Continue monitoring.** Consider whether any actions are required (e.g. implementation of management measures as outlined in the Longwall 304 LMP, initiation of the Contingency Plan as outlined in the Longwall 304 LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.).
								Level 2	Moderate cracking (i.e. cracking that requires implementation of management measures).	Implement management measures as outlined in the Longwall 304 LMP.
								Level 3	Greater than moderate cracking.	Implement contingency measures as outlined in the Longwall 304 LMP.

11 FUTURE EXTRACTION PLANS

In accordance with Condition 7, Schedule 3 of the Project Approval, Metropolitan Coal will collect baseline data for the next Extraction Plan (i.e. Longwalls 305-310). The baseline (and post-mining) data collected for Longwalls 301-304 will be used as baseline for Longwalls 305 onward as longwall mining progressively moves further away from the Waterfall Cemetery.

In addition to the baseline data collection, consideration of the environmental performance and management measures in accordance with the review(s) conducted as part of this BFMP-CEM will inform the appropriate type and frequency of monitoring relevant to the next Extraction Plan.

12 ANNUAL REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

In accordance with Condition 3, Schedule 7 of the Project Approval, Metropolitan Coal will conduct an Annual Review of the environmental performance of the Project by the end of March each year.

The Annual Review will:

- describe the works carried out in the past year, and the works proposed to be carried out over the next year;
- include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the EA, Preferred Project Report and Extraction Plan;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

As described in Section 2, this BFMP will be reviewed within three months of the submission of an Annual Review, and revised where appropriate.

13 INCIDENTS

An incident is defined as a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval.

The reporting of incidents will be conducted in accordance with Condition 6, Schedule 7 of the Project Approval. Metropolitan Coal will notify the Director-General (now Secretary) of DP&E and any other relevant agencies of any incident associated with the Project as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of DP&E and any relevant agencies with a detailed report on the incident.

The Wollongong City Council will be notified within 24 hours of any access limitations or restrictions.

14 COMPLAINTS

A protocol for the managing and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

The Environment & Community Superintendent is responsible for maintaining a system for recording complaints.

Metropolitan Coal will maintain public signage advertising the telephone number on which environmental complaints can be made. The Environment & Community Superintendent is responsible for ensuring that the currency and effectiveness of the service is maintained. Notifications of complaints received are to be provided as quickly as practicable to the Environment & Community Superintendent.

Complaints and enquiries do not have to be received via the telephone line and may be received in any other form. Any complaint or enquiry relating to environmental management or performance is to be relayed to the Environment & Community Superintendent as soon as practicable. All employees are responsible for ensuring the prompt relaying of complaints. All complaints will be recorded in a complaints register.

For each complaint, the following information will be recorded in the complaints register:

- date and time of complaint;
- method by which the complaint was made;
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- nature of the complaint;
- the action(s) taken by Metropolitan Coal in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken by Metropolitan Coal, the reason why no action was taken.

The Environment & Community Superintendent is responsible for ensuring that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary.

In accordance with Condition 10, Schedule 7 of the Project Approval, the complaints register will be made publicly available on the website and updated on a monthly basis. A summary of complaints received and actions taken will be presented to the Community Consultative Committee as part of the operational performance review.

15 NON-COMPLIANCES WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with Metropolitan Coal, and will be developed through promotion of Metropolitan Coal ownership under the direction of the General Manager.

The Manager - Technical Services and/or Environment & Community Superintendent will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 13, Metropolitan Coal will notify the Director-General (now Secretary) of the DP&E and any other relevant agencies of any incident associated with Metropolitan Coal as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of the DP&E and any relevant agencies with a detailed report on the incident.

A review of Metropolitan Coal's compliance with all conditions of the Project Approval, mining leases and all other approvals and licenses will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the Peabody website.

Additionally, in accordance with Condition 8, Schedule 7 of the Project Approval, an independent environmental audit was undertaken by the end of December 2011, and is undertaken a minimum of once every three years thereafter. A copy of the audit report will be submitted to the Director-General (now Secretary) of the DP&E and made publicly available on the Peabody website. The independent audit will be undertaken by an appropriately qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General (now Secretary) of the DP&E.

16 REFERENCES

Biosis (2013) *Waterfall General (Garrawarra) Cemetery Conservation Management Plan*. Prepared for Wollongong City Council. 7 June 2013.

Department of Planning & Environment and Division of Resources and Energy (2014) *Guidelines for the Preparation of Extraction Plans*. Draft.

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Howard Tanner & Associates (1993) *Conservation Plan for the Garrawarra Centre for Aged Care.*

Mine Subsidence Engineering Consultants (2008) *Subsidence Assessment Report on the Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Surface Infrastructure Resulting from the Proposed Extraction of Longwalls 20 to 44 at Metropolitan Colliery in Support of a Part 3A Application.*

Mine Subsidence Engineering Consultants (2016) *Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Waterfall General [Garrawarra] Cemetery – Wollongong City Council*, 31 August 2016.

Mine Subsidence Engineering Consultants (2019) *Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Waterfall General [Garrawarra] Cemetery.*

University of Queensland [UQ] (2017) *Pre-mine Audit at Waterfall General (Garrawarra) Cemetery near Helensburgh, NSW – UQ Cultural & Heritage Unit, 31 July 2017.*

Wollongong City Council (2013) *Waterfall General [Garrawarra] Cemetery: A Photographic Index of Identifiable Graves.* September 2013.

APPENDIX 1

MSEC (2016) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 301 TO 303 - SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE WATERFALL GENERAL [GARRAWARRA] CEMETERY – WOLLONGONG CITY COUNCIL, DATED 31 AUGUST 2016

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

31st August 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-11

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Waterfall General (Garrawarra) Cemetery - Wollongong City Council

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Waterfall General (Garrawarra) Cemetery (the Cemetery) resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery.

The Wollongong City Council (WCC) LEP 2009 identifies the cemetery as an item of heritage significance (Item 6486 within Schedule 5 Part 1. A Conservation Plan for the Garrawarra Centre for Aged Care (Howard Tanner & Associates, 1993) provides the following information on the cemetery:

- The cemetery was closed when the Sanatorium closed (i.e. now the Garrawarra Complex), which was in 1957;
- No maintenance has been carried out since it closed;
- The cemetery has been recolonised by neighbouring bushland;
- The cemetery is described as “Mounds in ground, some broken pieces of marble. Overgrown with Eucalyptus haemastoma,…. and other indigenous vegetation”;
- The condition is described as “poor – little remains to identify this area as the Cemetery”

In 1967, Wollongong City Council was handed responsibility for maintenance and control of the Cemetery. Details of the cemetery and future recommendations are outlined in a report published in the Wollongong City Council minutes of ordinary meeting on Monday 27 August 2012. A summary of points from the report is as follows:

- The Cemetery is understood to have received some 2000 burials between 1909 and mid 1950’s
- Little maintenance of the cemetery has occurred since the hand over in 1967
- Surrounding bush has encroached onto the site making it unrecognisable as a cemetery
- A site inspection was undertaken by WCC in March 2012 which found:
    - Many graves were damaged by overgrown vegetation, vandalism and grave subsidence.
    - Bush fires are believed to have resulted in the loss of much of the evidence of the Cemetery including timber grave markers
    - 43 identifiable graves were located during the site inspection
    - Clearing of the site would likely reveal further evidence of burials
    - Some evidence of fencing, roadways and entry gates remains on site
- A staged process is proposed for working towards further options for the future management, conservation and potential public accessibility

The location of the Cemetery and the proposed longwalls are shown in the attached Drawing No. MSEC844-11. The Cemetery is located directly above Longwall 301. The cemetery is located in an area of relatively flat topography at a topographical high point. The area is approximately 22 hectares and has average dimensions of approximately 156 metres by 142 metres.

The predictions and impact assessments for the WCC infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the Cemetery

The following provides summaries of the maximum predicted conventional movements for the Cemetery resulting from the extraction of Longwalls 301 to 303. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures. Discussions on the potential for non-conventional movements are provided in this letter report.

A summary of the maximum predicted values of incremental subsidence, tilt and curvature for the Cemetery, due to the extraction of each of the Longwalls 301 to 303, is provided in Table 1. The values are the maxima anywhere within the Cemetery and within 20 metres of the cemetery boundary at any time during or after the extraction of each longwall.

Table 1 Maximum Predicted Incremental Subsidence, Tilt and Curvature for the Cemetery Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
Due To LW301	75	< 0.5	< 0.01	0.01
Due To LW302	600	4.0	0.04	0.1
Due To LW303	150	1.0	< 0.01	< 0.01

The maximum predicted incremental subsidence for the Cemetery of 600 mm, occurs due to the extraction of Longwall 302.

A summary of the maximum predicted values of total subsidence, tilt and curvature for the Cemetery, resulting from the extraction of Longwalls 301 to 303, is provided in Table 2. The values are the maxima anywhere within the Cemetery and within 20 metres of the cemetery boundary at any time during or after the extraction of each longwall.

Table 2 Maximum Predicted Total Subsidence, Tilt and Curvature for the Cemetery Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	75	< 0.5	< 0.01	0.01
After LW302	650	4.0	0.03	0.1
After LW303	800	5.0	0.04	0.1

The maximum predicted total subsidence for the Cemetery, resulting from the extraction of Longwalls 301 to 303, is 800 mm. The maximum predicted conventional tilt for the Cemetery is 5.0 mm/m (i.e. 0.5 %, or 1 in 200). The maximum predicted conventional curvatures are 0.04 km^{-1} hogging and 0.1 km^{-1} sagging, which equate to minimum radii of curvature of 25 kilometres and 10 kilometres, respectively.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the Cemetery has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 1. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

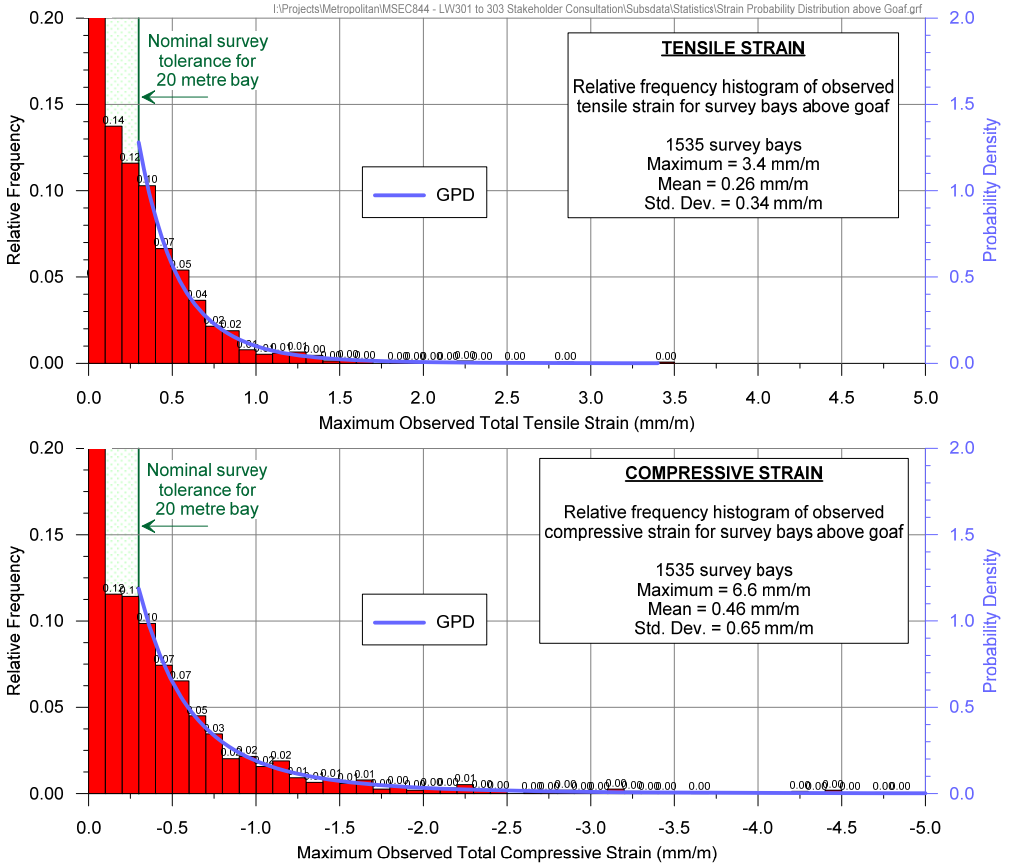


Figure 1 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based the fitted GPDs, is provided in Table 3.

Table 3 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the

maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements. There are no identified geological structures in the vicinity of the Cemetery.

It is possible that the Cemetery could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The Cemetery is not located near any streams within the Study Area. The Cemetery, therefore, is not expected to experience any measurable valley closure effects.

Impact Assessments for the Cemetery

The maximum predicted conventional tilt for the Cemetery is 5.0 mm/m (i.e. 0.5 %, or 1 in 200). The predicted changes in grade are small, less than 1 %, and therefore are unlikely to result in adverse impacts on the Cemetery features including headstones or fencing.

The maximum predicted conventional curvatures for the Cemetery are 0.04 km^{-1} hogging and 0.1 km^{-1} sagging, which equate to minimum radii of curvature of 25 kilometres and 10 kilometres, respectively. The predicted strains are 0.9 mm/m tensile and 1.6 mm/m compressive based on the 95 % confidence level and 1.5 mm/m tensile and 3.2 mm/m compressive based on the 99 % confidence level.

The maximum predicted curvatures and the range of potential strains for the Cemetery are similar to those typically experienced elsewhere in the Southern Coalfield.

It is possible that some minor cracking of the surface soils or exposed bedrock in the cemetery could occur as a result of the extraction of the extraction of Longwalls 301 to 303. Identification of cracking may be difficult given the overgrown nature of the Cemetery. If these cracks eventuate and can be identified, they can be readily repaired by infilling with soil or other suitable materials.

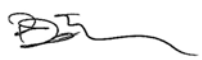
It is recommended that monitoring and management strategies are developed, in consultation with WCC, to manage the potential impacts on the Cemetery.

Summary

The Cemetery is located directly above Longwall 301. The previous experience from the Southern Coalfield has found that the potential impacts can be managed with the implementation of suitable monitoring and management strategies.

It is recommended that monitoring and management strategies are developed, in consultation with WCC, to manage the potential impacts on the Cemetery.

Yours sincerely



Peter DeBono

Attachments:

Drawing No. MSEC844-11 – Longwalls 301 to 303 – Cemetery WCC

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COAL

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
CEMETERY WCC

DATE:	SCALE:	DRAWING No:	Rev No
30-Aug-2016	1:12500	MSEC844-11	A

313 000
314 000
6 218 000
6 217 000
6 216 000
6 215 000

Grid to MGA co-ordinates

CAWLEY ROAD OVERPASS
CAWLEYS CK
STUDY AREA
METROPOLITAN FAULT
M1 PRINCES MOTORWAY
WORONORA RESERVOIR
OLD PRINCES HWY
PREDICTED 20mm SUBSIDENCE CONTOUR
20
20
LW303
LW302
LW301
CEMETERY
WILSONS CK
PRINCES HIGHWAY UNDERPASS 2
FAULT
MAIN WEST FAULT
POWELL FAULT

GEOLOGICAL STRUCTURES
FAULTS
DYKES

APPENDIX 2

MSEC (2019) METROPOLITAN COLLIERY – PROPOSED LONGWALL 304 - SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE WATERFALL GENERAL [GARRAWARRA] CEMETERY – WOLLONGONG CITY COUNCIL

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

14th March 2019

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC1013-11

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Waterfall General (Garrawarra) Cemetery - Wollongong City Council

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Waterfall General (Garrawarra) Cemetery (the Cemetery) following the extraction of LW303 and after the extraction of LW304 at Metropolitan Colliery.

The Wollongong City Council (WCC) LEP 2009 identifies the cemetery as an item of heritage significance (Item 6486 within Schedule 5 Part 1. A Conservation Plan for the Garrawarra Centre for Aged Care (Howard Tanner & Associates, 1993) provides the following information on the cemetery:

- The cemetery was closed when the Sanatorium closed (i.e. now the Garrawarra Complex), which was in 1957;
- No maintenance has been carried out since it closed;
- The cemetery has been recolonised by neighbouring bushland;
- The cemetery is described as “Mounds in ground, some broken pieces of marble. Overgrown with Eucalyptus haemastoma,…. and other indigenous vegetation”;
- The condition is described as “poor – little remains to identify this area as the Cemetery”

In 1967, Wollongong City Council was handed responsibility for maintenance and control of the Cemetery. Details of the cemetery and future recommendations are outlined in a report published in the Wollongong City Council minutes of ordinary meeting on Monday 27 August 2012. A summary of points from the report is as follows:

- The Cemetery is understood to have received some 2000 burials between 1909 and mid 1950’s
- Little maintenance of the cemetery has occurred since the hand over in 1967
- Surrounding bush has encroached onto the site making it unrecognisable as a cemetery
- A site inspection was undertaken by WCC in March 2012 which found:
    - Many graves were damaged by overgrown vegetation, vandalism and grave subsidence.
    - Bush fires are believed to have resulted in the loss of much of the evidence of the Cemetery including timber grave markers
    - 43 identifiable graves were located during the site inspection
    - Clearing of the site would likely reveal further evidence of burials
    - Some evidence of fencing, roadways and entry gates remains on site
- A staged process is proposed for working towards further options for the future management, conservation and potential public accessibility

The location of the Cemetery and the proposed longwalls are shown in the attached Drawing No. MSEC1013-11. A Study Area is shown in Drawing No. MSEC1013-11 and is based on the outer limits of a 35° angle of draw line from Longwall 304 and the predicted 20mm subsidence contour for Longwall 304. The Cemetery is located within the Study Area but not directly above proposed Longwall 304. The cemetery is located in an area of relatively flat topography at a topographical high point. The area is approximately 22 hectares and has average dimensions of approximately 156 metres by 142 metres.

The predictions and impact assessments for the WCC infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the Cemetery

The following provides a summary of the maximum predicted conventional movements for the Cemetery following the extraction of LW303 and after the extraction of LW304. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures. Discussions on the potential for non-conventional movements are provided in this letter report.

A summary of the maximum predicted values of total subsidence, tilt and curvature for the Cemetery, following the extraction of LW303 and after the extraction of LW304, is provided in Table 1. The values are the maxima anywhere within the Cemetery and within 20 metres of the cemetery boundary at any time during or after the extraction of each longwall.

Table 1 Maximum Predicted Total Subsidence, Tilt and Curvature for the Cemetery after the Extraction of Longwalls 303 and 304

Longwall	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})
After LW303	750	5.0	0.03	0.03
After LW304	800	5.0	0.04	0.03

The maximum predicted total subsidence for the Cemetery, following the extraction of LW303 and after the extraction of LW304, is 800 mm. The maximum predicted conventional tilt for the Cemetery is 5.0 mm/m (i.e. 0.5 %, or 1 in 200). The maximum predicted conventional curvatures are 0.04 km^{-1} hogging and 0.03 km^{-1} sagging, which equate to minimum radii of curvature of 25 km and 33 km, respectively.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature.

We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the Cemetery has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 1. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

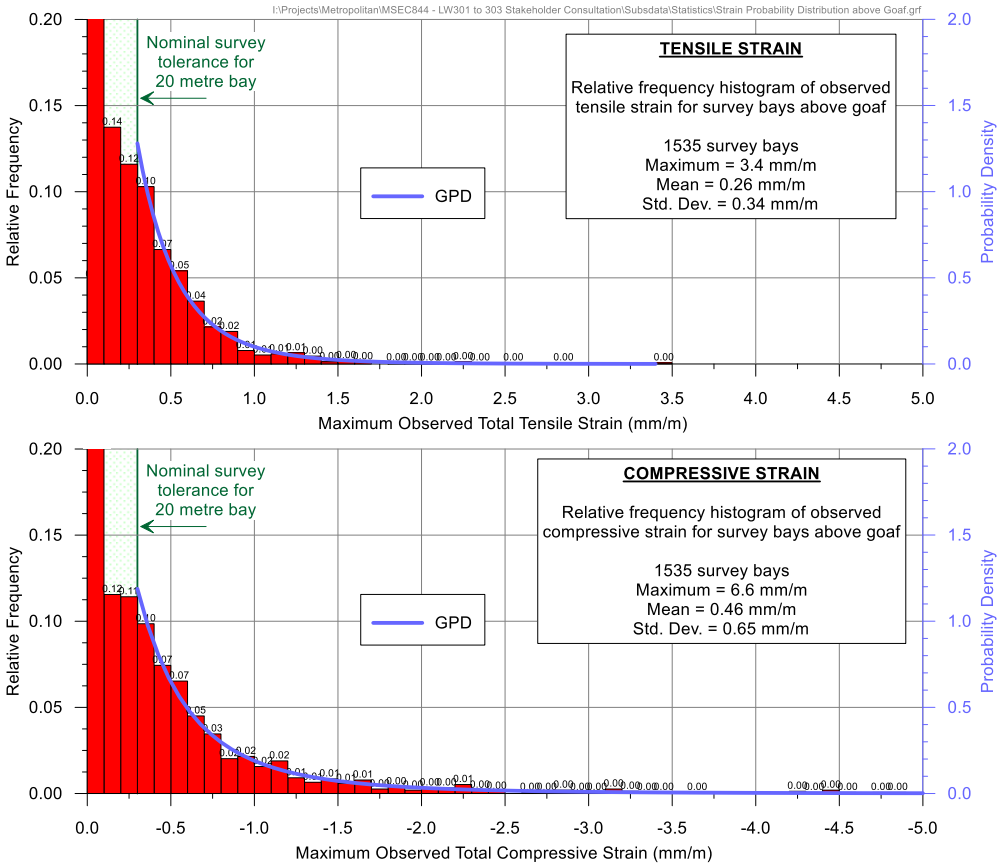

Figure 1 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based the fitted GPDs, is provided in Table 2.

Table 2 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures at seam level and the major streams are shown in Drawing No. MSEC1013-04. There are no mapped faults located within the Study Area that extend beneath the Cemetery. It is possible that localised and elevated strains could develop due to unknown geological structures (i.e. anomalies). Non-conventional or anomalous movements have not been identified during the extraction of Longwalls 301 and 302 and part extraction of Longwall 303. The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The Cemetery is not located near any streams within the Study Area. The Cemetery, therefore, is not expected to experience any measurable valley closure effects.

Impact Assessments for the Cemetery

The maximum predicted conventional tilt for the Cemetery is 5.0 mm/m (i.e. 0.5 %, or 1 in 200). The predicted changes in grade are small, less than 1 %, and therefore are unlikely to result in adverse impacts on the Cemetery features including headstones or fencing.

The maximum predicted conventional curvatures for the Cemetery are 0.04 km^{-1} hogging and 0.03 km^{-1} sagging, which equate to minimum radii of curvature of 25 km and 33 km, respectively. The predicted strains are 0.9 mm/m tensile and 1.6 mm/m compressive based on the 95 % confidence level and 1.5 mm/m tensile and 3.2 mm/m compressive based on the 99 % confidence level.

The maximum predicted curvatures and the range of potential strains for the Cemetery are similar to those typically experienced elsewhere in the Southern Coalfield.

It is possible that some minor cracking of the surface soils or exposed bedrock in the cemetery could occur after the extraction of the extraction of Longwall 304. The cemetery is located above Longwall 301, however and it can be seen from Table 1 that the increase in predicted subsidence parameters due to Longwall 304 are very small. The likelihood of impact to the cemetery due to the extraction of Longwall 304 is considered to be low. The Identification of cracking may be difficult given the overgrown nature of the Cemetery. If surface cracks develop and can be identified, they can be readily repaired by infilling with soil or other suitable materials.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301-303 are updated, in consultation with Wollongong City Council, to manage the potential impacts on the Cemetery.

Summary

The Cemetery is located within the Study Area but not directly above proposed Longwalls 304. The previous experience from the Southern Coalfield has found that the potential impacts can be managed with the implementation of suitable monitoring and management strategies.

It is recommended that monitoring and management strategies are developed, in consultation with WCC, to manage the potential impacts on the Cemetery.

Yours sincerely

Peter DeBono

Attachments:

Drawing No. MSEC1013-11 – Longwall 304 – Cemetery WCC

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COAL

METROPOLITAN COLLIERY
LONGWALL 304
CEMETERY WCC

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	1:10000	MSEC1013-11	02

Grid to MGA co-ordinates

6 218 000
313 000
312 000
6 217 000
6 216 000

CAWLEYS CK
WORONORA RESERVOIR
STUDY AREA
PREDICTED 20mm SUBSIDENCE CONTOUR
LW304
OLD PRINCES HWY
LW303
LW302
LW301
CEMETERY
M1 PRINCES MOTORWAY
WILSONS CK

GEOLOGICAL STRUCTURES
FAULTS
DYKES

APPENDIX 3

BUILT FEATURES MANAGEMENT PLAN – SUBSIDENCE IMPACT REGISTER

Built Features Management Plan - Subsidence Impact Register

Impact Register Number[1]	Built Feature[2]	Impact Description	Does Impact Exceed the Built Feature Performance Measure/Indicators? (Yes/No)	Management Measures Implemented	Were Management Measures Effective? (Yes/No)

Notes:

1: Fill out all details in the Assessment Form and record the register number here.

2: Built feature (e.g. headstone, etc.).

3: Impacts to access roads/tracks to be included in the Land Management Plan – Subsidence Impact Register.

Built Feature Management Plan – Subsidence Impact Register
Assessment Form

Date:

Observer (Name and position):

Register Number (i.e. Number 1, 2, etc.):

Longwall Number and Chainage:

Location of Observed Impact:

(Examples: location of tower, include GPS co-ordinates and a sketch)

Description of Observed Impact:

(Examples: nature and extent of impact - cracks in road etc any relevant information, attach photographs)

Person Notified:	Manager - Technical Services	☐

Description of Photographs:

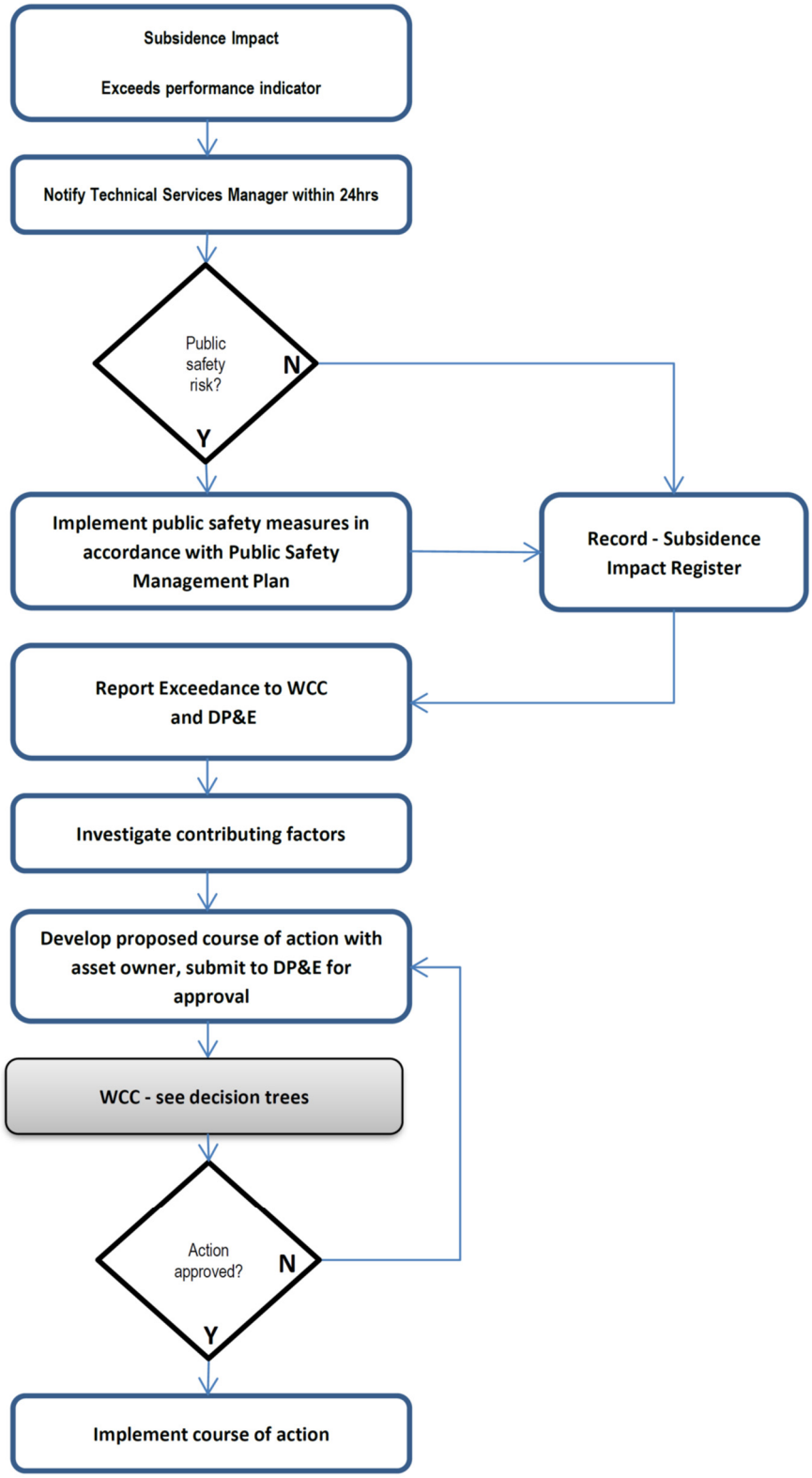
Actions Required:	Contingency Plan Initiated	☐
	Incident Notification	☐
	Safety Measures/Public Safety Management Plan Requirements	☐

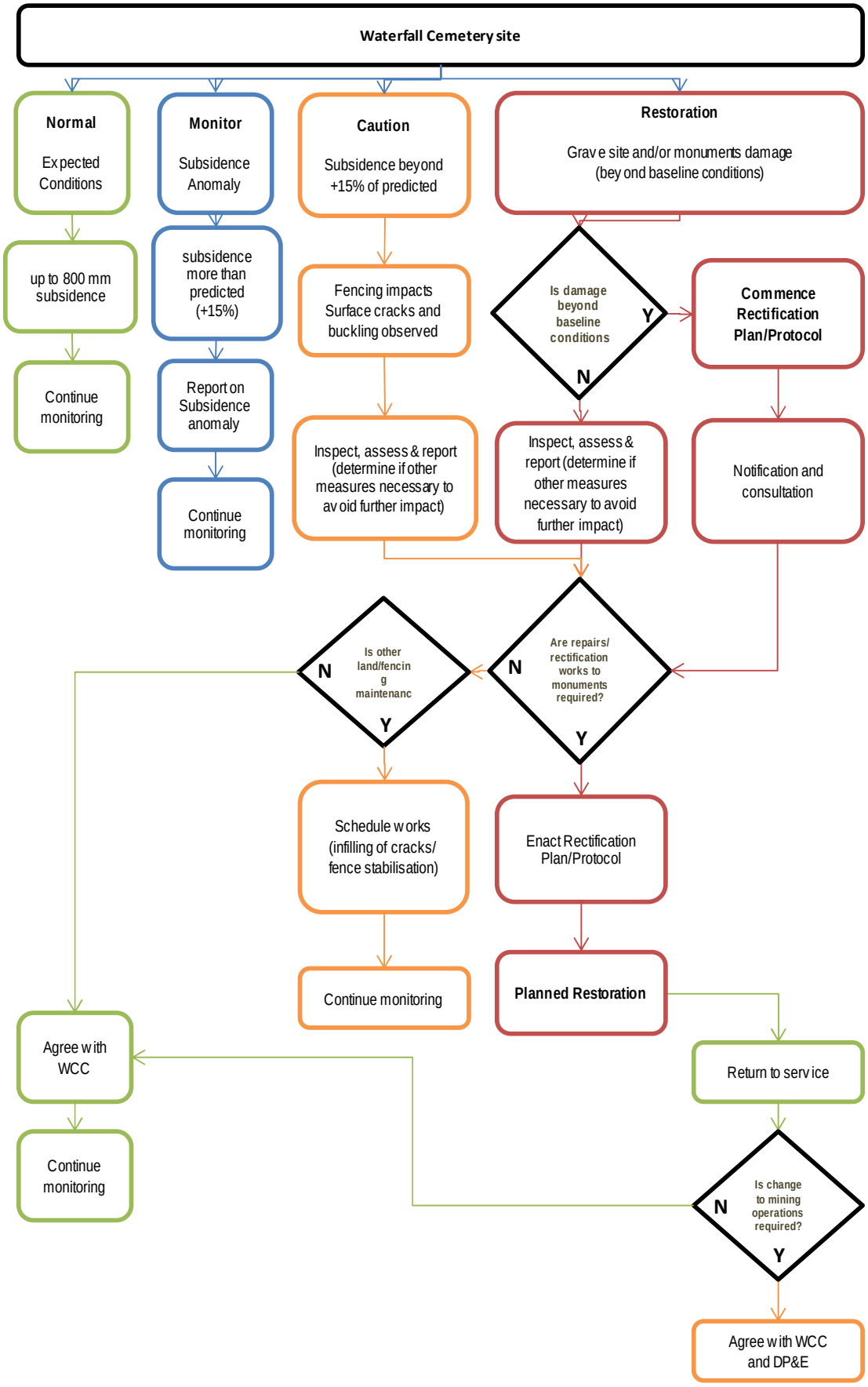
Management or Contingency Measures Implemented:

Effectiveness of Management or Contingency Measures:

APPENDIX 4

CONTINGENCY PLAN PROCEDURE AND DECISION TREE


Subsidence Impact
Exceeds performance indicator
Notify Technical Services Manager within 24hrs
Public safety risk?
N
Y
Implement public safety measures in accordance with Public Safety Management Plan
Record - Subsidence Impact Register
Report Exceedance to WCC and DP&E
Investigate contributing factors
Develop proposed course of action with asset owner, submit to DP&E for approval
WCC - see decision trees
Action approved?
N
Y
Implement course of action


Waterfall Cemetery site
Normal
Expected Conditions
Monitor
Subsidence Anomaly
Caution
Subsidence beyond +15% of predicted
Restoration
Grave site and/or monuments damage (beyond baseline conditions)
up to 800 mm subsidence
subsidence more than predicted (+15%)
Fencing impacts Surface cracks and buckling observed
Is damage beyond baseline conditions
Y
N
Commence Rectification Plan/Protocol
Continue monitoring
Report on Subsidence anomaly
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Notification and consultation
Continue monitoring
Is other land/fencing maintenanc
N
Y
Are repairs/ rectification works to monuments required?
N
Y
Schedule works (infilling of cracks/ fence stabilisation)
Enact Rectification Plan/Protocol
Continue monitoring
Planned Restoration
Agree with WCC
Return to service
Continue monitoring
Is change to mining operations required?
N
Y
Agree with WCC and DP&E

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BUILT FEATURES MANAGEMENT PLAN
SYDNEY WATER

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&E Approval Date
All	LW301-303 BFMP_SYDWATER-R01-A	Original – Draft for Consultation	Sydney Water, DRG and DP&E	-
Table 3, Section 8 and Figure 4	LW301-303 BFMP_SYDWATER-R01-B	Revised – Incorporating Sydney Water Review Comments (4 October 2016)	Sydney Water, DRG and DP&E	11 May 2017*
Tables 2, 3, 4 & 6 and Appendix 4	LW301-303 BFMP_SYDWATER-R01-C	Revised – Addressing DP&E and DRG requirements	Sydney Water, DRG and DP&E	-
All	LW301-303 BFMP_SYDWATER-R01-D	Update to include LW303	Sydney Water and DRG	8 November 2018#
All	BFMP_SYDWATER-R01-E	Inclusion of Longwall 304 into BFMP	Sydney Water	-

* The approval allows for the extraction of Longwalls 301 and 302 only.

Approval for the extraction of Longwall 303.

April 2019

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1 INTRODUCTION

Metropolitan Coal is a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under section 75J of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com).

The Project comprises the continuation, upgrade and extension of underground coal mining operations (Longwalls 20-27 and Longwalls 301-317) and surface facilities at Metropolitan Coal. The underground mining longwall layout is shown on Figure 1. Following the completion of Longwall 27 in 2017, Longwalls 301, 302, 303 and 304 define the next mining sub-domains within the Project underground mining area (Figures 1 to 3).

1.1 PURPOSE AND SCOPE

In accordance with Condition 6(f), Schedule 3 of the Project Approval, this Built Features Management Plan – Sydney Water (BFMP-SYDNEY WATER) has been developed to manage the potential consequences of longwall extraction on the Sydney Water assets.

The relationship of this BFMP-SYDNEY WATER to the Metropolitan Coal Environmental Management Structure is shown on Figure 4.

In accordance with Condition 6, Schedule 3 of the Project Approval, the suitably qualified and experienced experts that have prepared this BFMP-SYDNEY WATER, namely representatives from Mine Subsidence Engineering Consultants (MSEC) and Metropolitan Coal were endorsed by the Director-General (now Secretary) of the Department of Planning and Environment (DP&E). This BFMP-SYDNEY WATER has been prepared in consultation with Sydney Water, including consideration of prior consultation during the development of the previously approved Built Features Management Plans.

1.2 STRUCTURE OF THE BFMP-SYDNEY WATER

The remainder of the BFMP-SYDNEY WATER is structured as follows:

Section 2: Describes the review and update of the BFMP-SYDNEY WATER.

Section 3: Outlines the statutory requirements applicable to the BFMP-SYDNEY WATER.

Section 4: Provides a revised assessment of the potential subsidence impacts and environmental consequences for Longwalls 301-304.

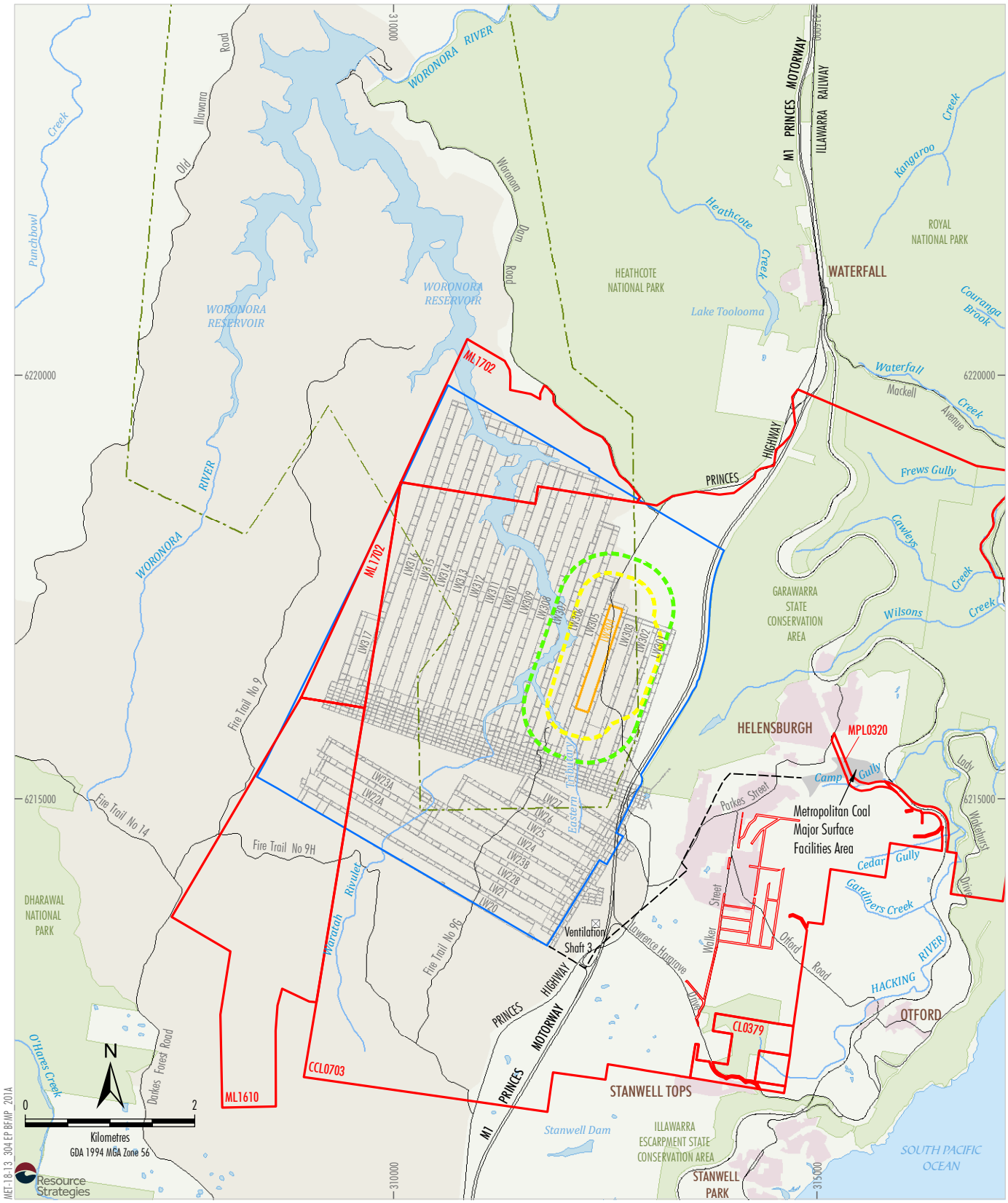
Section 5: Details the performance measures and indicators that will be used to assess the Project.

Section 6: Provides the detailed baseline data.

Section 7: Describes the monitoring program.

Section 8: Describes the management measures that will be implemented.

Section 9: Provides a contingency plan to manage any unpredicted impacts and their consequences.



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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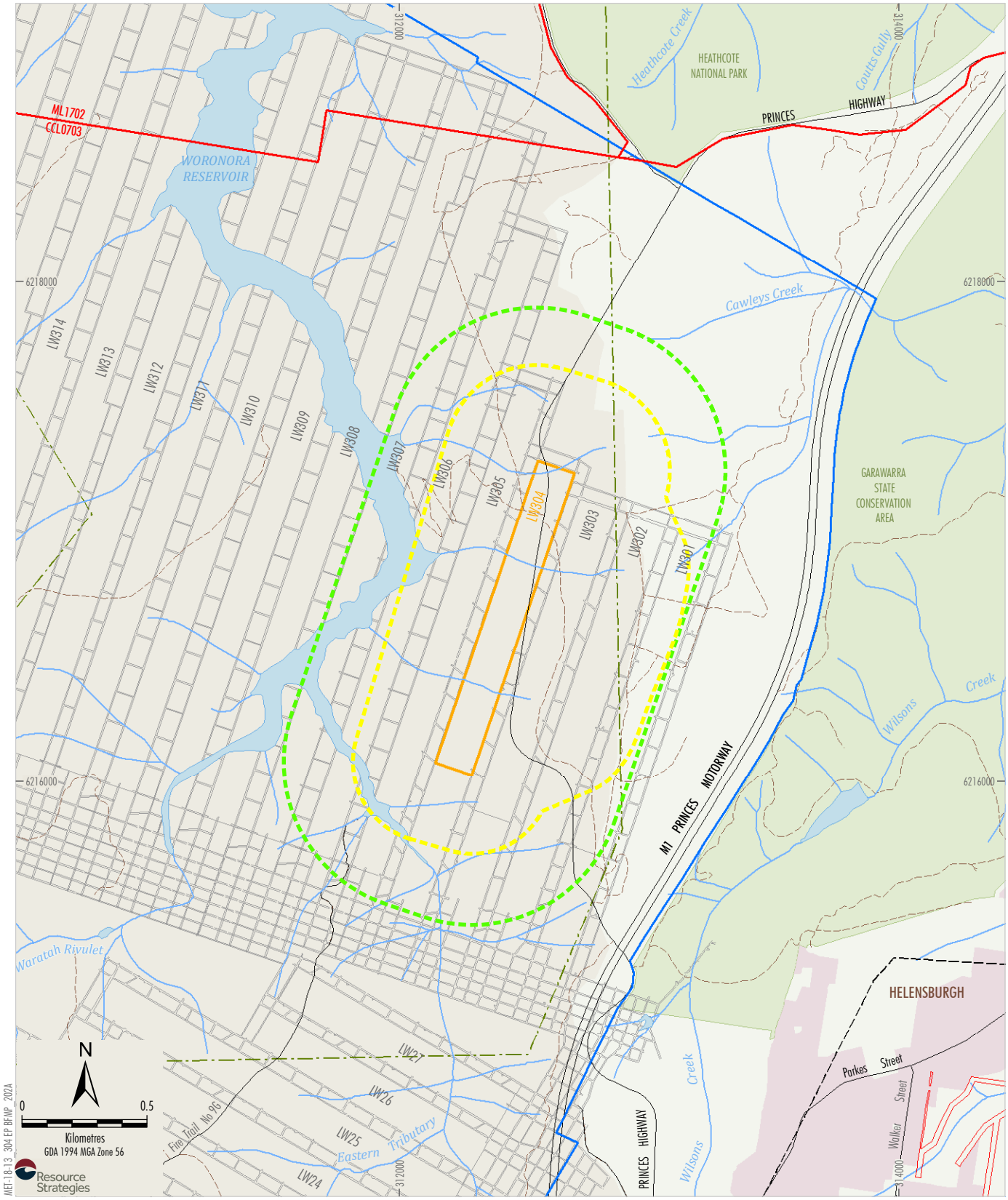
Longwalls 20-27 and Longwalls 301-317 Layout

Figure 1



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)
- Vehicular Track

Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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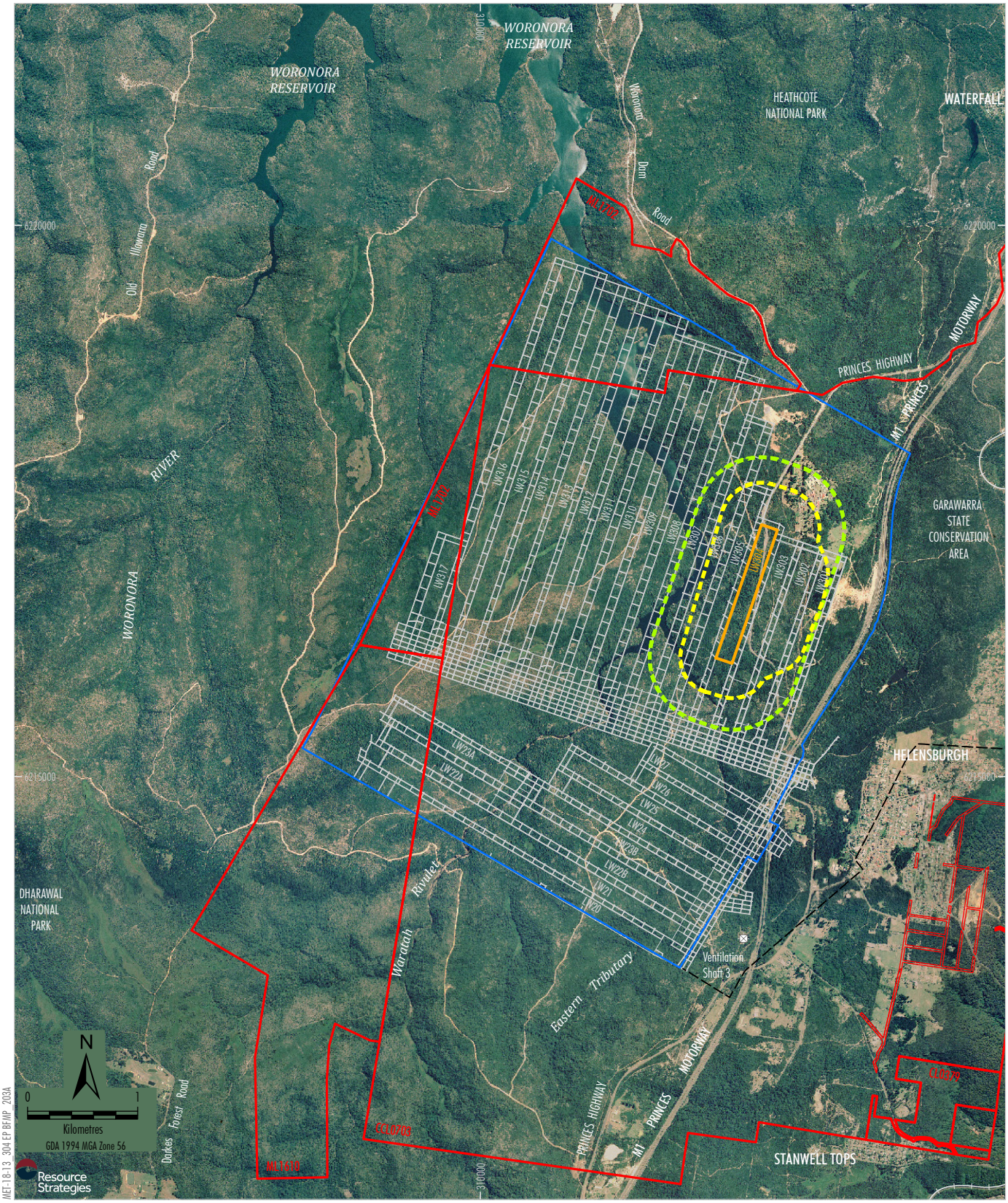
Longwalls 301-304 Layout

Figure 2



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwall 304 Secondary Extraction
- 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Secondary Extraction of Longwall 304
- Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

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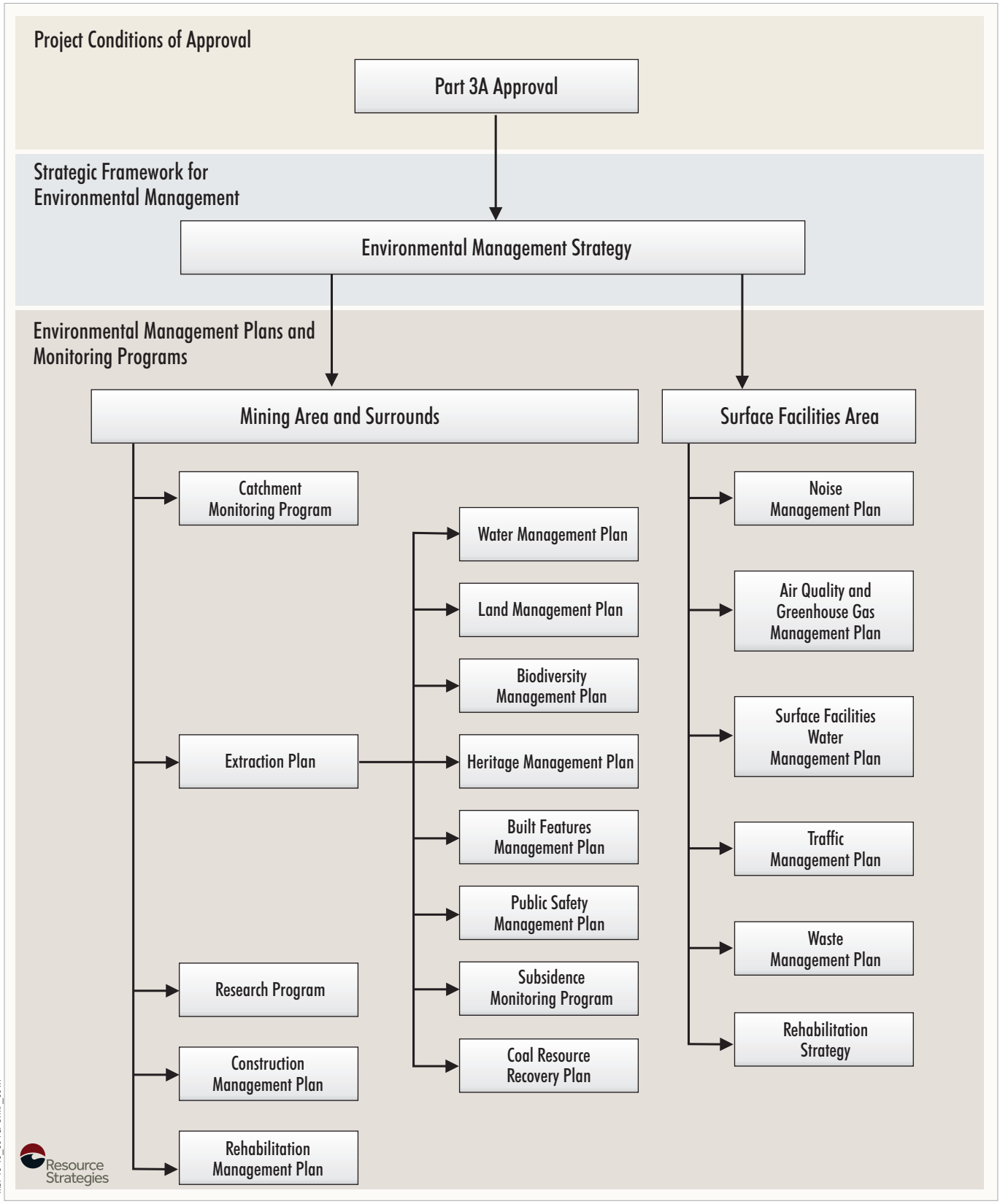
Longwalls 20-27 and Longwalls 301-317 Layout - Aerial Photograph

Figure 3



MET-18-13_304 EP BHMP_001A

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Environmental Management Structure

Figure 4

Section 10: Describes the Trigger Action Response Plan (TARP) management tool.

Section 11: Describes the program to collect sufficient baseline data for future Extraction Plans.

Section 12: Describes the annual review and improvement of environmental performance.

Section 13: Outlines the management and reporting of incidents.

Section 14: Outlines the management and reporting of complaints.

Section 15: Outlines the management and reporting of non-compliances with statutory requirements.

Section 16: Lists the references cited in this BFMP-SYDNEY WATER.

2 BFMP-SYDNEY WATER REVIEW AND UPDATE

In accordance with Condition 4, Schedule 7 of the Project Approval, this BFMP-SYDNEY WATER will be reviewed within three months of the submission of:

- an audit under Condition 8 of Schedule 7;
- an incident report under Condition 6 of Schedule 7;
- an annual review under Condition 3 of Schedule 7; and

if necessary, revised to the satisfaction of the Director-General (now Secretary) of DP&E, to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

This BFMP-SYDNEY WATER will also be reviewed within three months of approval of any Project modification and if necessary, revised to the satisfaction of the DP&E.

The revision status of this plan is indicated on the title page of each copy of the BFMP-SYDNEY WATER. The distribution register for controlled copies of the BFMP-SYDNEY WATER is described in Section 2.1.

Revisions to any documents listed within this BFMP-SYDNEY WATER will not necessarily constitute a revision of this document.

2.1 DISTRIBUTION REGISTER

In accordance with Condition 10, Schedule 7 ‘Access to Information’, Metropolitan Coal will make the BFMP-SYDNEY WATER publicly available on the Peabody website. A hard copy of the BFMP-SYDNEY WATER will also be maintained at the Metropolitan Coal site.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format. An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom the Metropolitan Coal plans and programs, such as the BFMP-SYDNEY WATER, will be distributed;
- the format (i.e. electronic or hard copy) of distribution; and
- the format of revision notification.

Metropolitan Coal will make the Distribution Register publicly available on the Peabody website.

Metropolitan Coal will be responsible for maintaining the Distribution Register and for ensuring that the notification of revisions is sent by email or post as appropriate. In addition, Metropolitan Coal employees with local computer network access will be able to view the controlled electronic version of this BFMP-SYDNEY WATER on the Metropolitan Coal local area network. Metropolitan Coal will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on Metropolitan Coal's computer system and the Peabody website.

3 STATUTORY REQUIREMENTS

Metropolitan Coal's statutory obligations are contained in:

(i) the conditions of the Project Approval;

(ii) relevant licences and permits, including conditions attached to mining leases; and

(iii) other relevant legislation.

These are described below.

3.1 EP&A ACT APPROVAL

Condition 6(f), Schedule 3 of the Project Approval requires the preparation of a BFMP as a component of Extraction Plan(s) for second workings. Project Approval Condition 6(f), Schedule 3 states:

> ***SECOND WORKINGS***
>
> ***Extraction Plan***
>
> *6. The Proponent shall prepare and implement an Extraction Plan for all second workings in the mining area to the satisfaction of the Director-General. This plan must:*
>
> *…*
>
> *(f) include a:*
>
> *…*
>
> - *Built Features Management Plan, which has been prepared in consultation with the owner of the relevant feature, to manage the potential environmental consequences of the Extraction Plan on any built features;*
>
> *…*

In addition, Condition 2, Schedule 7 and Condition 7, Schedule 3 of the Project Approval outline management plan requirements that are applicable to the preparation of the BFMP-SYDNEY WATER. Table 1 indicates where each component of the conditions is addressed within this BFMP-SYDNEY WATER.

Table 1
Management Plan Requirements

Project Approval Condition	BFMP-SYDNEY WATER Section
Condition 2 of Schedule 7	
2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	Section 6
b) a description of:	
• the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 3
• any relevant limits or performance measures/criteria;	Section 5
• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	Section 5
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Sections 7, 8, 9 and 10
d) a program to monitor and report on the:	Sections 7, 8 and 12
• impacts and environmental performance of the project;	
• effectiveness of any management measures (see c above);	
e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 9 and Appendix 4
f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Sections 7 and 12
g) a protocol for managing and reporting any;	
• incidents;	Section 13
• complaints;	Section 14
• non-compliances with statutory requirements; and	Section 15
• exceedances of the impact assessment criteria and/or performance criteria; and	Section 9 and Appendix 4
h) a protocol for periodic review of the plan.	Section 2
Condition 7 of Schedule 3	
7. In addition to the standard requirements for management plans (see condition 2 of schedule 7), the Proponent shall ensure that the management plans required under condition 6(f) above include:	
a) a program to collect sufficient baseline data for future Extraction Plans;	Section 11
b) a revised assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval;	Section 4
c) a detailed description of the measures that would be implemented to remediate predicted impacts; and	Section 8
d) a contingency plan that expressly provides for adaptive management.	Section 9 and Appendix 4

3.2 LICENCES, PERMITS AND LEASES

In addition to the Project Approval, all activities at or in association with the Metropolitan Coal Mine will be undertaken in accordance with the following licences, permits and leases which have been issued or are pending issue.

- The conditions of mining leases issued by the NSW Division of Resources and Geoscience (DRG), under the NSW *Mining Act, 1992* (e.g. Consolidated Coal Lease [CCL] 703, Mining Lease [ML] 1610, ML 1702, Coal Lease [CL] 379 and Mining Purpose Lease [MPL] 320).

- The *Metropolitan Coal Mining Operations Plan 1 October 2012 to 30 September 2019* approved by NSW Department of Industry.
- The conditions of Environment Protection Licence (EPL) No. 767 issued by the NSW Environment Protection Authority (EPA) under the NSW *Protection of the Environment Operations Act, 1997*. Revision of the EPL will be required prior to the commencement of Metropolitan Coal activities that differ from those currently licensed.
- The prescribed conditions of specific surface access leases within CCL 703 for the installation of surface facilities as required.
- Water Access Licences (WALs) issued by the NSW Department of Primary Industries – Water (now the Department of Industry – Water) under the NSW *Water Management Act, 2000*, including WAL 36475 under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* and WAL 25410 under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*.
- Mining and workplace health and safety related approvals granted by the NSW Resources Regulator and WorkCover NSW.
- Supplementary approvals obtained from WaterNSW for surface activities within the Woronora Special Area (e.g. fire road maintenance activities).

3.3 OTHER LEGISLATION

Metropolitan Coal will conduct the Project consistent with the Project Approval and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to the conduct of the Project (Helensburgh Coal Pty Ltd [HCPL], 2008)[1]:

- *Biodiversity Conservation Act, 2016;*
- *Biosecurity Act, 2015;*
- *Contaminated Land Management Act, 1997;*
- *Crown Land Management Act, 2016;*
- *Dams Safety Act, 2015;*
- *Dangerous Goods (Road and Rail Transport) Act, 2008;*
- *Energy and Utilities Administration Act, 1987;*
- *Fisheries Management Act, 1994;*
- *Mining Act, 1992;*
- *Protection of the Environment Operations Act, 1997;*
- *Rail Safety (Adoption of National Law) Act, 2012;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Water NSW Act, 2014;*

[1] The list of potentially applicable Acts has been updated to reflect changes to the Acts that were in force at the time of submission of the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008).

- *Work Health and Safety Act, 2011;* and
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

Relevant licences or approvals required under these Acts will be obtained as required.

4 REVISED ASSESSMENT OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

4.1 EXTRACTION LAYOUT

Longwalls 301-304 and the area of land within 600 metres (m) of Longwall 304 secondary extraction are shown on Figures 2 and 3. Longwall extraction occurs from north to south. The longwall layouts include 163 m panel widths (void) with 45 m pillars (solid).

The provisional extraction schedule for Longwalls 301-304 is provided in Table 2.

Table 2
Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
301	June 2017	6 months	February 2018
302	March 2017	7 months	October 2018
303	November 2018	7 months	May 2019
304	July 2019	6 months	December 2019

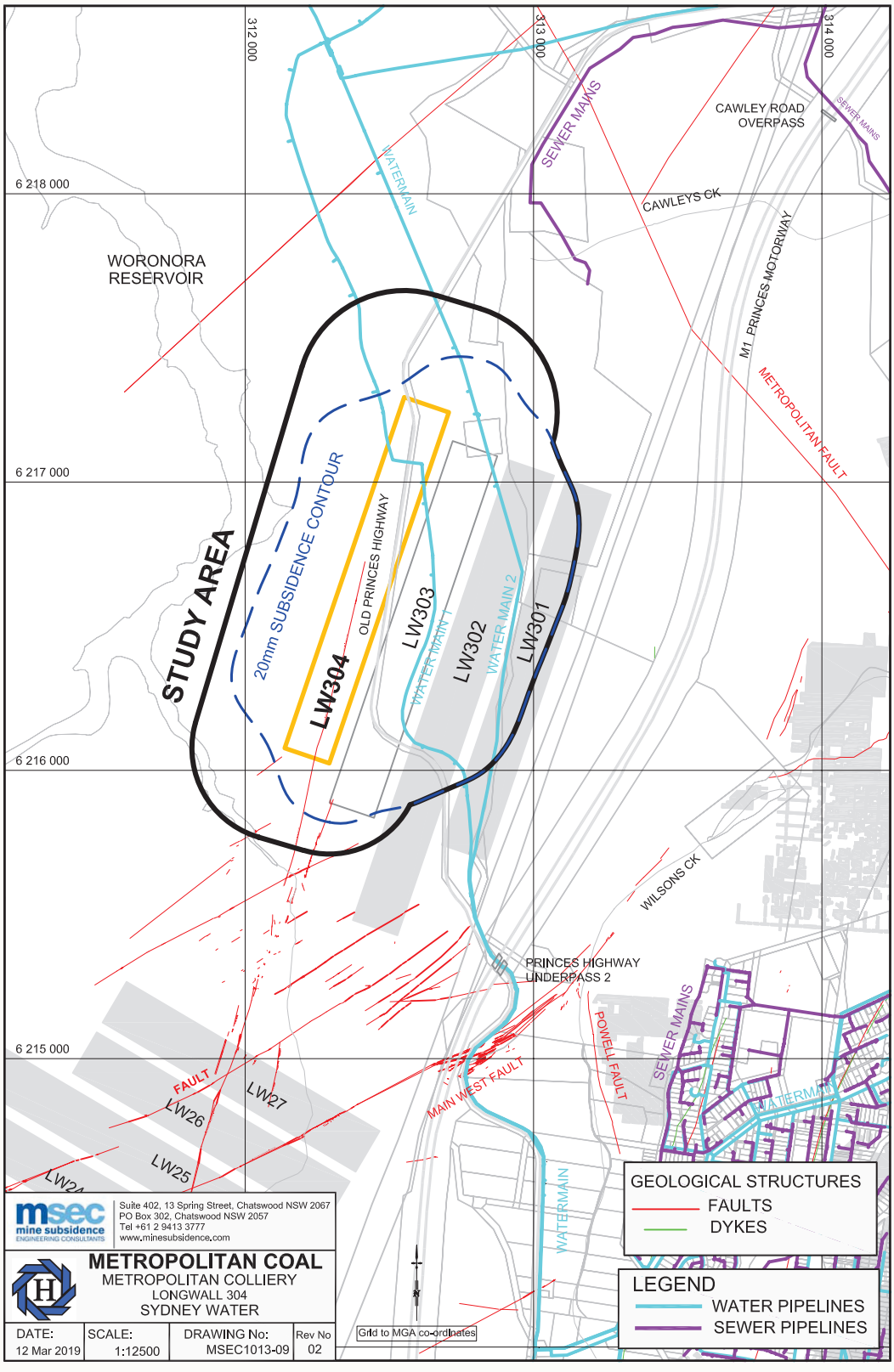
The future Extraction Plans will consider the cumulative subsidence effects, subsidence impacts and/or environmental consequences. Note that the total cumulative predicted subsidence effects, subsidence impacts and/or environmental consequences at the completion of the Project are considered in the Metropolitan Coal Project Environmental Assessment (Project EA) (HCPL, 2008) and the Preferred Project Report (HCPL, 2009).

4.1.1 Sydney water Assets

Figure 5 illustrates the Sydney Water assets in relation to Longwalls 301-304 extraction. The assets include two 300 millimetre (mm) diameter cast iron cement lined (CICL) potable water supply pipelines (referred in this BFMP as ‘Water Main 1’ and ‘Water Main 2’).

It is understood that while the water storage tanks within the Garrawarra Centre Complex (including Garrawarra Reservoir WS0406 and connecting pipelines) are used by Sydney Water, the assets are owned by NSW Health. The water storage tanks and connecting pipelines are therefore considered separately in the BFMP for the Garrawarra Centre Complex (BFMP-GAR).

Other networks of potable water and sewer pipelines are located within the township of Helensburgh approximately 900 m to the south-east from the nearest Longwall 301, as well as sewer mains to the north of the Longwalls 301-304.



MET-18-13_304 EP BFMP_008A

Source: MSEC (2019)

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Sydney Water Assets

Figure 5

4.2 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

4.2.1 Revised Subsidence Predictions

Subsidence predictions for Longwalls 20-44 in relation to the Sydney Water assets was conducted by MSEC (2008) as part of the Metropolitan Coal Project EA. MSEC (2008) includes a table summarising the incremental systematic subsidence parameters for the extraction of each longwall from Longwalls 20-44. These include:

- maximum predicted incremental subsidence (vertical movement);
- maximum predicted incremental tilt along alignment;
- maximum predicted incremental tilt across alignment;
- maximum predicted incremental tensile strain; and
- maximum predicted incremental compressive strain.

Revised subsidence and impact predictions for the extraction of Longwalls 301-303 and Longwall 304 on Sydney Water assets were conducted by MSEC and reported in MSEC (2016) and MSEC (2019) (Appendices 1 and 2), respectively.

In relation to subsidence predictions for Longwalls 301-303, MSEC (2016) make the following conclusions:

- Water Main 1 and Water Main 2 are pressure mains located above the longwalls and are therefore unlikely to be impacted by mining induced vertical subsidence or tilt.
- The predicted strains for the water mains are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar pipelines. It has been found from this previous experience that the impacts on CICL pipelines in the Southern Coalfield are rare and generally of minor nature.
- It is expected that the potential impacts on the Sydney Water infrastructure (e.g. minor leakages) can be managed with the implementation of appropriate monitoring and management strategies. However the incidence of impacts is likely to be very low and of a minor nature.
- It is unlikely that adverse impacts would occur for the water and sewer mains located outside the extent of Longwalls 301-303 (i.e. the PVC sewer main or other networks of potable water and sewer pipelines).

In relation to subsidence predictions for Longwall 304, MSEC (2019) make the following conclusions:

- Monitoring adjacent to Watermain 2 indicates the pipeline has experienced 1000mm maximum total subsidence, 4mm/m total tilt, 1.3 mm/m tensile strain and 1.8 mm/m compressive strain due to Longwalls 301-303. No impacts have been recorded to date for Watermain 1 and 2.
- It is expected that the potential impacts on the Sydney Water infrastructure (e.g. minor leakages) can be managed with the implementation of appropriate monitoring and management strategies. However, the incidence of impacts is likely to be very low and of a minor nature.

4.2.2 Risk Assessment Meeting

In accordance with the *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) a risk assessment meeting for Longwalls 301-303 was held on 15 August 2016. Attendees at the risk assessment meeting included representatives from Metropolitan Coal, Sydney Water, MSEC, Resource Strategies and Axys Consulting (risk assessment facilitator).

The investigation and analysis methods used during the risk assessment included:

- preliminary identification of Sydney Water assets[2];
- review of the revised subsidence predictions and potential impacts on Sydney Water assets (including consideration of past experience in the Southern Coalfield); and
- development of a preliminary monitoring plan.

A number of risk control measures and procedures were identified during the risk assessment which considered the extraction of coal beneath the Sydney Water assets, and are summarised as follows:

Baseline Data / Validation

1. Carry out an audit of the Sydney Water pipelines and valve chambers within the Study area to confirm physical access is available if the need to carry out repairs was required.
2. Install surface indicators (markers) that identify the location of the pipelines (where appropriate) so that the pipelines are easily located if the need to carry out repairs was required.

Management / Monitoring / Response Measures

3. Include acoustic monitoring as an additional monitoring system to monitor for leakage during the mining of Longwalls 301-303.
4. Investigate and develop a Trigger Action Response Plan (TARP) utilising the results of acoustic monitoring.

Contingency Planning

5. Include in the BFMP a table of key contacts of water suppliers that could assist to provide additional water for Sydney Water customers (if required).

Metropolitan Coal considers all risk control measures and procedures to be feasible to manage all identified risks.

The proposed risk control measures and procedures have been incorporated where relevant in this BFMP and the program for implementation is summarised in Table 3.

[2] During the risk assessment meeting, Sydney Water confirmed that the water storage tanks and connecting pipelines at the Garrawarra Centre Complex (initially considered during the Sydney Water risk assessment) were not a Sydney Water asset and are therefore managed separately in the Garrawarra Centre Complex BFMP (BFMP-GAR).

Table 3
Program for Implementation of Proposed Risk Control Measures and Procedures

	Risk Control Measure / Procedure	BFMP Section	Timing
Baseline Data / Validation			
1	Carry out an audit of Sydney Water pipelines and valve chambers to confirm physical access is available	Section 6	Completed
2	Install surface indicators (markers) so that pipelines are easily located	Section 6	Completed
Management / Monitoring / Response Measures			
3	Include acoustic monitoring to monitor for leakage in water mains during mining of Longwalls 301-303	Section 7 / Table 4	Under Trial during LW303
4	Investigate and develop a TARP utilising the results of acoustic monitoring	Section 10 / Table 6	Under consideration with Sydney Water
Contingency Planning			
5	Include a list of key contacts of water suppliers that could assist to provide additional water for Sydney Water customers.	Section 8	Complete

The risk control measures and procedures identified during the risk assessment for Longwalls 301-303 will be implemented for the extraction of Longwall 304.

5 PERFORMANCE MEASURES AND INDICATORS

The Project Approval requires Metropolitan Coal not to exceed the subsidence impact performance measures outlined in Table 1 of Condition 1, Schedule 3. The subsidence impact performance measure specified in Table 1 of Condition 1, Schedule 3 in relation to built features is:

> *Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.*

The performance indicators proposed to ensure that the above performance measure is achieved include:

- no more than repairable (minor) leakages of the water pipelines occur due to mining; and
- no more than repairable (minor) defects (cracks, etc.) in the structural integrity of the pipes and associated connections occur due to mining.

Section 7 of this BFMP-SYDNEY WATER describes the monitoring that will be conducted to assess the Project against the above performance measure. Sections 8 and 9 of this BFMP-SYDNEY WATER provide management measures and a Contingency Plan in the event the performance indicators are triggered or the performance measure is exceeded, respectively.

6 BASELINE DATA

A site inspection and audit of the pipelines occurred prior to commencement of secondary extraction of Longwall 301 to establish the pre-mining condition of the lines. The inspection will include:

- confirmation of physical access to the pipeline and valve chambers;
- recording of any existing pipeline defects (cracking, etc.);
- recording of any existing pipeline leaks;
- inspections of fittings (valves and hydrants) along the water mains in the vicinity of the longwalls for operability and condition. Water mains (size varies from 150 to 300 mm) to be checked.

The site inspection and audit will be conducted by representative(s) from Sydney Water and Metropolitan Coal. The inspections conducted as part of baseline data will include photographic records where appropriate.

Surface indicators (markers) were installed by Metropolitan Coal so that pipelines are easily located if the need to carry out repairs was required. Tracks were restored near pipeline to allow easier access for monitoring with vegetation removal and road repairs.

6.1 KEY CONTACTS LIST

The list of key contacts for Peabody and Sydney Water during the development and implementation of this BFMP are provided in Table 4.

Table 4
List of Key Contacts

Company / Agency	Peabody (Metropolitan Coal)	Sydney Water
Position	Manager – Technical Services	Networks Manager South
Name	Jon Degotardi	David Cantlon
Contact	Control Room 24hr 02 4294 7333	24hr Contact 13 20 90

7 MONITORING

A monitoring program has been implemented to monitor the impacts of the Project on the Sydney Water assets. Table 5 summarises the BFMP-SYDNEY WATER monitoring components.

Table 5
BFMP-SYDNEY WATER Monitoring Program Overview

Program	Aspect	Method	How	Why	Timing	Frequency
Baseline	Pipelines	Survey	Adjacent optic / water subsidence monitoring points at approximately 20 m spacing	Establish base condition	Prior to Longwall 301 extraction	Twice
		Visual inspection	Identify evidence of pre-existing cracks or leaks in the pipelines or fittings			
During Mining	Pipelines	Survey	Adjacent optic / water subsidence monitoring points at approximately 20 m spacing	Monitor subsidence effects during mining (subsidence, tilt, strain)	At the completion of each longwall	At end of each longwall extraction
		Visual inspection (Metropolitan Coal)	Identify evidence of subsidence effects (surface ground cracks), or cracks or leaks in the pipelines or fittings		Weekly when longwall within 400m of passing under pipeline	
		Visual inspection (Sydney Water)	Identify evidence of subsidence effects (surface ground cracks), or cracks or leaks in the pipelines or fittings		As per Sydney Water routine inspection program	
		Acoustic Monitoring – *additional option to be confirmed in consultation with Sydney Water*		Monitor for leak detection	Monitoring to occur in consultation with Sydney Water access to pipeline. Trial underway for Longwall 303 to confirm suitability of technique.	
	Helensburgh Tank Reservoir	Storage Levels (Sydney Water)	Monitor for sudden reduction in water levels		24 hours, 7 days per week (Sydney Water)	
Post Mining	Pipelines	Visual inspection (Sydney Water)		Validation	Next scheduled post mining	Once

Metropolitan Coal understands that Sydney Water monitors the nearby Helensburgh Tank/reservoir storage levels 24 hours, 7 days per week to operate as an indicator of significant water loss.

The frequency of monitoring will be reviewed either:

- in accordance with the Annual Review outlined in Section 12; or
- if triggered as a component of the Contingency Plan as outlined in Section 9 of this BFMP-SYDNEY WATER.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts for comparison with baseline photographic records. Sydney Water or their delegates will conduct the various visual inspections. Metropolitan Coal will be notified of the timing of inspections and accompany Sydney Water or delegates if considered necessary. All personnel will complete necessary inductions or orientation relevant to the tasks required.

7.1 SUBSIDENCE PARAMETERS

Subsidence parameters (i.e. subsidence, tilt, tensile strain, compressive strain, absolute horizontal translation, and differential leg movement) associated with mining will be measured by Metropolitan Coal in accordance with the Longwall 304 Subsidence Monitoring Program (Figure 6).

In summary, surveys will be conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence movements (i.e. subsidence, tilt, tensile strain and compressive strain) will be measured along subsidence lines that have been positioned across the general landscape.

Monitoring of subsidence parameters specific to the Sydney Water assets include the survey lines along the Old Princes Highway and the Optic / Water Line. The surveys will monitor the general movement about the longwalls and the data will allow evaluation of the likely ground movements about the pipelines (by comparison between measured and predicted movements).

7.2 SUBSIDENCE IMPACTS

7.2.1 Pipelines

Routine visual inspections by Sydney Water will also be conducted of the pipelines in accordance with the Sydney Water inspection program. For pipelines, this generally includes:

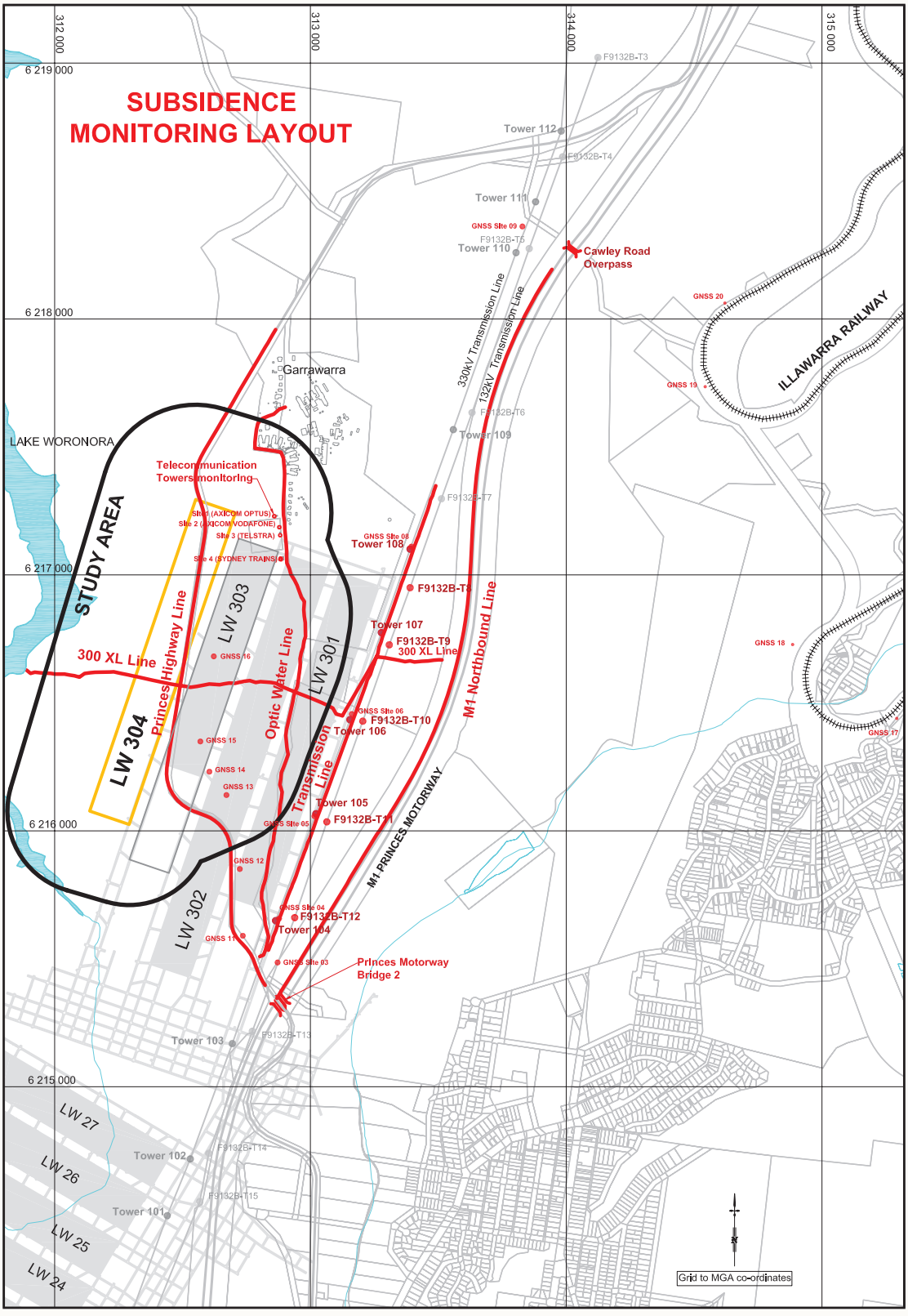
- assessment of the condition of water mains and associated fittings;
- inspection on fittings (valves and hydrants); and
- detection of leaks, breaks or water pressure drops in the pipeline reported by Sydney Water customers.

A visual inspection by Metropolitan Coal of the pipeline routes will occur prior to the longwall face approaching within 400 m of the pipelines, then weekly within 400 m zone.

Additional observations of subsidence impacts will be conducted during routine works. Specific details that will be noted and/or photographed include:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- assessment against the performance indicators and performance measure;
- whether any actions are required (e.g. initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

Acoustic monitoring will be considered to monitor for leakage in the Sydney Water pipelines. A trial was initiated in consultation with Sydney Water for Watermain 1 during Longwall 303 extraction to confirm suitability of technique.



MET-18-13_304 EP BFMP_017A

Source: MSEC (2019)

Peabody

METROPOLITAN COAL

Subsidence Monitoring Layout

Figure 6

7.3 ENVIRONMENTAL CONSEQUENCES

Metropolitan Coal and Sydney Water will compare the results of the subsidence impact monitoring against the built features performance indicators and performance measure. In the event the observed subsidence impacts exceed the performance measure, Metropolitan Coal and Sydney Water will assess the consequences of the exceedance in accordance with the Contingency Plan described in Section 9.

8 MANAGEMENT MEASURES

A number of potential management measures in relation to pipelines are considered to be applicable. These include:

- repair of broken pipes or fittings by Sydney Water maintenance staff; and
- if major adjustment is required to re-align pipe, the pipe can be temporarily end capped to maintain supply to customers either side of break and/or alternative water supply provided to service properties while repair of the water main is in progress[3].

A list of potential water suppliers (and key contact details) to temporarily supply water to Sydney Water customers (if required) is provided below:

- Aquarius (02 4776 2496); and
- CAC Transport (0418 386 177).

Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.

Management measures will be reported in the Annual Review (Section 12).

9 CONTINGENCY PLAN

In the event the subsidence impacts observed exceed the performance measure detailed in Section 5 of this BFMP–SYDNEY WATER, Metropolitan Coal will implement the following Contingency Plan (Appendix 4):

- The observation will be reported to the Manager – Technical Services within 24 hours.
- The observation will be recorded in the Built Features Management Plan – Subsidence Impact Register (Appendix 3) consistent with the monitoring program described in Section 7 of this BFMP-SYDNEY WATER.
- Metropolitan Coal will report any exceedance of the performance measure to the DP&E and Sydney Water as soon as practicable after Metropolitan Coal becomes aware of the exceedance.
- Metropolitan Coal will assess public safety and where appropriate implement safety measures in accordance with the Metropolitan Coal Longwall 304 Public Safety Management Plan;

[3] It is understood that water supply via reservoirs at Helensburgh, Stanwell Tops and Stanwell Park is available for a period of up to 12 hours.

- Metropolitan Coal will conduct an investigation to evaluate the potential contributing factors. The investigation will:
  - include the re-survey of relevant subsidence monitoring lines;
  - compare and critically analyse measured versus predicted subsidence parameters;
  - review measured subsidence parameters against the observed impact; and
  - review the subsidence monitoring program and update the program where appropriate.
- The course of action with respect to the identified impact(s), in consultation with specialists and relevant agencies, will include:
  - a program to review the effectiveness of the contingency measures; and
  - consideration of adaptive management.

  Contingency measures are provided in Section 9.1.
- Metropolitan Coal will submit the proposed course of action to the DP&E for approval.
- Metropolitan Coal will implement the approved course of action to the satisfaction of the DP&E.

In accordance with Condition 6, Schedule 6 of the Project Approval, Metropolitan Coal will provide a suitable offset to compensate for the impact to the satisfaction of the Director-General (now Secretary) of DP&E if either the contingency measures implemented by Metropolitan Coal have failed to remediate the impact or the Director-General (now Secretary) determines that it is not reasonable or feasible to remediate the impact.

Metropolitan Coal will comply with the NSW *Coal Mine Subsidence Compensation Act, 2017* in the event that property damages occur as a result of mining Longwalls 301-304.

9.1 CONTINGENCY MEASURES

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of environmental consequences).

Contingency measures that could be considered in the event the performance measure for the pipelines is exceeded are summarised in Table 6. The decision tree for the contingency measures are shown in Appendix 4.

Table 6
Contingency Measures – Pipelines

Environmental Consequence	Contingency Measures	
	Measure	**Description**
Impact on Pipelines	Re-install water main.	• Construction of new section of water main.

10 TARP – MANAGEMENT TOOL

The framework for the various components of the BFMP-SYDNEY WATER are summarised in the BFMP-SYDNEY WATER TARP shown in Table 7. The BFMP-SYDNEY WATER TARP shows how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

The TARP comprises:

- baseline conditions;
- predicted subsidence impacts;
- trigger levels from monitoring to assess performance; and
- triggers that flag implementation of contingency measures.

The TARP system provides a simple and transparent snapshot of the monitoring of environmental performance and the implementation of management and/or contingency measures.

Table 7
BFMP-SYDNEY WATER Trigger Action Response Plan

SYDNEY WATER Pipelines				
SYDNEY WATER Pipelines	*Risk: Subsidence effect on pipelines resulting in impact to structural integrity and leakage / loss of water.*			
	TRIGGER LEVEL			**RESPONSE**
	Level 1 - Normal **Expected subsidence conditions (at M1 Princes Motorway)**			
	Subsidence LW301/302 • less than 700 mm Tilt • less than 4.0 mm/m Tensile strain • less than 0.9 mm/m Compressive strain • less than 1.6 mm/m	Subsidence LW303 • less than 975 mm Tilt • less than 4.0 mm/m Tensile strain • less than 0.9 mm/m Compressive strain • less than 1.6 mm/m	Subsidence LW304 • less than 1050 mm Tilt • less than 4.0 mm/m Tensile strain • less than 0.9 mm/m Compressive strain • less than 1.6 mm/m	**Normal Operations** • Pipelines are safe and serviceable. • Negligible impact to Sydney Water infrastructure. • Continue monitoring activities as planned.
	Level 2 - Monitor **Subsidence elevated up to +15% of predicted but pipeline condition normal**			
	Subsidence LW301/302 • between 700 and 805 mm Tensile strain • between 0.9 mm/m and 1.0 mm/m Compressive strain • between 1.6 mm/m and 1.8 mm/m	Subsidence LW303 • between 975 and 1120 mm Tensile strain • between 0.9 mm/m and 1.0 mm/m Compressive strain • between 1.6 mm/m and 1.8 mm/m	Subsidence LW304 • between 1050 and 1200 mm Tensile strain • between 0.9 mm/m and 1.0 mm/m Compressive strain • between 1.6 mm/m and 1.8 mm/m	**Continue operations but report on subsidence anomaly** • Pipelines are safe and serviceable. • Negligible impact to Sydney Water infrastructure. **Metropolitan Coal** • Immediately resurvey subsidence line in affected area to confirm results. • Engage subsidence expert to assess results. • Confirm results are consistent with adjacent subsidence lines. • Compare and critically analyse measured versus predicted subsidence. • Inform and provide report to Sydney Water of subsidence results. • Collaboratively share information with Sydney Water to monitor situation. **Sydney Water** • Assess information provided by Metropolitan Coal. • Continue to conduct routine inspection program.

Table 7 (Continued)
BFMP-SYDNEY WATER Trigger Action Response Plan

<table>
<tr><td colspan="5">SYDNEY WATER Pipelines</td></tr>
<tr><td rowspan="4">SYDNEY WATER Pipelines</td><td colspan="4">Risk: Subsidence effect on pipelines resulting in impact to structural integrity and leakage / loss of water.</td></tr>
<tr><td colspan="3">TRIGGER LEVEL</td><td>RESPONSE</td></tr>
<tr><td colspan="4">Level 3 - Cautionary
Anomalous service condition detected or Subsidence beyond +15% of predicted</td></tr>
<tr><td>Subsidence LW301/302
• greater than 805 mm
Tensile strain
• greater than 1.0 mm/m
Compressive strain
• greater than 1.8 mm/m

Observable subsidence ground deformations or surface cracks at/near pipelines
Cracks or leaks in the pipelines or fittings
Loss of flow /pressure (acoustic monitoring for leakage)</td><td>Subsidence LW303
• greater than 1120 mm
Tensile strain
• greater than 1.0 mm/m
Compressive strain
• greater than 1.8 mm/m

Observable subsidence ground deformations or surface cracks at/near pipelines
Cracks or leaks in the pipelines or fittings
Loss of flow /pressure (acoustic monitoring for leakage)</td><td>Subsidence LW304
• greater than 1200 mm
Tensile strain
• greater than 1.0 mm/m
Compressive strain
• greater than 1.8 mm/m

Observable subsidence ground deformations or surface cracks at/near pipelines
Cracks or leaks in the pipelines or fittings
Loss of flow /pressure (acoustic monitoring for leakage)</td><td><u>Investigate & Resolve</u>
• Pipelines are safe and serviceable.
• Indication of impact (cracks / leakage) to Sydney Water infrastructure.
<u>Metropolitan Coal</u>
• Steps as per Level 2 event, plus:
o Inform Sydney Water and NSW Principal Subsidence Engineer of subsidence results (immediately following awareness of trigger).
o Increase frequency of subsidence line surveys to weekly in affected area.
o In conjunction with Sydney Water identify impact location and have Sydney Water assess pipeline condition.
o Review the subsidence monitoring program and update the program where appropriate.
o Provide report on issue to both Sydney Water and DP&E.
<u>Sydney Water</u>
• Inform Metropolitan Coal of deformations, cracks or leaks observed during routine monitoring inspections.
• In conjunction with Metropolitan Coal identify impact location, inspect pipeline infrastructure, assess condition and determine appropriate response
(e.g. greater monitoring data or frequency, or schedule maintenance on the pipeline infrastructure).
• Make determination if other measures necessary to avoid further impact.</td></tr>
</table>

Table 7 (Continued)
BFMP-SYDNEY WATER Trigger Action Response Plan

SYDNEY WATER Pipelines		
SYDNEY WATER Pipelines	*Risk: Subsidence effect on pipelines resulting in impact to structural integrity and leakage / loss of water.*	
	TRIGGER LEVEL	**RESPONSE**
	Level 4 – Restoration **Fault occurs (Significant flow/water loss)**	
	Fault Occurs • Sudden water loss at nearby reservoir storage levels	**Implement Contingency Plan** • As per BFMP Section 9 and Appendix 4. **Metropolitan Coal** As per Level 3 event, plus: o General Manager to be involved in all decision-making processes. o Assess public safety implications and where appropriate implement safety measures in accordance with Metropolitan Coal Longwall 304 Public Safety Management Plan. o Report exceedance of the performance measure or indicators to the DP&E and Sydney Water as soon as practicable. o Update the 'Built Features Management Plan – Subsidence Impact Register'. o Investigate circumstances of the fault / flow loss and determine requirement for adaptive management of mining operations prior to future operations. **Sydney Water** As per Level 3 event, plus: o Sydney Water to enact emergency measures (e.g. temporary supply of water to customers) and determine restoration works required. Complete restoration works. • Work in conjunction with Metropolitan Coal to investigate root cause of incident and determine appropriate future control measures.

11 FUTURE EXTRACTION PLANS

In accordance with Condition 7, Schedule 3 of the Project Approval, Metropolitan Coal will collect baseline data for the next Extraction Plan (i.e. Longwalls 305-310). The collection of baseline data will be consistent with the baseline data collected for Longwalls 301-304. Where possible, the baseline (and post-mining) data collected for Longwalls 301-304 will be used as baseline for Longwalls 305 onward as longwall mining progressively moves further away from the Sydney Water assets.

In addition to the baseline data collection, consideration of the environmental performance and management measures in accordance with the review(s) conducted as part of this BFMP-SYDNEY WATER will inform the appropriate type and frequency of monitoring of the assets relevant to the next Extraction Plan.

12 ANNUAL REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

In accordance with Condition 3, Schedule 7 of the Project Approval, Metropolitan Coal will conduct an Annual Review of the environmental performance of the Project by the end of March each year.

The Annual Review will:

- describe the works carried out in the past year, and the works proposed to be carried out over the next year;
- include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
  - relevant statutory requirements, limits or performance measures/criteria;
  - monitoring results of previous years; and
  - relevant predictions in the EA, Preferred Project Report and Extraction Plan;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

As described in Section 2, this BFMP-SYDNEY WATER will be reviewed within three months of the submission of an Annual Review, and revised where appropriate.

13 INCIDENTS

An incident is defined as a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in the Project Approval.

The reporting of incidents will be conducted in accordance with Condition 6, Schedule 7 of the Project Approval. Metropolitan Coal will notify the Director-General (now Secretary) of DP&E and any other relevant agencies of any incident associated with the Project as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of DP&E and any relevant agencies with a detailed report on the incident.

Sydney Water will be notified within 24 hours of any access limitations or restrictions.

14 COMPLAINTS

A protocol for the managing and reporting of complaints has been developed as a component of Metropolitan Coal's Environmental Management Strategy and is described below.

The Environment & Community Superintendent is responsible for maintaining a system for recording complaints.

Metropolitan Coal will maintain public signage advertising the telephone number on which environmental complaints can be made. The Environment & Community Superintendent is responsible for ensuring that the currency and effectiveness of the service is maintained. Notifications of complaints received are to be provided as quickly as practicable to the Environment & Community Superintendent.

Complaints and enquiries do not have to be received via the telephone line and may be received in any other form. Any complaint or enquiry relating to environmental management or performance is to be relayed to the Environment & Community Superintendent as soon as practicable. All employees are responsible for ensuring the prompt relaying of complaints. All complaints will be recorded in a complaints register.

For each complaint, the following information will be recorded in the complaints register:

- date and time of complaint;
- method by which the complaint was made;
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
- nature of the complaint;
- the action(s) taken by Metropolitan Coal in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken by Metropolitan Coal, the reason why no action was taken.

The Environment & Community Superintendent is responsible for ensuring that all complaints are appropriately investigated, actioned and that information is fed back to the complainant, unless requested to the contrary.

In accordance with Condition 10, Schedule 7 of the Project Approval, the complaints register will be made publicly available on the website and updated on a monthly basis. A summary of complaints received and actions taken will be presented to the Community Consultative Committee as part of the operational performance review.

15 NON-COMPLIANCES WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of the Metropolitan Coal Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with Metropolitan Coal, and will be developed through promotion of Metropolitan Coal ownership under the direction of the General Manager.

The Manager - Technical Services and/or Environment & Community Superintendent will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 13, Metropolitan Coal will notify the Director-General (now Secretary) of the DP&E and any other relevant agencies of any incident associated with Metropolitan Coal as soon as practicable after Metropolitan Coal becomes aware of the incident. Within seven days of the date of the incident, Metropolitan Coal will provide the Director-General (now Secretary) of the DP&E and any relevant agencies with a detailed report on the incident.

A review of Metropolitan Coal's compliance with all conditions of the Project Approval, mining leases and all other approvals and licences will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the Peabody website.

Additionally, in accordance with Condition 8, Schedule 7 of the Project Approval, an independent environmental audit was undertaken by the end of December 2011, and is undertaken a minimum of once every three years thereafter. A copy of the audit report will be submitted to the Director-General (now Secretary) of the DP&E and made publicly available on the Peabody website. The independent audit will be undertaken by an appropriately qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General (now Secretary) of the DP&E.

16 REFERENCES

Department of Planning & Environment and Division of Resources and Energy (2015) *Guidelines for the Preparation of Extraction Plans*.

Helensburgh Coal Pty Ltd [HCPL] (2008) *Metropolitan Coal Project Environmental Assessment*.

Helensburgh Coal Pty Ltd [HCPL] (2009) *Metropolitan Coal Project Preferred Project Report.*

Mine Subsidence Engineering Consultants (2008) *Subsidence Assessment Report on the Prediction of Subsidence Parameters and the Assessment of Mine Subsidence Impacts on Natural Features and Surface Infrastructure Resulting from the Proposed Extraction of Longwalls 20 to 44 at Metropolitan Colliery in Support of a Part 3A Application.*

Mine Subsidence Engineering Consultants (2016) *Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Sydney Water Infrastructure, dated 1 September 2016*.

Mine Subsidence Engineering Consultants (2019) *Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Sydney Water Infrastructure.*

APPENDIX 1

MSEC (2016) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 301 TO 303 - SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE SYDNEY WATER INFRASTRUCTURE, DATED 1 SEPTEMBER 2016

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

1st September 2016

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC844-09

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Sydney Water Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Sydney Water infrastructure resulting from the extraction of the proposed Longwalls 301 to 303 at Metropolitan Colliery.

The locations of the Sydney Water infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC844-09. There are two potable water supply pipelines located above the longwalls. Water main 1 is a 300 mm diameter Cast Iron Cement Lined (CICL) pipeline and Water Main 2 is a 300 mm diameter CICL pipeline.

A sewer main is located outside the Study Area to the north of the longwalls. This pipeline is 150 mm PVC pressure main. There are also networks of potable water and sewer pipelines located outside and in the vicinity of the Study Area, within the township of Helensburgh to the south-east of the longwalls. These networks are located at a minimum distance of 0.9 kilometres from Longwall 301.

The predictions and impact assessments for the Sydney Water infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the Sydney Water Infrastructure

The following provides summaries of the maximum predicted conventional movements for the Sydney Water infrastructure resulting from the extraction of Longwalls 301 to 303. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

The predicted profiles of incremental and total conventional subsidence, tilt and curvature along the alignments of the two potable water mains, resulting from the extraction of Longwalls 301 to 303, are shown in the attached Figs. A.1 and A.2. The black dashed lines are the incremental profiles that represent the additional movements due to each of the longwalls. The solid blue lines represent the total or accumulated movements after the completion of each longwall. The range of predicted curvatures in any direction at any time during or after the extraction of the longwalls is shown by the grey shading.

Summaries of the maximum predicted values of incremental subsidence, tilt and curvature for the water mains, due to the extraction of each of the Longwalls 301 to 303, are provided in Table 1 and Table 2. The values are the maxima anywhere along the pipelines at any time during or after the extraction of each longwall.

Table 1 Maximum Predicted Incremental Subsidence, Tilt and Curvature for Water Main 1 Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
Due To LW301	70	< 0.5	< 0.01	0.01
Due To LW302	650	4.0	0.05	0.07
Due To LW303	625	3.0	0.06	0.06

Table 2 Maximum Predicted Incremental Subsidence, Tilt and Curvature for Water Main 2 Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
Due To LW301	80	< 0.5	< 0.01	0.01
Due To LW302	625	2.0	0.04	0.12
Due To LW303	500	2.5	0.06	0.07

The maximum predicted incremental subsidence for the water mains, due to the extraction of each of the Longwalls 301 to 303, varies between 70 mm to 650 mm.

Summaries of the maximum predicted values of total subsidence, tilt and curvature for the water mains, resulting from the extraction of Longwalls 301 to 303, are provided in Table 3 and Table 4. The values are the maxima anywhere along the pipelines at any time during or after the extraction of the longwalls.

Table 3 Maximum Predicted Total Subsidence, Tilt and Curvature for Water Main 1 Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	70	< 0.5	< 0.01	0.01
After LW302	700	4.0	0.05	0.06
After LW303	900	2.5	0.05	0.09

Table 4 Maximum Predicted Total Subsidence, Tilt and Curvature for Water Main 2 Resulting from the Extraction of Longwalls 301 to 303

Longwall	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})
After LW301	80	< 0.5	< 0.01	0.01
After LW302	675	2.5	0.04	0.11
After LW303	875	3.0	0.04	0.13

The maximum predicted total subsidence for the water mains, resulting from the extraction of Longwalls 301 to 303, are 900 mm for Water Main 1 and 875 mm for Water Main 2. The maximum predicted conventional tilt for these pipelines is 3.0 mm/m (i.e. 0.3 %, or 1 in 333). The maximum predicted conventional curvatures are 0.05 km^{-1} hogging and 0.13 km^{-1} sagging, which equate to minimum radii of curvature of 20 kilometres and 8 kilometres, respectively.

The sewer main and networks of water and sewerage pipelines located within the township of Helensburgh are not expected to experience any measurable vertical subsidence, tilts, curvatures or strains. The pipelines could experience low level far-field horizontal movements. However, these absolute horizontal movements tend to be bodily movements that are not associated with measurable strains.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the Sydney Water infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The Sydney Water infrastructure is partially located above Longwalls 301 to 303. A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 1. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

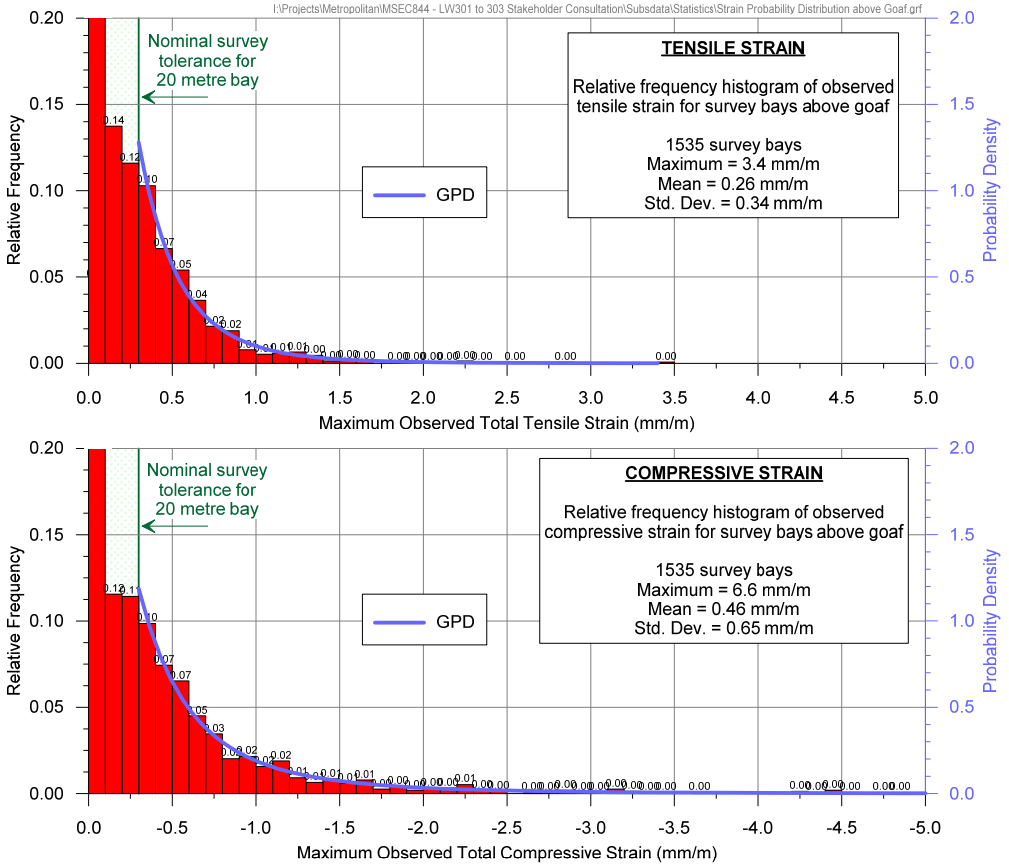


Figure 1 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based on the fitted GPDs, is provided in Table 5.

Table 5 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures and the streams are shown in Drawing No. MSEC844-09.

There are no mapped faults located within the extents of Longwalls 301 to 303. It is possible that the infrastructure located above the longwalls could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The water mains do not cross any major streams within the Study Area. These pipelines, therefore, are not expected to experience any measurable valley closure effects.

Impact Assessments for the Water Pipelines

The two potable water mains located above the longwalls are pressure mains and, therefore, are unlikely to be adversely impacted by the mining induced vertical subsidence or tilt. These pipelines are direct buried and are likely to experience the curvatures and ground strains resulting from the extraction of these longwalls.

The maximum predicted conventional curvatures for the water mains are 0.05 km^{-1} hogging and 0.13 km^{-1} sagging, which equate to minimum radii of curvature of 20 kilometres and 8 kilometres, respectively. Localised and elevated curvatures could develop along the pipelines due to non-conventional movements resulting from near surface geological structures (i.e. anomalies).

The predicted curvatures and strains for the water mains are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar pipelines. It has been found from this previous experience that the impacts on CICL pipelines in the Southern Coalfield are rare and generally of a minor nature.

Some examples of mining beneath water mains in the Southern Coalfield are provided in Table 6.

Table 6 Examples of Mining Beneath Water Mains in the Southern Coalfield

Colliery and Longwalls	Pipelines	Observed Movements	Observed Impacts
Appin LW301 and LW302	0.6 km of 150 dia DICL 0.6 km of 300 dia CICL 0.6 km of 1200 dia SCL	650 mm Subsidence 4.5 mm/m Tilt 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	Leakage of the 150 mm and 300 mm CICL pipelines at a creek crossing, elsewhere no other reported impacts
Tahmoor LW22 to LW25	2.7 km DICL pipes 7.3 km CICL pipes	1200 mm Subsidence 6 mm/m Tilt 1.5 mm Tensile Strain 2 mm (typ.) and up to 5 mm/m Comp. Strain (Extensive street monitoring)	One reported impact to the distribution network and a very small number of minor leaks in the consumer connection pipes
West Cliff LW5A3, LW5A4 & LW29 to LW34	2.8 km of 100 dia CICL pipe directly mined beneath	1100 mm Subsidence 10 mm/m Tilt 1 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	No reported impacts

Based on this experience, it is possible that some minor leakages of the water mains could occur as the result of the extraction of Longwalls 301 to 303. However, the incidence of impacts is likely to be very low and of a minor nature. It is expected that any impacts could be remediated by locally exposing the pipeline and repairing or replacing the affected section.

It is recommended that monitoring and management strategies are developed, in consultation with Sydney Water, to manage the potential impacts on the water mains that are located directly above the longwalls. It is expected that these pipelines can be maintained in serviceable conditions with the implementation of the appropriate monitoring and management strategies.

The sewer main in the northern part of the Study Area and the networks of water and sewer pipelines located within the township of Helensburgh are all located outside of the predicted 20 mm subsidence contour. It is unlikely that these pipelines would experience adverse impacts as a result of Longwalls 301 to 303.

Summary

The potable water mains are located directly above Longwalls 301 to 303. The previous experience from the Southern Coalfield has found that the potential impacts on these types of pipelines can be managed with the implementation of suitable monitoring and management strategies. It is unlikely that adverse impacts would occur for the water and sewer mains located outside the extents of the longwalls.

It is expected that the potential impacts on the Sydney Water infrastructure can be managed with the implementation of the appropriate monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:

Drawing No. MSEC844-09 – Longwalls 301 to 303 – Sydney Water Infrastructure

Fig. A.1 Predicted Profiles of Conventional Subsidence, Tilt and Curvature for Water Main (1) due to LW301 to LW303

Fig. A.2 Predicted Profiles of Conventional Subsidence, Tilt and Curvature Water Main (2) due to LW301 to LW303

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msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
PO Box 302, Chatswood NSW 2057
Tel +61 2 9413 3777
www.minesubsidence.com

METROPOLITAN COAL

METROPOLITAN COLLIERY
LONGWALLS 301 TO 303
SYDNEY WATER

DATE:	SCALE:	DRAWING No:	Rev No
30-Aug-2016	1:12500	MSEC844-09	D

Grid to MGA co-ordinates

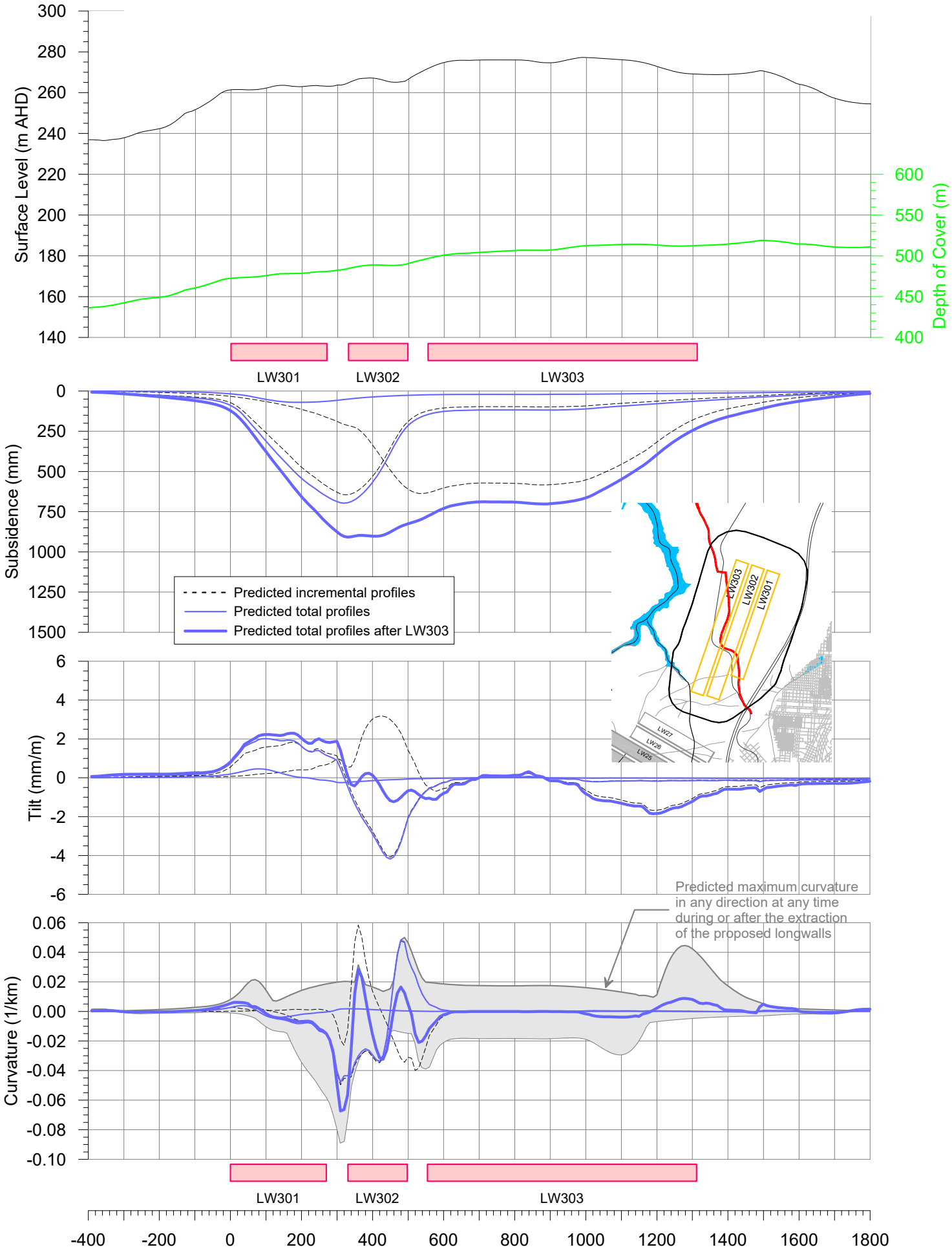
313 000
314 000
312 000
6 217 000
6 216 000
6 215 000
6 214 000

WATERMAIN
SEWER MAINS
CAWLEY ROAD OVERPASS
CAWLEYS CK
M1 PRINCES MOTORWAY
METROPOLITAN FAULT
WORONORA RESERVOIR
20mm SUBSIDENCE CONTOUR
20
OLD PRINCES HIGHWAY
LW303
LW302
LW301
WATER MAIN 1
WATER MAIN 2
WILSONS CK
PRINCES HIGHWAY UNDERPASS 2
STUDY AREA
FAULT
LW27
LW26
LW25
LW24
LW23B
MAIN WEST FAULT
POWELL FAULT
LONG HOLE FAULT
HELENSBURGH RESERVOIR WS0048

GEOLOGICAL STRUCTURES
FAULTS
DYKES

LEGEND
WATER PIPELINES
SEWER PIPELINES

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Water Main (1) due to LW301 to LW303



msec

Fig. A.1

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Water Main (2) due to LW301 to LW303

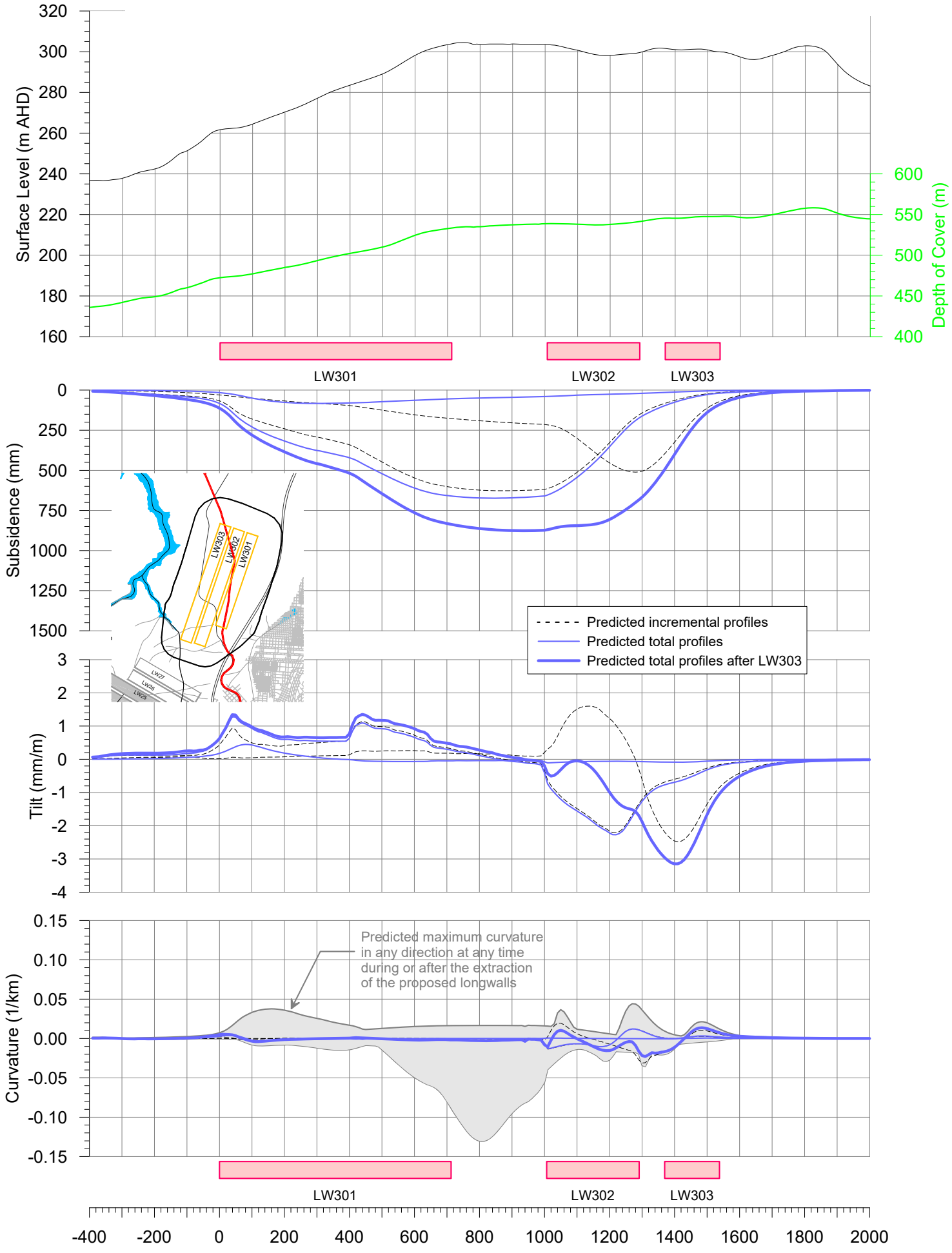


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Fig. A.2

APPENDIX 2

MSEC (2019) METROPOLITAN COLLIERY – PROPOSED LONGWALL 304 – SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENTS FOR THE SYDNEY WATER INFRASTRUCTURE

Suite 402, Level 4, 13 Spring Street
Chatswood NSW 2067
PO Box 302
Chatswood NSW 2057
Tel +61 2 9413 3777
enquiries@minesubsidence.com
www.minesubsidence.com

14th March 2019

Jon Degotardi
Peabody Energy Australia
Metropolitan Colliery
PO Box 402
Helensburgh NSW 2508

Ref: MSEC1013-09

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwall 304 - Subsidence Predictions and Impact Assessments for the Sydney Water Infrastructure

This letter report summarises the predicted subsidence movements and the assessed subsidence impacts for the Sydney Water infrastructure resulting from the extraction of the proposed Longwall 304 at Metropolitan Colliery.

The locations of the Sydney Water infrastructure and the proposed longwall are shown in the attached Drawing No. MSEC1013-09. A Study Area is shown in Drawing No. MSEC1013-09 and is based on the outer limits of a 35° angle of draw line from Longwall 304 and the predicted 20mm subsidence contour for Longwall 304. There are two potable water supply pipelines located within the Study Area. *Water Main 1* crosses the proposed Longwall 304 and Longwalls 301 to 303, and comprises a 300 mm diameter Cast Iron Cement Lined (CICL) pipeline. *Water Main 2* crosses Longwalls 301 to 303 and comprises a 300 mm diameter CICL pipeline.

A sewer main is located outside the Study Area, 650 m to the north east of Longwall 304. This pipeline is 150 mm PVC pressure main. There are also networks of potable water and sewer pipelines located outside of the Study Area, within the nearby township of Helensburgh to the south-east of the longwalls. These networks are located at a minimum distance of 1.5 km from Longwall 304.

The predictions and impact assessments for the Sydney Water infrastructure are provided in the following sections.

Conventional Subsidence Parameters for the Sydney Water Infrastructure

The following provides summaries of the maximum predicted conventional movements for the Sydney Water infrastructure following the extraction of Longwall 303 and after the extraction of Longwall 304. It is possible that localised and elevated movements could develop as the result of non-conventional ground movements due to geological structures or valley closure effects. Discussions on the potential for non-conventional movements are provided in this letter report.

The predicted profiles of total conventional subsidence, tilt and curvature along the alignments of the two potable water mains, following the extraction of Longwall 303 and after the extraction of Longwall 304, are shown in the attached Figs. A.1 and A.2. The solid blue lines represent the total or accumulated movements after the completion of each longwall. The range of predicted curvatures in any direction at any time during or after the extraction of the longwalls is shown by the grey shading.

Summaries of the maximum predicted values of total subsidence, tilt and curvature for the water mains, following the extraction of Longwall 303 and after the extraction of Longwall 304, are provided in Table 1 and Table 2. The values are the maxima anywhere along the pipelines at any time during or after the extraction of the longwalls.

Table 1 Maximum Predicted Total Subsidence, Tilt and Curvature for Water Main 1 after the Extraction of Longwalls 303 and 304

Longwall	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})
After LW303	975	2.0	0.05	0.09
After LW304	1050	3.5	0.05	0.09

Table 2 Maximum Predicted Total Subsidence, Tilt and Curvature for Water Main 2 after the Extraction of Longwalls 303 and 304

Longwall	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})
After LW303	925	3.5	0.03	0.13
After LW304	1000	3.5	0.04	0.13

The maximum predicted total subsidence for the water mains, following the extraction of Longwall 303 and after the extraction of Longwall 304, are 1050 mm for Water Main 1 and 1000 mm for Water Main 2. The maximum predicted conventional tilt for these pipelines is 3.5 mm/m (i.e. 0.35 %, or 1 in 285). The maximum predicted conventional curvatures are 0.05 km^{-1} hogging and 0.13 km^{-1} sagging, which equate to minimum radii of curvature of 20 kilometres and 8 kilometres, respectively.

The sewer main and networks of water and sewerage pipelines located within the township of Helensburgh are not expected to experience any measurable vertical subsidence, tilts, curvatures or strains. The pipelines could experience low level far-field horizontal movements. However, these absolute horizontal movements tend to be bodily movements that are not associated with measurable strains.

Predicted Strains

The prediction of strain is more difficult than the predictions of subsidence and tilt. 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 average 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. In the Southern Coalfield, it has been found that a factor of 15 provides a reasonable relationship between the predicted maximum curvatures and the predicted maximum conventional 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 to experience sagging or concave curvature are expected to be net compressive strain zones.

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 strain for low magnitudes of curvature. We have therefore provided a statistical approach to account for the variability, instead of just providing a single predicted conventional strain.

The range of predicted strains for the Sydney Water infrastructure has been determined using the monitoring data from Metropolitan Colliery and other nearby collieries. 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. The strains resulting from damaged or disturbed survey marks have also been excluded.

The Sydney Water infrastructure is located above existing Longwalls 301 to 303, and 304. A histogram of the maximum tensile and compressive strains measured in survey bays located above previously extracted longwalls in the Southern Coalfield is provided in Figure 1. The probability distribution functions, based on a fitted *Generalised Pareto Distribution (GPD)*, have also been shown in this figure.

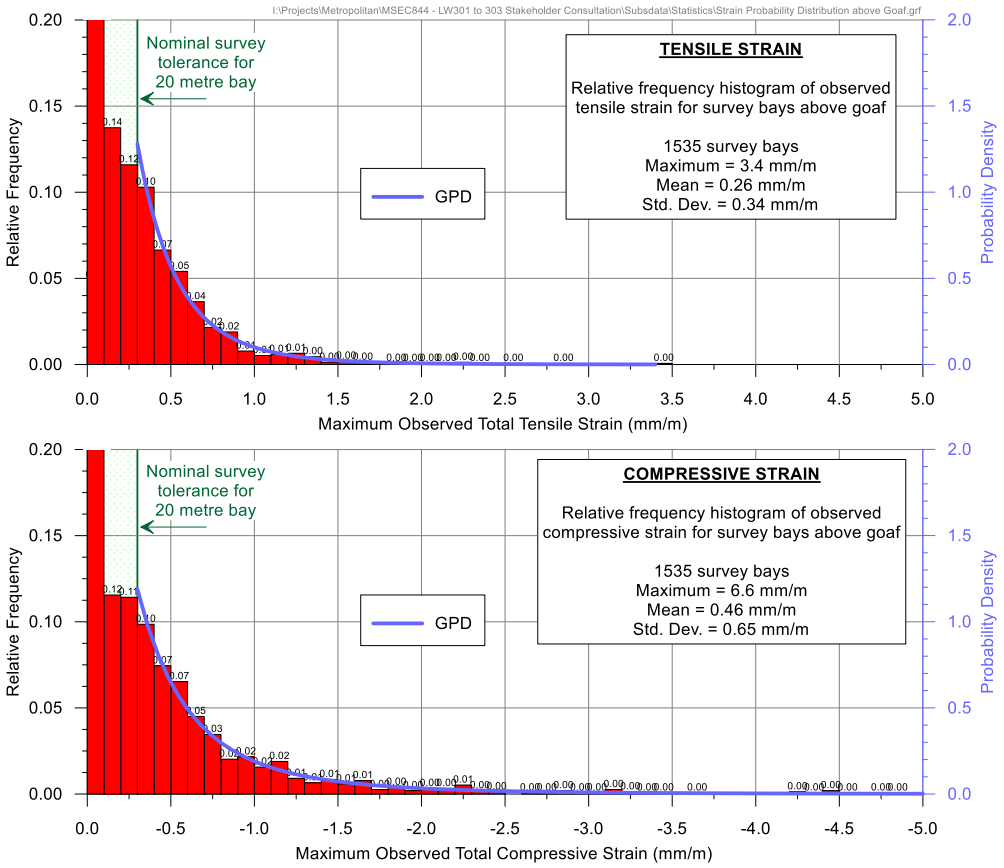

Figure 1 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

Confidence intervals 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).

A summary of the probabilities of exceedance for tensile and compressive strains for survey bays located above goaf, based on the fitted GPDs, is provided in Table 3.

Table 3 Probabilities of Exceedance for Strain for Survey Bays Located above Goaf

Strain (mm/m)		Probability of Exceedance
Compression	-8.0	1 in 1,300
	-6.0	1 in 570
	-4.0	1 in 185
	-2.0	1 in 35
	-1.0	1 in 9
	-0.5	1 in 3
	-0.3	1 in 2
Tension	+0.3	1 in 3
	+0.5	1 in 6
	+1.0	1 in 30
	+2.0	1 in 300
	+3.0	1 in 1,800

The 95 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 0.9 mm/m tensile and 1.6 mm/m compressive. The 99 % confidence intervals for the maximum total strains that the individual survey bays above goaf experienced at any time during mining are 1.5 mm/m tensile and 3.2 mm/m compressive.

Potential for Non-Conventional Movements

Non-conventional movements can develop due to the presence of geological structures or valley related effects. In some cases, non-conventional movements can develop with no known cause and these are often referred to as 'anomalous' movements.

The locations of the known geological structures at seam level and the major streams are shown in Drawing No. MSEC1013-09. There are no mapped faults located within the Study Area that extend beneath the Sydney Water infrastructure. It is possible that the infrastructure located above the longwalls could experience localised and elevated strains due to unknown geological structures (i.e. anomalies). Non-conventional or anomalous movements have not been identified during the extraction of Longwalls 301 and 302 and part extraction of Longwall 303. The range of strains provided in the previous section include those resulting from irregular anomalous movements.

The water mains do not cross any major streams within the Study Area. These pipelines, therefore, are not expected to experience any measurable valley closure effects.

Impact Assessments for the Water Pipelines

The two potable water mains located above the longwalls are pressure mains and, therefore, are unlikely to be adversely impacted by the mining induced vertical subsidence or tilt. These pipelines are direct buried and are likely to experience the curvatures and ground strains resulting from the extraction of these longwalls.

The maximum predicted conventional curvatures for the water mains are 0.05 km^{-1} hogging and 0.13 km^{-1} sagging, which equate to minimum radii of curvature of 20 kilometres and 8 kilometres, respectively. Localised and elevated curvatures could develop along the pipelines due to non-conventional movements resulting from unknown near surface geological structures (i.e. anomalies).

The predicted curvatures and strains for the water mains are similar to those where longwalls in the Southern Coalfield have previously mined directly beneath similar pipelines. It has been found from this previous experience that the impacts on CICL pipelines in the Southern Coalfield are rare and generally of a minor nature.

Some examples of mining beneath water mains in the Southern Coalfield are provided in Table 4.

Table 4 Examples of Mining Beneath Water Mains in the Southern Coalfield

Colliery and Longwalls	Pipelines	Observed Movements	Observed Impacts
Appin LW301 and LW302	0.6 km of 150 dia DICL 0.6 km of 300 dia CICL 0.6 km of 1200 dia SCL	650 mm Subsidence 4.5 mm/m Tilt 1 mm/m Tensile Strain 3 mm/m Comp. Strain (Measured M & N-Lines)	Leakage of the 150 mm and 300 mm CICL pipelines at a creek crossing, elsewhere no other reported impacts
Tahmoor LW22 to LW25	2.7 km DICL pipes 7.3 km CICL pipes	1200 mm Subsidence 6 mm/m Tilt 1.5 mm Tensile Strain 2 mm (typ.) and up to 5 mm/m Comp. Strain (Extensive street monitoring)	One reported impact to the distribution network and a very small number of minor leaks in the consumer connection pipes
West Cliff LW5A3, LW5A4 & LW29 to LW34	2.8 km of 100 dia CICL pipe directly mined beneath	1100 mm Subsidence 10 mm/m Tilt 1 mm/m Tensile Strain 5.5 mm/m Comp. Strain (Measured B-Line)	No reported impacts

Based on this experience, it is possible that some minor leakages of the water mains could occur following the extraction of Longwall 303 and after the extraction of Longwall 304. However, the incidence of impacts is likely to be very low and of a minor nature. It is expected that any impacts could be remediated by locally exposing the pipeline and repairing or replacing the affected section.

Watermain 1 and 2 have been mined beneath by Longwall 301 and 302 and currently by Longwall 303. Monitoring adjacent to Watermain 2 indicates the pipeline has experienced 1000mm maximum total subsidence, 4mm/m total tilt, 1.3 mm/m tensile strain and 1.8 mm/m compressive strain. No impacts have been recorded to date for Watermain 1 and 2.

It is recommended that monitoring and management strategies developed for the extraction of Longwalls 301 to 303 are updated and continued, in consultation with Sydney Water, to manage the potential impacts on the water mains that are located directly above the longwalls. It is expected that these pipelines can be maintained in serviceable conditions with the implementation of the appropriate monitoring and management strategies.

The sewer main adjacent to the north-eastern part of the Study Area and the networks of water and sewer pipelines located within the township of Helensburgh are all located outside of the predicted 20 mm subsidence contour. It is unlikely that these pipelines would experience adverse impacts as a result of the proposed Longwall 304.

Summary

Potable water mains are located directly above proposed Longwall 304 and the water mains also cross Longwalls 301 to 303. The previous experience from the Southern Coalfield has found that the potential impacts on these types of pipelines can be managed with the implementation of suitable monitoring and management strategies. It is unlikely that adverse impacts would occur for the water and sewer mains located outside the extents of the longwalls.

It is expected that the potential impacts on the Sydney Water infrastructure can be managed with the implementation of the appropriate monitoring and management strategies.

Yours sincerely

Peter DeBono

Attachments:

Drawing No. MSEC1013-09 – Longwall 304 – Sydney Water Infrastructure

Fig. A.1 Predicted Profiles of Conventional Subsidence, Tilt and Curvature for Water Main (1) after LW303 and after LW304

Fig. A.2 Predicted Profiles of Conventional Subsidence, Tilt and Curvature Water Main (2) after LW303 and after LW304

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Water Main 1 due to LW304

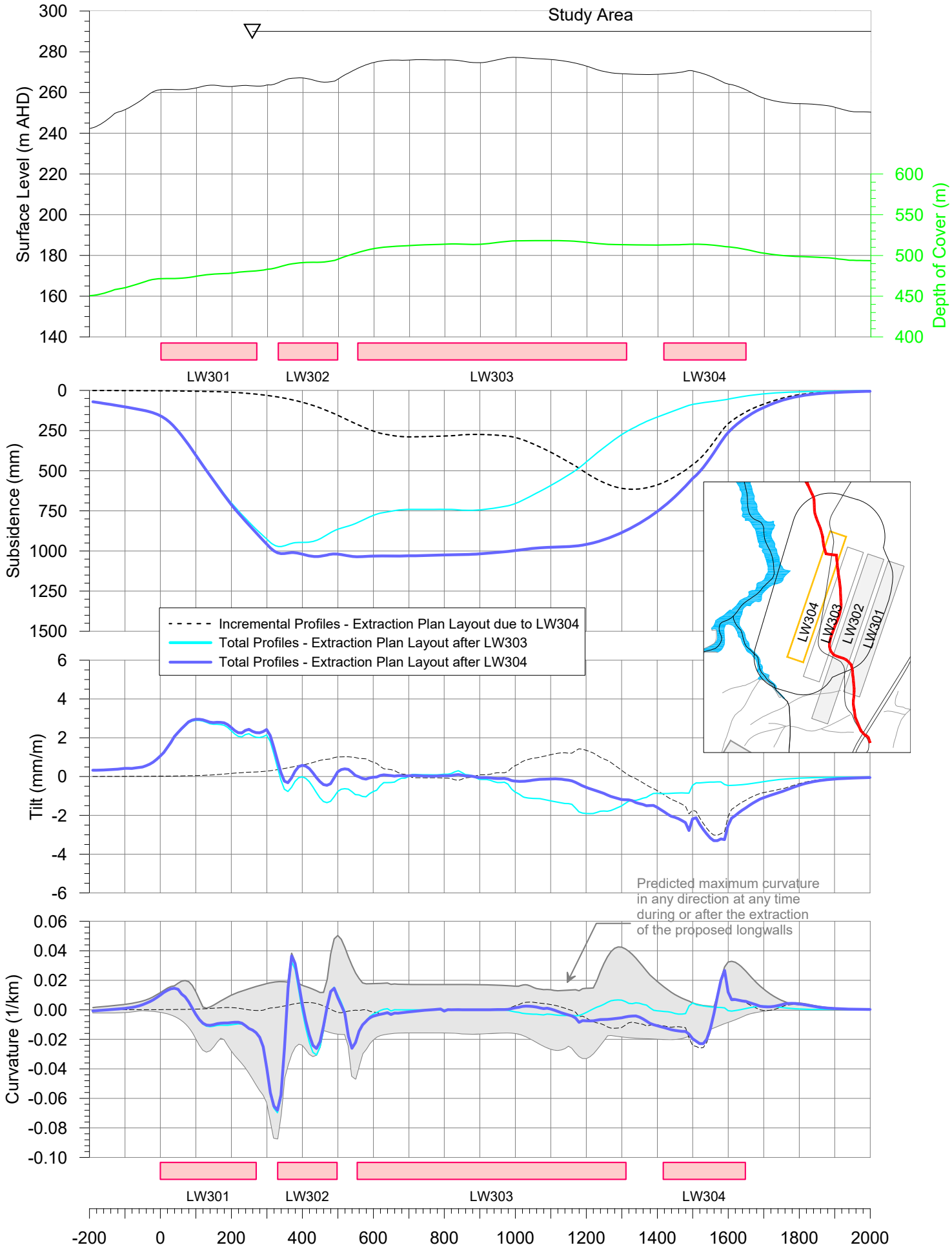

Fig. A.01

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along Water Main 2 due to LW304

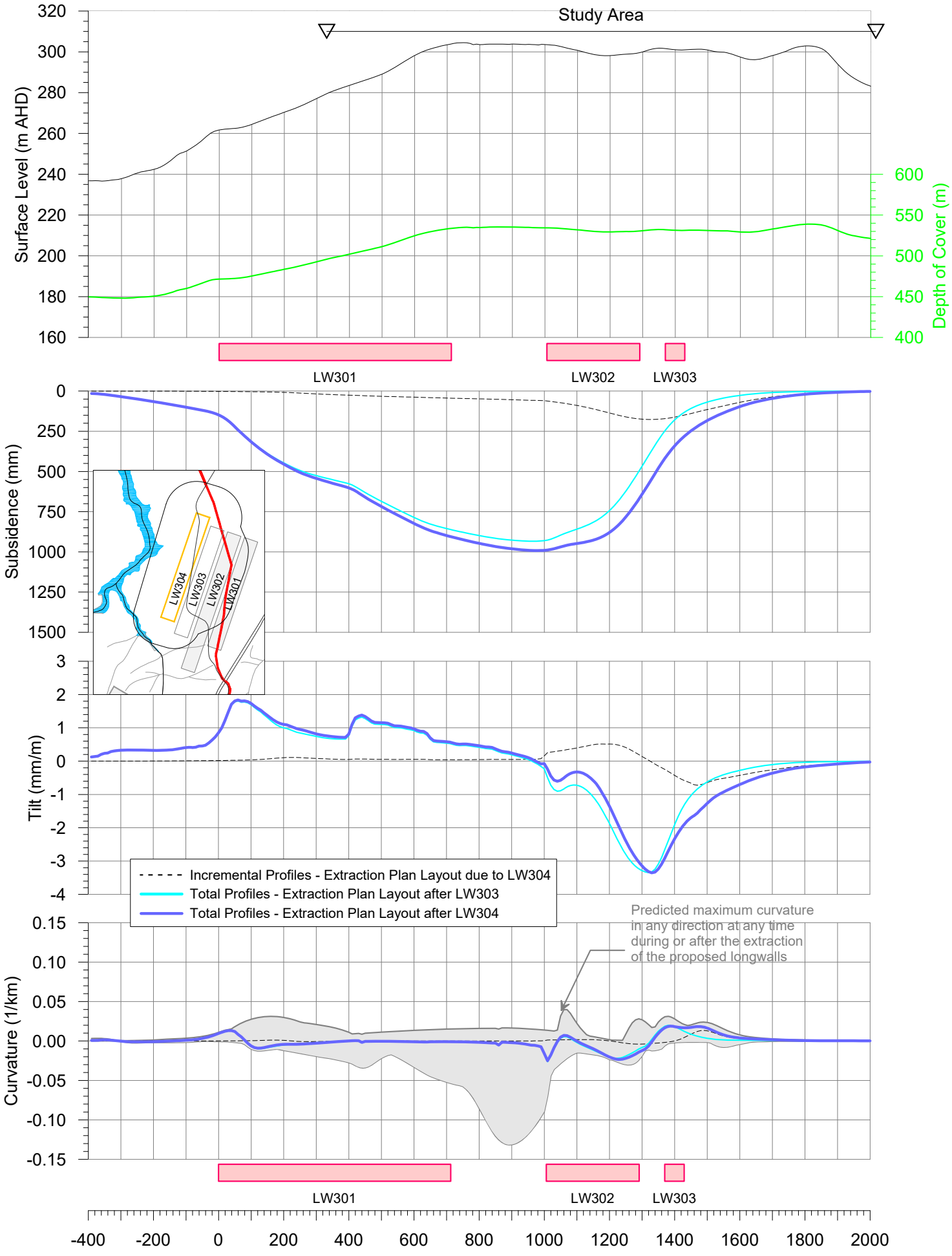

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Fig. A.02

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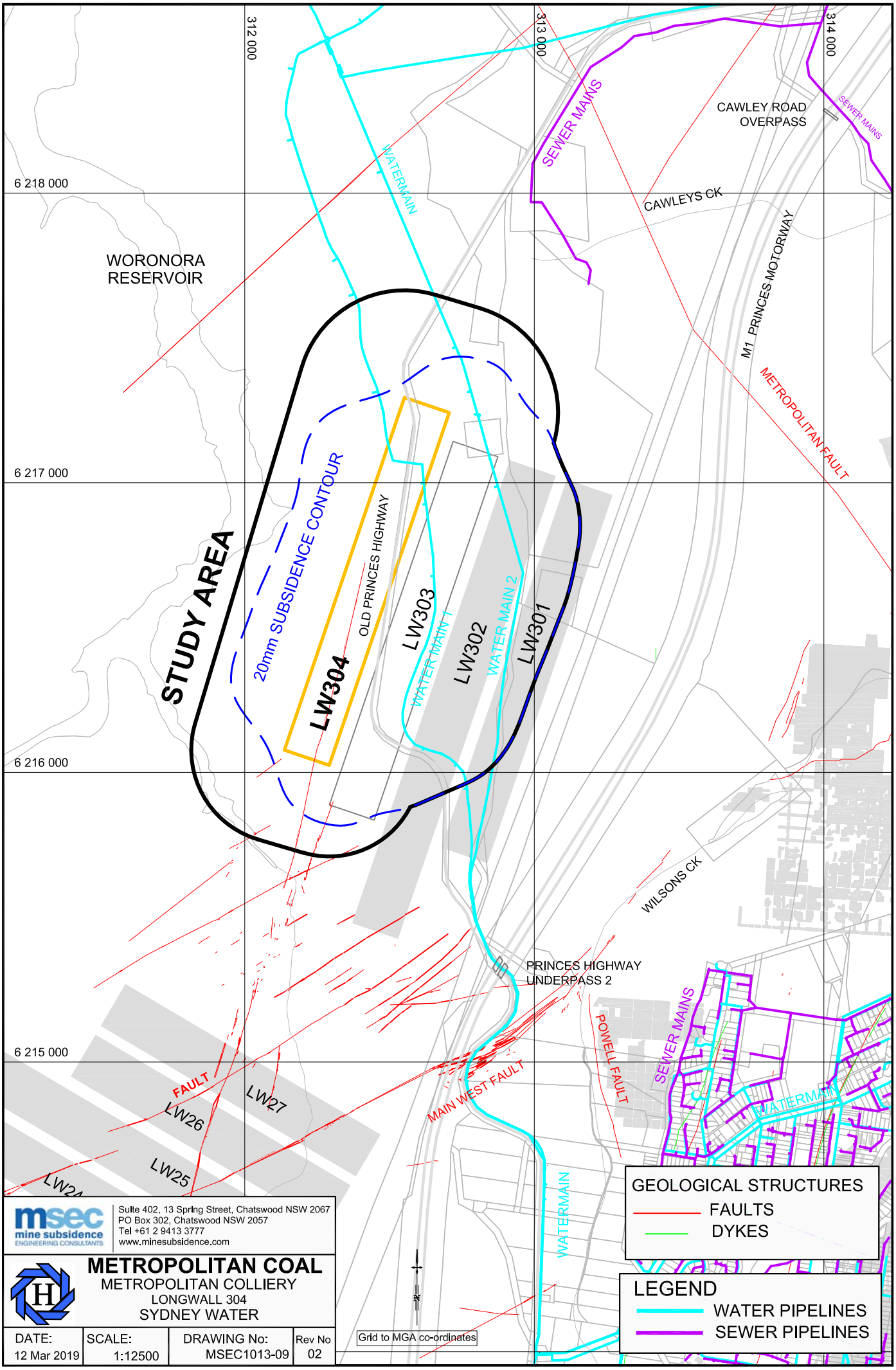

msec mine subsidence ENGINEERING CONSULTANTS
Suite 402, 13 Spring Street, Chatswood NSW 2067
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METROPOLITAN COAL

METROPOLITAN COLLIERY
LONGWALL 304
SYDNEY WATER

DATE:	SCALE:	DRAWING No:	Rev No
12 Mar 2019	1:12500	MSEC1013-09	02

APPENDIX 3

BUILT FEATURES MANAGEMENT PLAN – SUBSIDENCE IMPACT REGISTER

Built Features Management Plan - Subsidence Impact Register

Impact Register Number[1]	Built Feature[2]	Impact Description	Does Impact Exceed the Built Feature Performance Measure/Indicators? (Yes/No)	Management Measures Implemented	Were Management Measures Effective? (Yes/No)

Notes:

1: Fill out all details in the Assessment Form and record the register number here.

2: Built feature (e.g. pipeline, etc.).

Built Feature Management Plan – Subsidence Impact Register
Assessment Form

Date:

Observer (Name and position):

Register Number (i.e. Number 1, 2, etc.):

Longwall Number and Chainage:

Location of Observed Impact:

(Examples: location of tank, include GPS co-ordinates and a sketch)

Description of Observed Impact:

(Examples: nature and extent of impact - cracks in road etc any relevant information, attach photographs)

Person Notified:	Manager - Technical Services	☐

Description of Photographs:

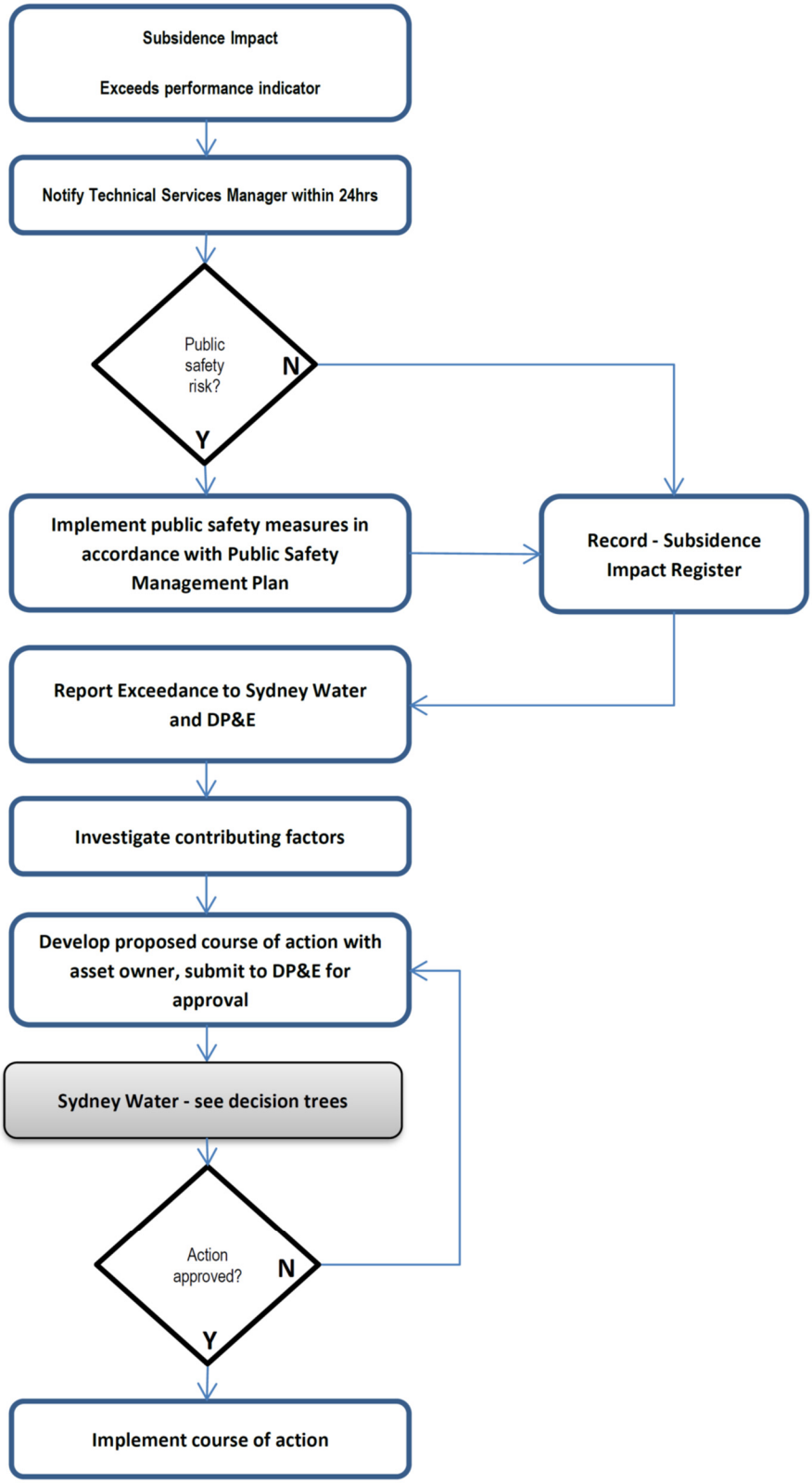
Actions Required:	Contingency Plan Initiated	☐
	Incident Notification	☐
	Safety Measures/Public Safety Management Plan Requirements	☐

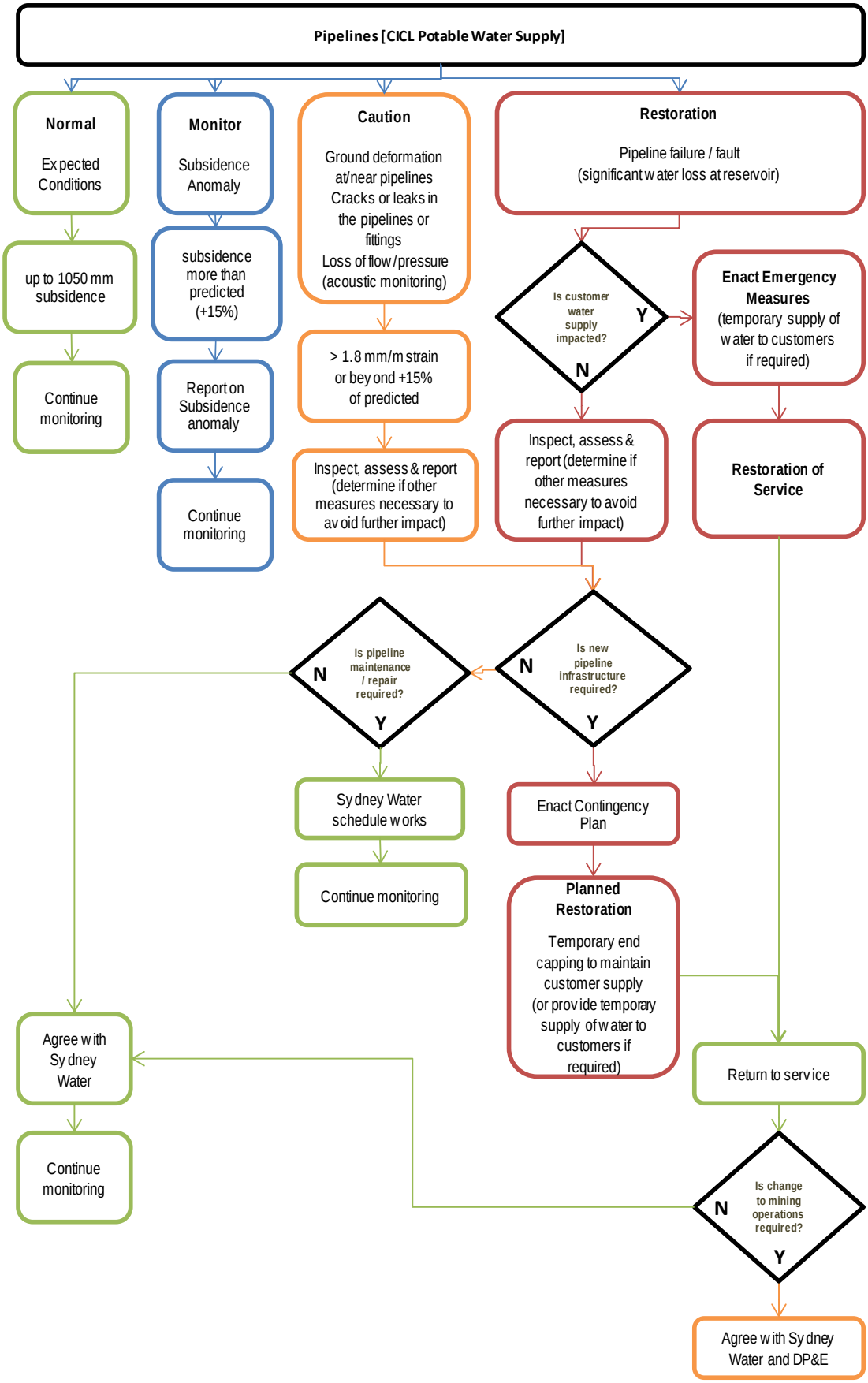
Management or Contingency Measures Implemented:

Effectiveness of Management or Contingency Measures:

APPENDIX 4

CONTINGENCY PLAN PROCEDURE AND DECISION TREE


Subsidence Impact
Exceeds performance indicator
Notify Technical Services Manager within 24hrs
Public safety risk?
N
Y
Implement public safety measures in accordance with Public Safety Management Plan
Record - Subsidence Impact Register
Report Exceedance to Sydney Water and DP&E
Investigate contributing factors
Develop proposed course of action with asset owner, submit to DP&E for approval
Sydney Water - see decision trees
Action approved?
N
Y
Implement course of action


Pipelines [CICL Potable Water Supply]
Normal
Expected Conditions
up to 1050 mm subsidence
Continue monitoring
Monitor
Subsidence Anomaly
subsidence more than predicted (+15%)
Report on Subsidence anomaly
Continue monitoring
Caution
Ground deformation at/near pipelines
Cracks or leaks in the pipelines or fittings
Loss of flow/pressure (acoustic monitoring)
> 1.8 mm/m strain or beyond +15% of predicted
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration
Pipeline failure / fault (significant water loss at reservoir)
Is customer water supply impacted?
Y
N
Enact Emergency Measures (temporary supply of water to customers if required)
Inspect, assess & report (determine if other measures necessary to avoid further impact)
Restoration of Service
Is new pipeline infrastructure required?
N
Y
Is pipeline maintenance / repair required?
N
Y
Sydney Water schedule works
Continue monitoring
Enact Contingency Plan
Planned Restoration
Temporary end capping to maintain customer supply (or provide temporary supply of water to customers if required)
Return to service
Is change to mining operations required?
N
Y
Agree with Sydney Water and DP&E
Agree with Sydney Water
Continue monitoring