METROPOLITAN COAL LONGWALLS 305-307

BUILT FEATURES MANAGEMENT PLAN




Peabody

METROPOLITAN COAL

LONGWALLS 305-307

BUILT FEATURES MANAGEMENT PLAN

OPTUS

ME-TSE-MNP-0087

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DPIE Approval Date
All	LW305-307 BFMP_OPTUS-R01-A	Original	Optus, DRG and DPIE	-
Appendix 4	LW305-307 BFMP_OPTUS-R01-B	Added Appendix 4 Optus Network Mine Subsidence Management Plan	DPIE	16 March 2020

January 2020

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

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. Longwalls 305-307 are situated to the west of Longwalls 301-304, and 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.

This BFMP-OPTUS includes post-mining monitoring and management of Optus assets subject to the previously approved Metropolitan Coal Longwall 304 Extraction Plan.

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 Secretary of the Department of Planning and Environment (DP&E) (now the NSW Department of Planning Industry and Environment [DPIE]). 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 305-307.

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

Section 6: Provides the detailed baseline data.

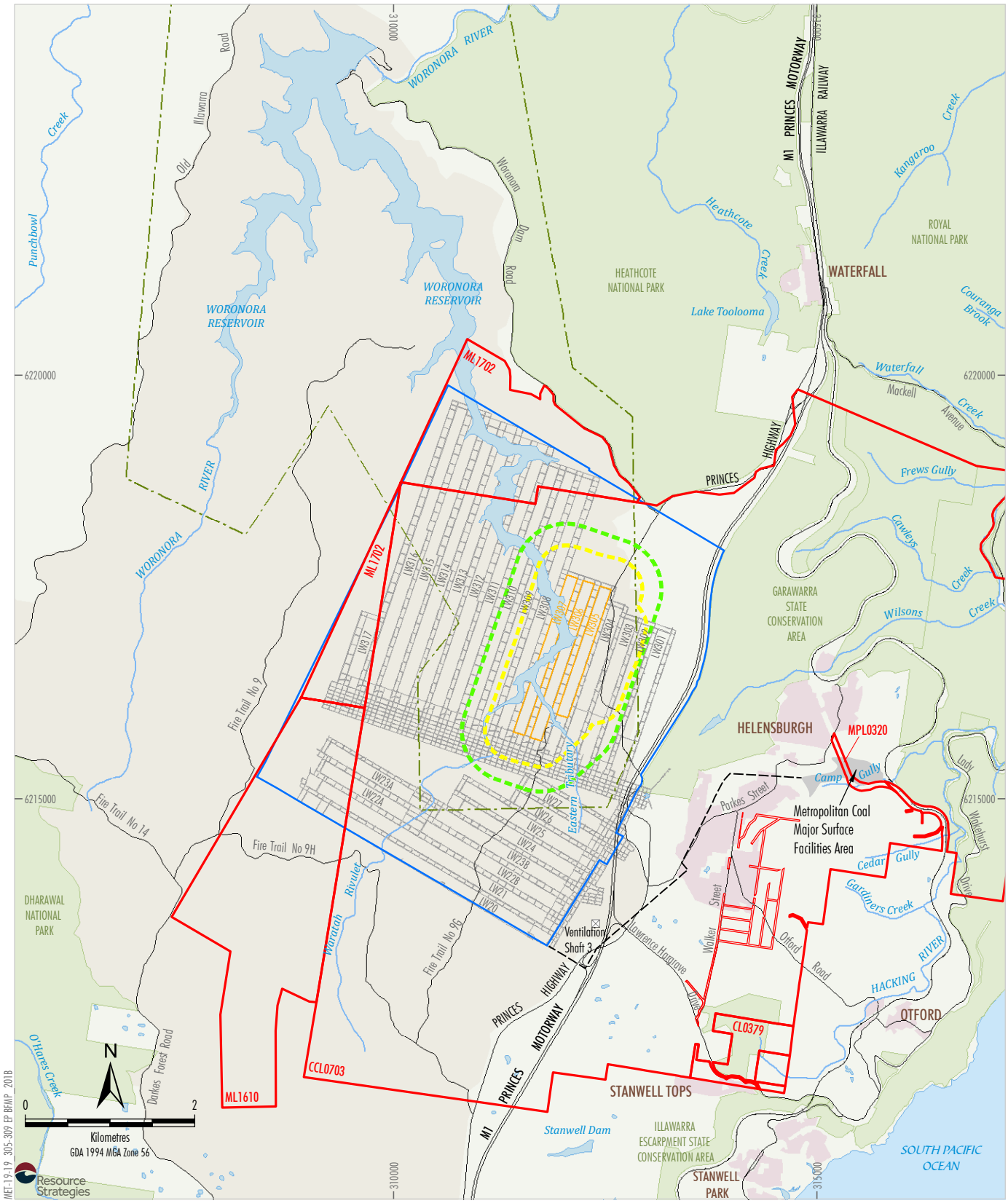
Section 7: Describes the monitoring program.

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

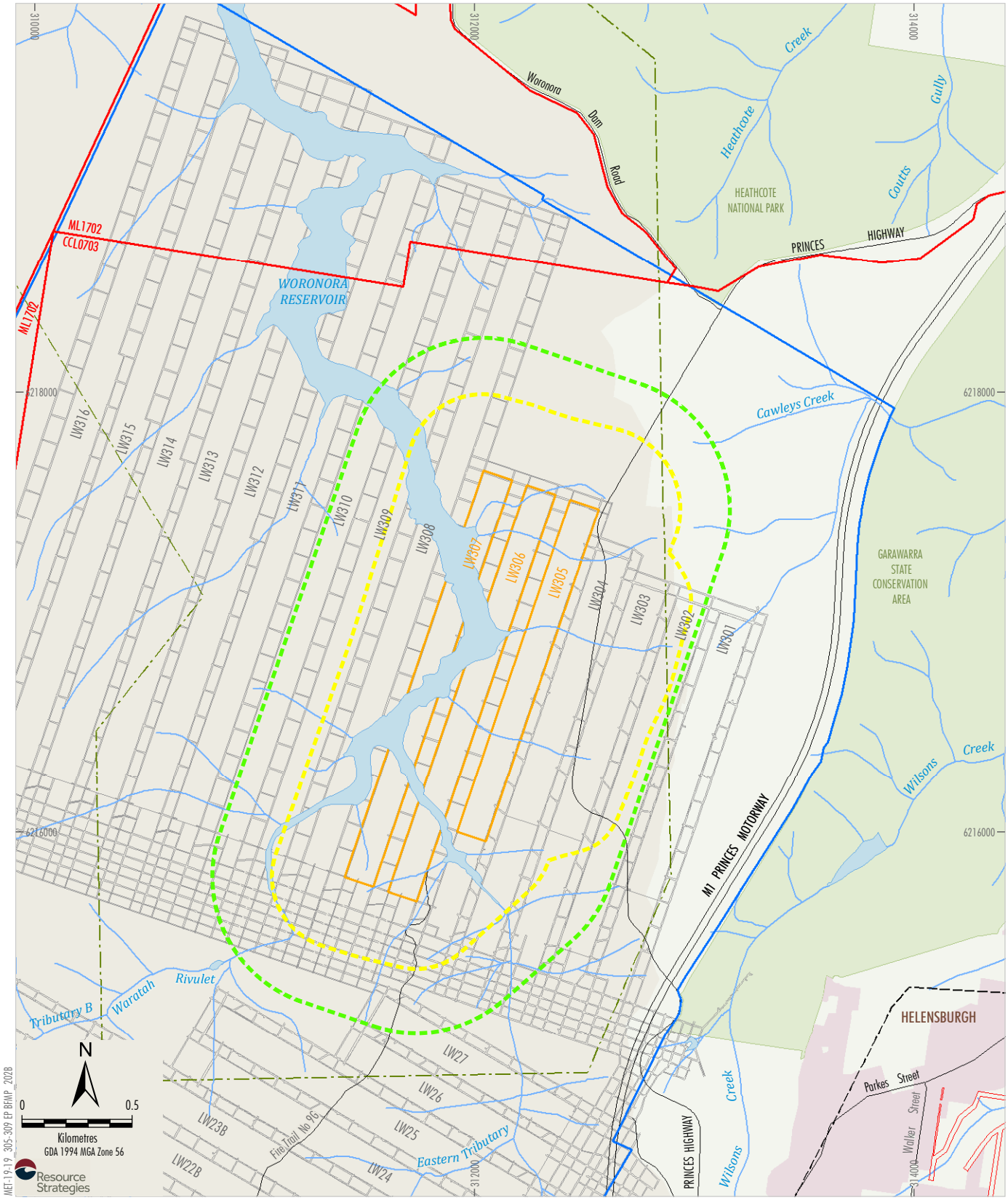
- Mining Lease Boundary
- Woronora Special Area
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwalls 305-307 Secondary Extraction
- Longwalls 305-307 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Longwalls 305-307 Secondary Extraction
- Woronora 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 305-307 and Project Underground Mining Area

Figure 1



LEGEND

- Mining Lease Boundary
- Woronora Special Area
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwalls 305-307 Secondary Extraction
- Longwalls 305-307 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Longwalls 305-307 Secondary Extraction
- Woronora Notification Area
- Existing Underground Access Drive (Main Drift)

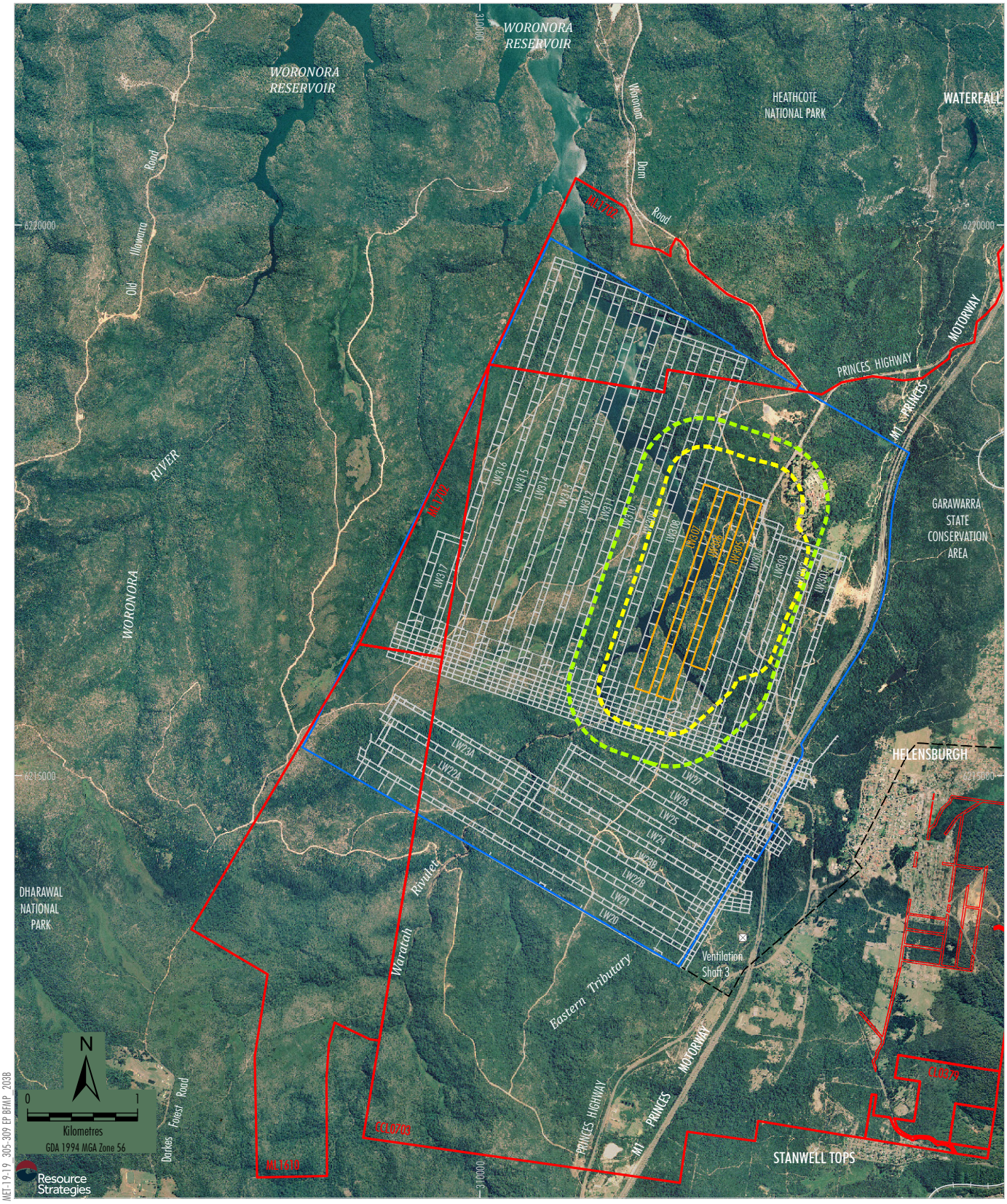
Source: Land and Property Information (2015); Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

Peabody

METROPOLITAN COAL

Longwalls 305-307 Layout

Figure 2



LEGEND

- Mining Lease Boundary
- Railway
- Project Underground Mining Area Longwalls 20-27 and 301-317
- Longwalls 305-307 Secondary Extraction
- Longwalls 305-307 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- 600 m from Longwalls 305-307 Secondary Extraction
- Existing Underground Access Drive (Main Drift)

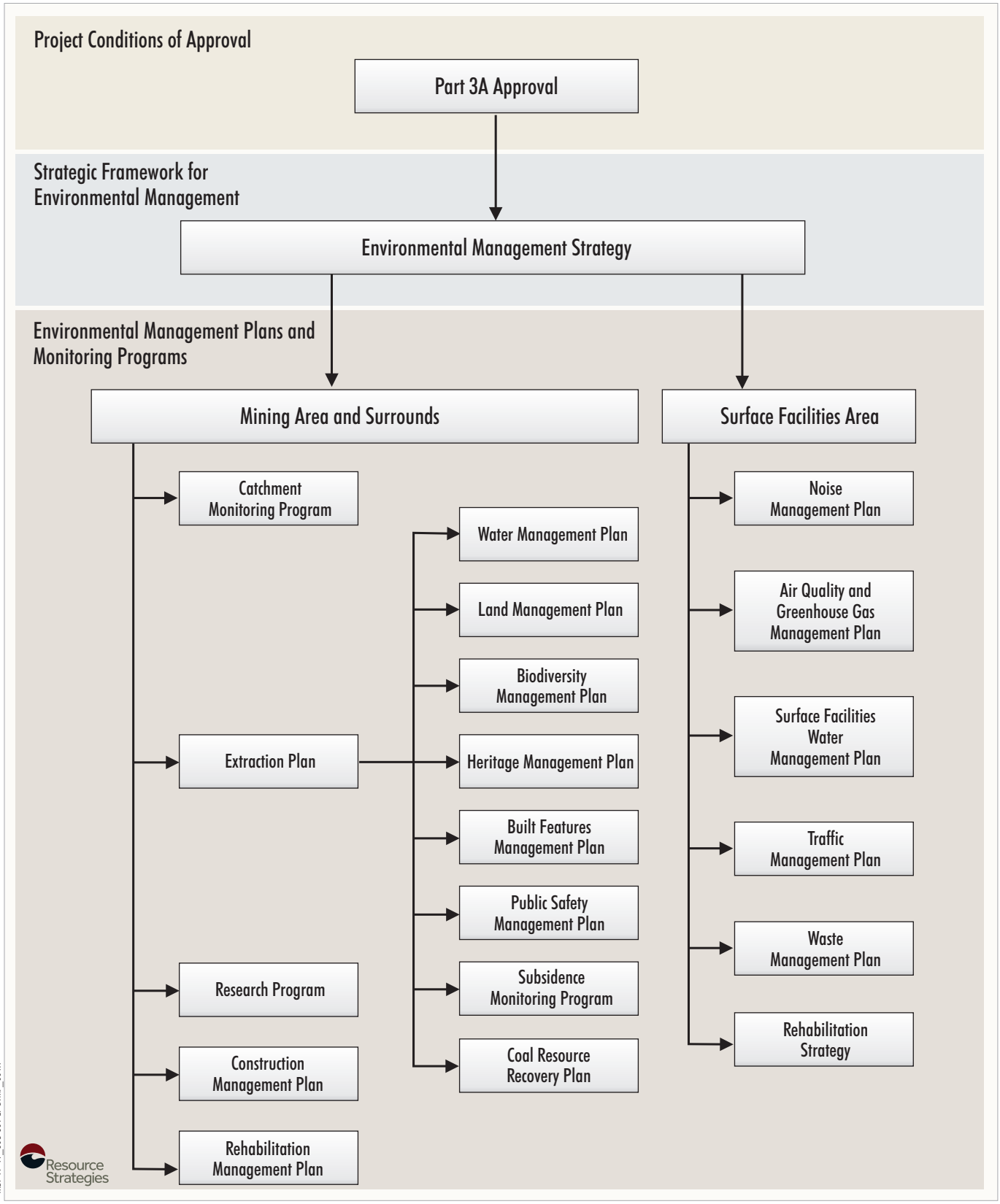
Source: Land and Property Information (2015); Date of Aerial Photography 1998; Department of Industry (2015); Metropolitan Coal (2019); MSEC (2019)

Peabody

METROPOLITAN COAL

Longwalls 305-307 and Project Underground Mining Area- Aerial Photograph

Figure 3



Peabody
METROPOLITAN COAL

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, Schedule 7;
- an incident report under Condition 6, Schedule 7;
- an annual review under Condition 3, Schedule 7; and

if necessary, revised to the satisfaction of the Director-General (now Secretary) of the DPIE, 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 DPIE.

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 3
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 3
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 3

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 Industry – Water (now the DPIE – 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 305-307 and the area of land within 600 metres (m) of Longwalls 305-307 secondary extraction are shown on Figures 2 and 3. Longwall extraction occurs from north to south. The Longwall 305 layout includes a 138 m panel width (void), a 45 m tailgate pillar width and a 70 m maingate pillar width. The layout of Longwalls 306 and 307 includes 138 m panel widths (void) and 70 m pillar widths (solid).

The provisional extraction schedule for Longwalls 305-307 is provided in Table 2.

Table 2
Provisional Extraction Schedule

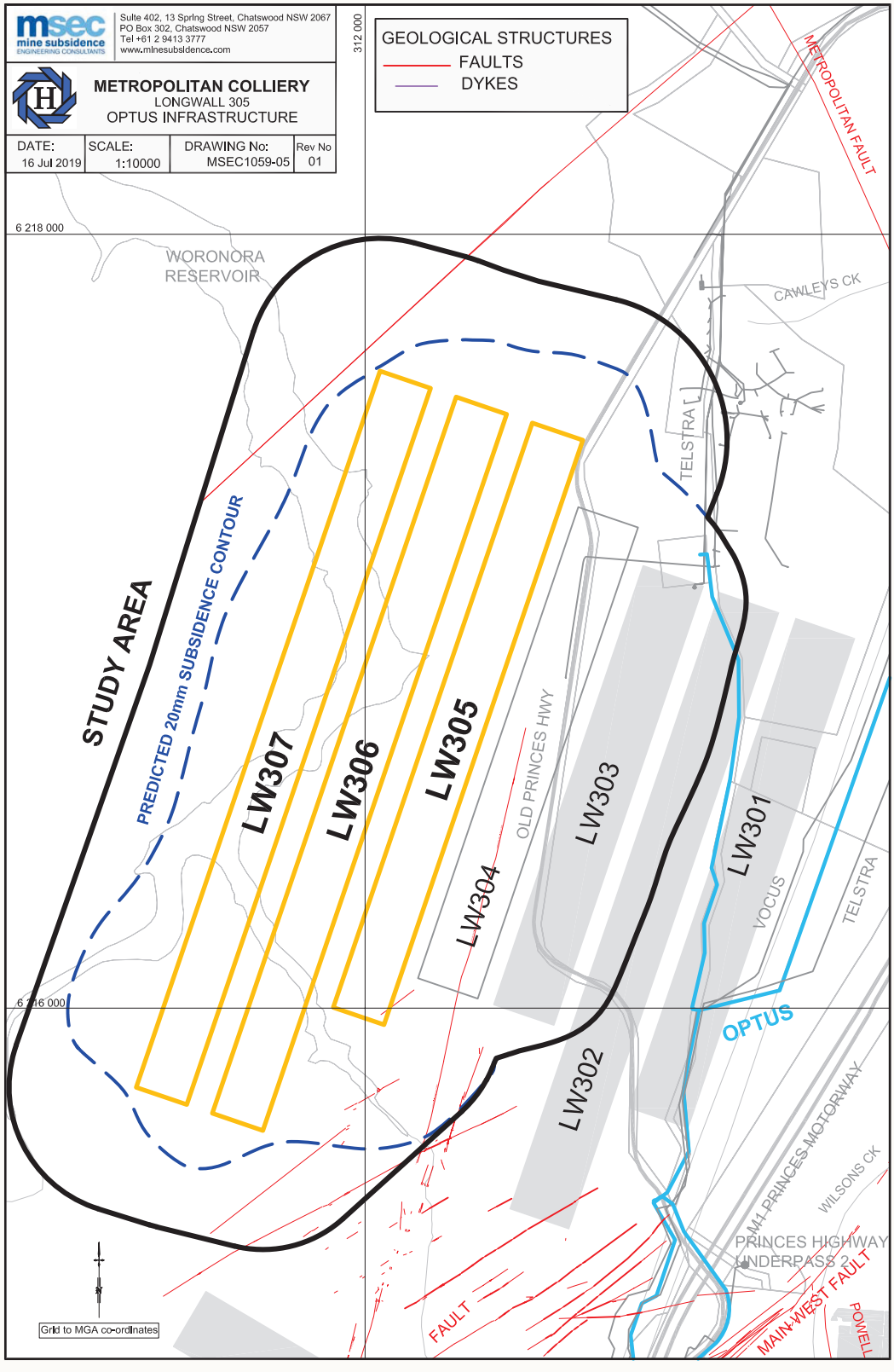
Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
Longwall 305	March 2020	7 Months	October 2020
Longwall 306	November 2020	8 Months	July 2021
Longwall 307	August 2021	8 Months	April 2022

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 305-307 (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



MET-19-19_305-309 EP BFMP_007B

Source: MSEC (2019)

Peabody

METROPOLITAN COAL

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 305-307 on Optus assets were conducted by MSEC and are reported in MSEC (2019) (Appendix 1).

In relation to subsidence predictions for Longwalls 305-307, MSEC (2019) make the following conclusions:

- Optical fibre Cable 1 is located outside of the Study Area and approximately 770 m to the east of Longwall 305 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 Longwalls 305-307. 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 Longwalls 305-307.
- Optical fibre Cable 2 is located to the east of Longwall 305, above extracted Longwalls 301 and 302. The northern end of Optical Fibre Cable 2 is approximately 380 m from Longwall 305. The predicted total subsidence within the Study Area boundary increases by 25 mm following the extraction of Longwall 305. The maximum predicted total tilt and curvatures do not increase as a result of the extraction of Longwalls 305-307.
- It is possible that the optical fibre cables could experience localised and elevated strains due to the presence of geological structures (known or unknown). Non-conventional subsidence movements have not been observed during the extraction of Longwalls 301-303 and the likelihood of non-conventional subsidence movements at the optical fibre cables due to Longwalls 305-307 is considered to be very low.
- 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.

4.2.2 Risk Assessment

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 were identified which considered the extraction of coal beneath the Optus assets. The proposed risk control measures and procedures were incorporated into the Longwalls 301-303 BFMP and the program and status of implementation is summarised in Table 3.

The risk control measures and procedures identified during the risk assessment for Longwalls 301-303 (Table 3) were implemented and continued for the extraction of Longwall 304.

Table 3
Program for Implementation of Proposed Risk Control Measures and Procedures

	Risk Control Measure / Procedure	Timing
Baseline Data / Validation		
1	Obtain from Optus an audit to confirm that all services have been identified and documented in the BFMP	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	Complete
3	Provide survey location information to Optus on the Optic Fibre Cable runs based on surface markers	Complete
4	Carry out further investigation to determine the asset owner of the telecommunications tower and compound	Complete*
5	Arrange further consultation with relevant personnel (e.g. mobile department) for the telecommunications tower and hut	Complete*
6	Include a reference to the “management plan process” in the BFMP	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	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	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	Complete
10	Include in the BFMP relevant details regarding the potential for underground blast vibration impacts at the surface	Complete

[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 contact information from Optus for liaison.	Complete
12	Obtain an understanding of the time the telecommunication tower and compound systems would operate in the event of a power outage	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 implemented for Longwalls 301-303 and Longwall 304 are to be continued for the extraction of Longwalls 305-307.

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)	Technical Services Manager 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. Further details of the monitoring program are provided in Appendix 4.

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 upon commencement of Longwall 305 extraction for the first 400 m	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 by Metropolitan (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 Longwalls 305-307 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 Longwall 307.	Once
		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 Longwall 307	Once
	Access roads/tracks	Visual inspection by Metropolitan (including notes on general condition of access roads/tracks)		Determine level of impact of mining (if any)	Within 3 months of the completion of Longwall 307	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 by Metropolitan Coal in accordance with the Longwalls 305-307 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 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:

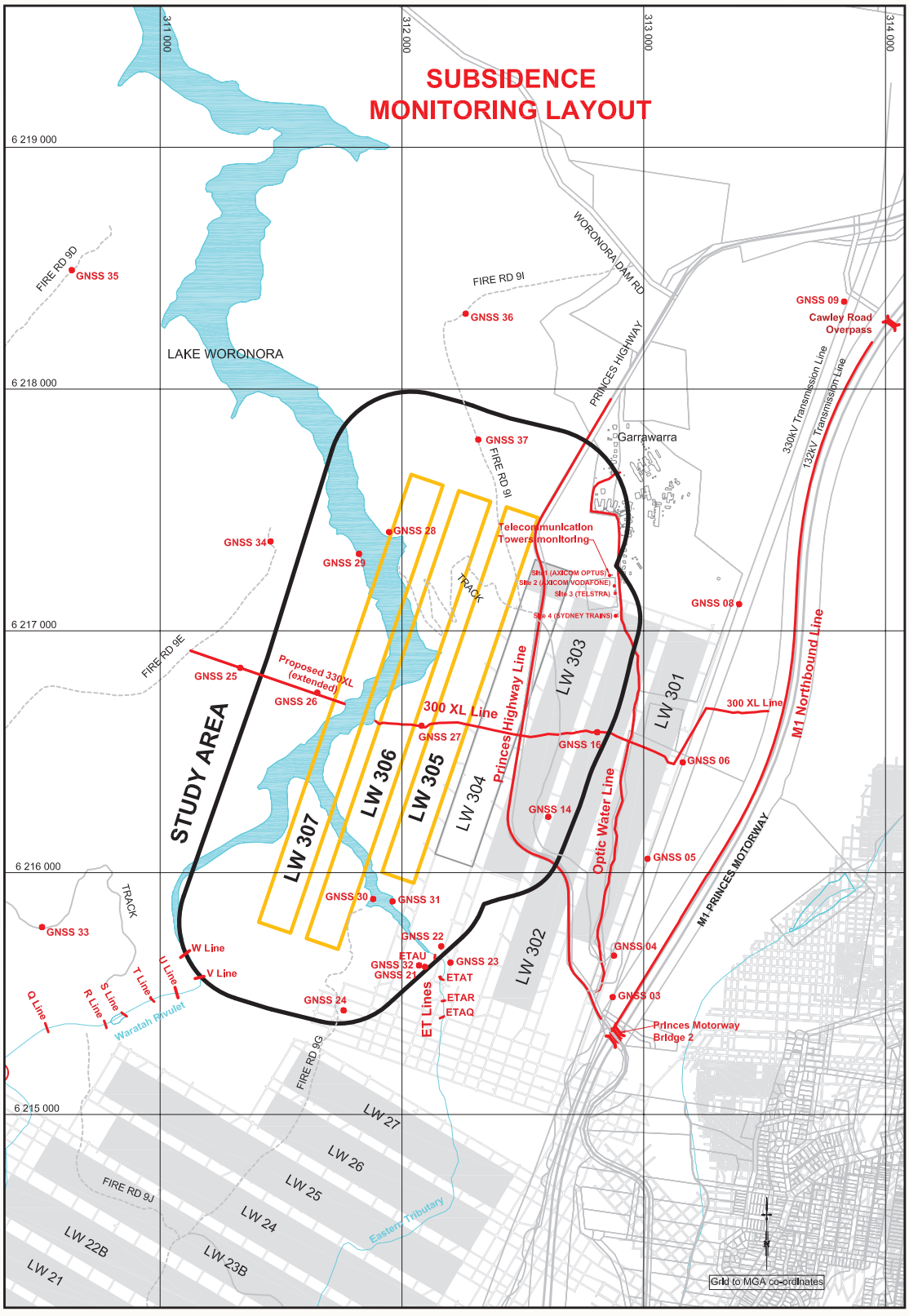
- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- assessment against the performance indicators and performance measure;
- whether any actions are required (e.g. initiation of the Contingency Plan, incident notification, implementation of appropriate 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 2) 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 each of Longwalls 305-307.

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 305-307 secondary extraction as described in the Metropolitan Coal Longwalls 305-307 Land Management Plan (Longwalls 305-307 LMP).



MEF-19-19_305-309 EP BEMP_017A

Source: MSEC (2019)

Peabody

METROPOLITAN COAL

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 Longwalls 305-307 LMP, initiation of the Contingency Plan as outlined in the Longwalls 305-307 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 Longwalls 305-307 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 Longwalls 305-307 LMP) and to identify required management measures. Management measures are discussed in the Longwalls 305-307 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 Longwalls 305-307 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. Further details of procedures for the management of Optus assets are provided in 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).

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 3):
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 Technical Services Manager within 24 hours.

Assess Public Safety;

- Metropolitan Coal will assess public safety and where appropriate implement safety measures in accordance with the Metropolitan Coal Longwalls 305-307 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 DPIE for approval.
- Metropolitan Coal will implement the approved course of action to the satisfaction of the DPIE.

Reporting;

- With the exception of access roads/tracks, the observation will be recorded in the Built Features Management Plan – Subsidence Impact Register (Appendix 2) 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 Longwalls 305-307 Land Management Plan – Subsidence Impact Register.

- Metropolitan Coal will report any exceedance of the performance measure or indicators to the DPIE 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 Secretary of DPIE if either the contingency measures implemented by Metropolitan Coal have failed to remediate the impact or the 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 3.

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: 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 the end of Longwall 307 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 longwall extraction is within 400m of cables until subsidence reduced below level of survey accuracy.	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.			Level 2	Signal loss < 4.5 dB Subsidence up to 15% greater than predicted between 1000 mm and 1150 mm 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.
	Subsidence parameters.	Survey on the adjacent transmission corridor and the 300 XL subsidence monitoring line	Subsidence, Strain.	Weekly when LW is within ±400m of being directly under cable and after each longwall	Evaluation of the general ground movements about the site by comparison between measured and predicted movements.	Subsidence measurement accuracy.		Level 3	Signal loss > 4.5 dB Subsidence greater than 1150 mm 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
								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 Public Safety Management Plan. Report exceedance of the performance measure or indicators to the DPIE 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.

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)	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 each longwall	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 301-307 secondary extraction as described in the Metropolitan Coal Longwalls 305-307 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 305-307 LMP, initiation of the Contingency Plan as outlined in the Longwall 305-307 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 305-307 LMP.
								Level 3	Greater than moderate cracking.	Implement contingency measures as outlined in the Longwalls 305-307 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 308 on). However, for the fibre optic cable, the baseline (and post-mining) data collected for Longwalls 301-307 will be used as baseline for Longwalls 308 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 Secretary of DPIE 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 Secretary of DPIE 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.

15 NON-COMPLIANCE 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 Technical Services Manager 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 Secretary of the DPIE 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 Secretary of the DPIE 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 Secretary of the DPIE 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 Secretary of the DPIE.

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 (2019) *Metropolitan Colliery – Proposed Longwalls 305 to 307 - Subsidence Predictions and Impact Assessments for the Optus Infrastructure.*

APPENDIX 1

MSEC (2019) METROPOLITAN COLLIERY – PROPOSED LONGWALLS 305 TO 307 – 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

23rd July 2019

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

Ref: MSEC1013-05

Dear Jon,

RE: Metropolitan Colliery – Proposed Longwalls 305 to 307 - 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 305 to 307 at Metropolitan Colliery.

The locations of the Optus infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC1059-05. A Study Area is also shown in Drawing No. MSEC1059-05 and is based on the outer limits of a 35° angle of draw line from Longwalls 305 to 307 and the predicted 20mm subsidence contour for Longwalls 305 to 307.

The Optus infrastructure includes two optical fibre cables that are located within and adjacent to the Study Area but not directly above the proposed Longwalls 305 to 307. 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 Longwalls 305 to 307. Optical Fibre Cable 1 is over 770 m from Longwall 305. A second optical fibre cable is located to the east of the proposed Longwall 305, above extracted Longwalls 301 and 302 (*Optical Fibre Cable 2*). The northern end of Optical Fibre Cable 2 is 380 m from Longwall 305.

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 304 and after the extraction of Longwall 305 to 307. 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 770 m to the east of Longwall 305 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 Longwalls 305 to 307. 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 305 to 307.

The predicted profiles of total conventional subsidence, tilt and curvature along the alignment of Optical Fibre Cable 2, following the extraction of Longwall 304 and after the extraction of Longwall 305 to 307, are shown in the attached Fig. A.01. 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 within the Study Area Boundary for Optical Fibre Cable 2, following the extraction of Longwall 304 and after the extraction of Longwall 305 to 307, are provided in Table 1. The curvature 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 within the Study Area Boundary for the Optus Optical Fibre Cable 2 after the Extraction of Longwalls 304 to 307

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 LW304	700	3.0	0.03	0.03
After LW305	725	3.0	0.03	0.03
After LW306	725	3.0	0.03	0.03
After LW307	725	3.0	0.03	0.03

It can be seen from Table 1 that the predicted total subsidence within the Study Area Boundary increases by 25mm following the extraction of Longwall 305. The maximum predicted total tilt and curvatures do not increase as a result of the extraction of Longwalls 305 to 307.

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 extracted Longwalls 301 and 302 but not directly above the proposed Longwalls 305 to 307. 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.

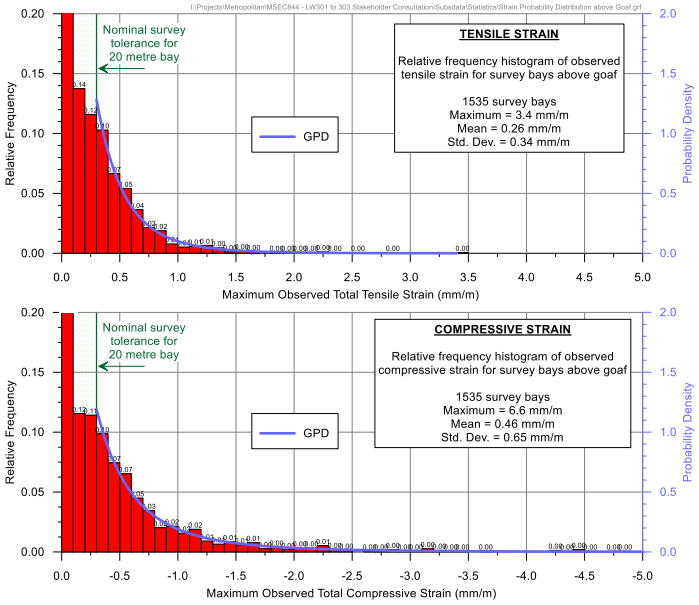


Figure 1 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

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. MSEC1059-05. 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 to 303. 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 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 Longwalls 305 to 307.

The cables are likely to experience minor vertical subsidence and horizontal movements resulting from the extraction of Longwalls 305 to 307. The predicted tilt and curvatures at the cables do not change as a result of the extraction of Longwalls 305 to 307. The optical fibre cables are unlikely to experience adverse impacts as a result of conventional subsidence movements.

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.

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.

Comprehensive monitoring of subsidence movements has been undertaken during the extraction of LW301 to 303 with magnitudes of observed differential movements consistent with predictions and no observed anomalous movements encountered. It is therefore considered unlikely that non-conventional movements would be observed at the Optus optical fibre cable during the extraction of LW305 to 307.

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 revised and continued, in consultation with Optus, to manage the optical fibre cables for potential non-conventional ground movements. Given the increasing distance of the longwall extraction from the optical fibre cables, it is considered that monitoring developed for the extraction of Longwalls 301 to 304 could be relaxed for the extraction of future longwalls from LW305 onwards. Consideration could be given to reducing the frequency of ground survey monitoring to monthly during the extraction of Longwall 305 then to end of panel survey for

Longwalls 306 and 307 after confirmation that no significant subsidence movements or impacts were observed during Longwall 305.

Summary

The Optus optical fibre cables are located to the south and east of the Study Area (Cable 1) and above extracted Longwall 302 within the Study Area (Cable 2) but not directly above the proposed Longwalls 305 to 307. 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 possible that the optical fibre cables could experience localised and elevated strains due to the presence of geological structures (known or unknown). Non-conventional subsidence movements have not been observed during the extraction of Longwalls 301 to 303 and the likelihood of non-conventional subsidence movements at the optical fibre cables due to Longwalls 305 to 307 is considered to be very low.

Based on monitoring data observed during Longwalls 301 to 303 and the increased distance to the optical fibre cables, a revision of the monitoring and management strategies is recommended in consultation with Optus with a view to reducing the frequency of monitoring. 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. MSEC1059-05 – Longwalls 305 to 307– Optus Infrastructure

Fig. A.01 Predicted Profiles of Conventional Subsidence, Tilt and Curvature for the Optus Optical Fibre Cable 2 due to LW305 to 307

I:\Projects\Metropolitan\MSEC1059 - LW305 to 307 Stakeholder Consultation\AcadData\MSEC1059-05 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 305
OPTUS INFRASTRUCTURE

DATE:	SCALE:	DRAWING No:	Rev No
16 Jul 2019	1:10000	MSEC1059-05	01

312 000

GEOLOGICAL STRUCTURES
FAULTS
DYKES

6 218 000

6 216 000

METROPOLITAN FAULT

WORONORA RESERVOIR

CAWLEYS CK

TELSTRA

STUDY AREA

PREDICTED 20mm SUBSIDENCE CONTOUR

LW307

LW306

LW305

LW304

LW303

LW302

LW301

OLD PRINCES HWY

VOCUS

TELSTRA

OPTUS

M1 PRINCES MOTORWAY

WILSONS CK

PRINCES HIGHWAY UNDERPASS 2

FAULT

MAIN WEST FAULT

POWELL

Grid to MGA co-ordinates

Predicted Profiles of Conventional Subsidence, Tilt and Curvature along the Optus Optical Fibre Cable due to LW305 to 307

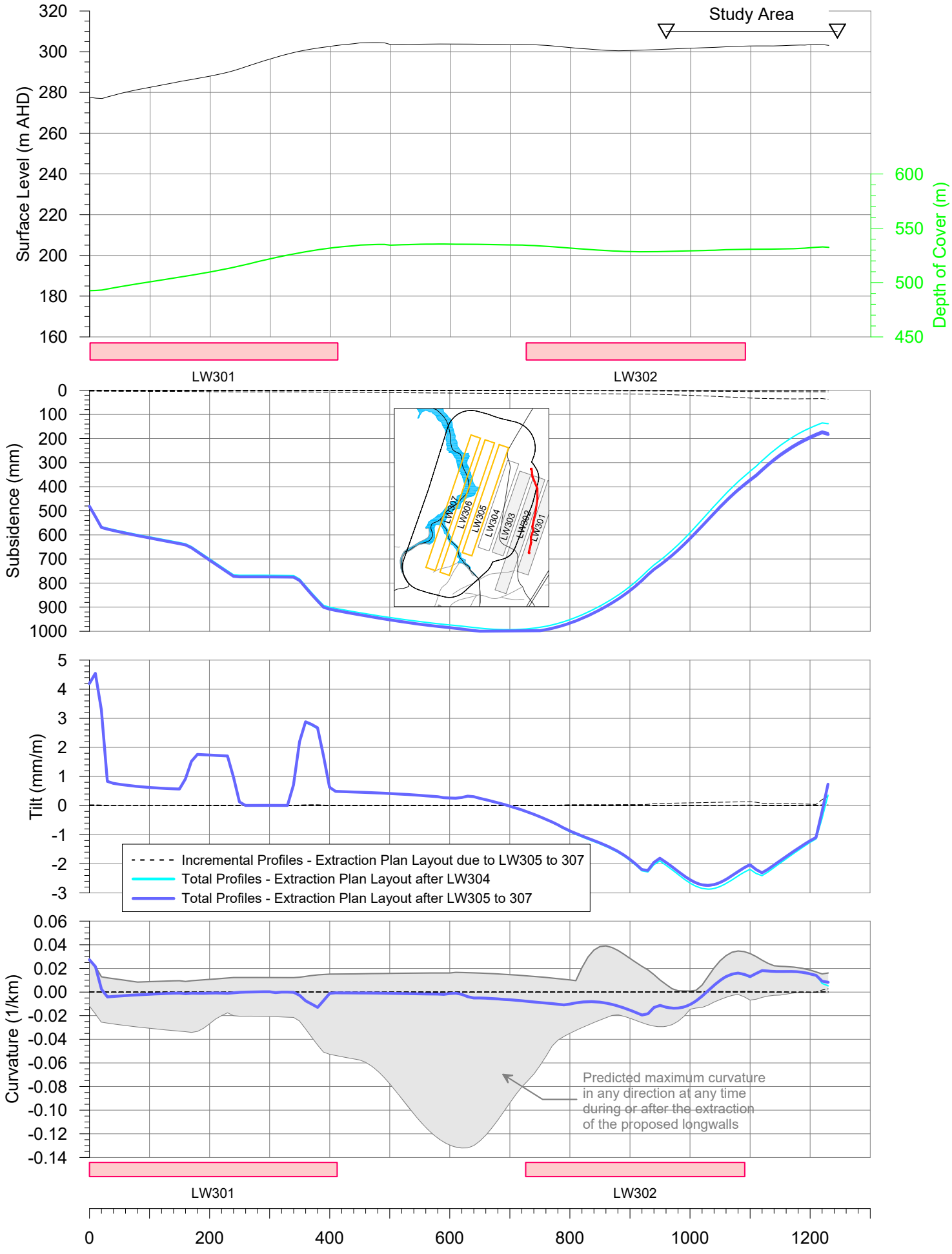


Fig. A.01

APPENDIX 2

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:

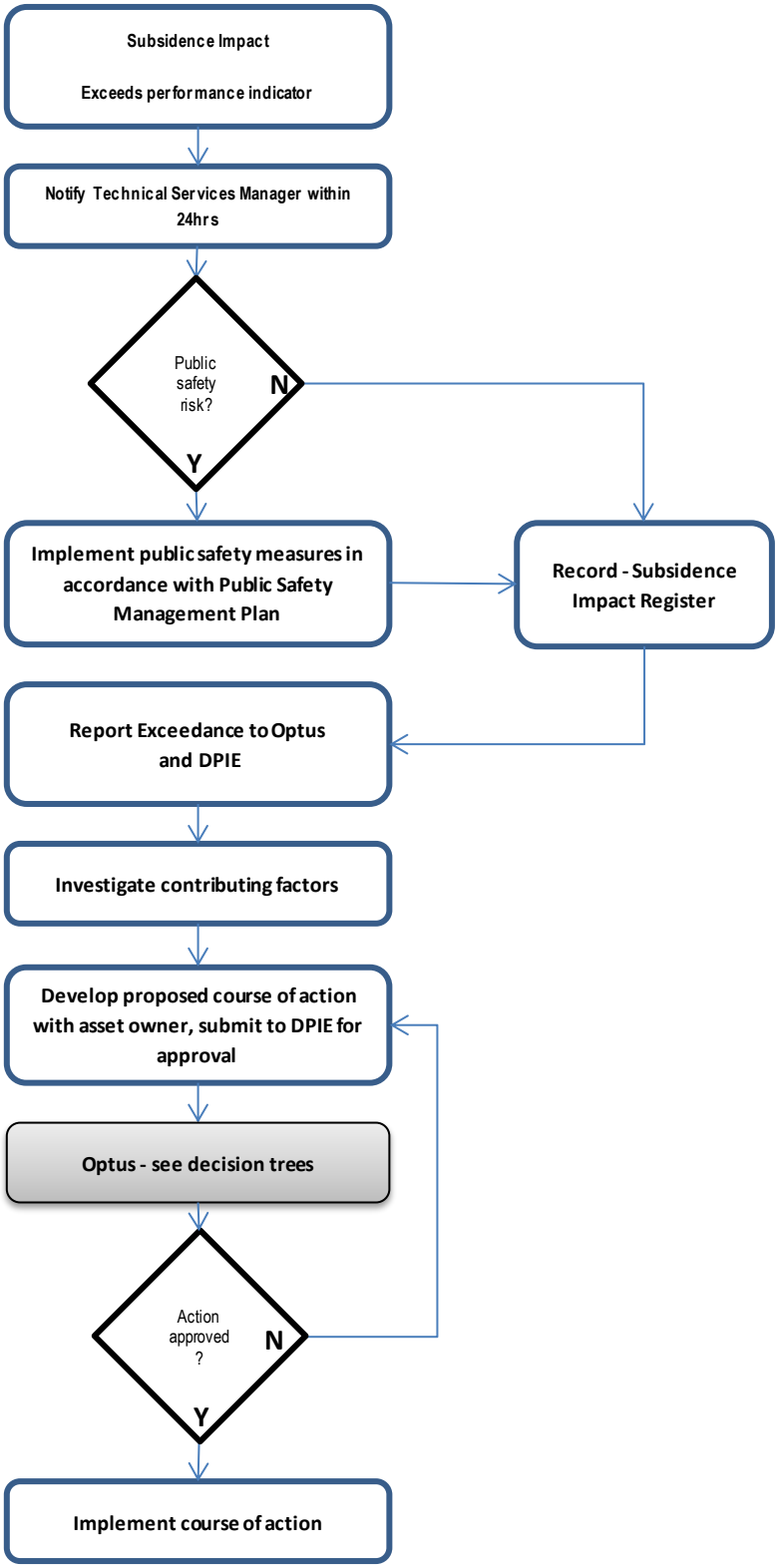
Actions Required:	Contingency Plan Initiated	☐
	Incident Notification	☐
	Safety Measures/Public Safety Management Plan Requirements	☐

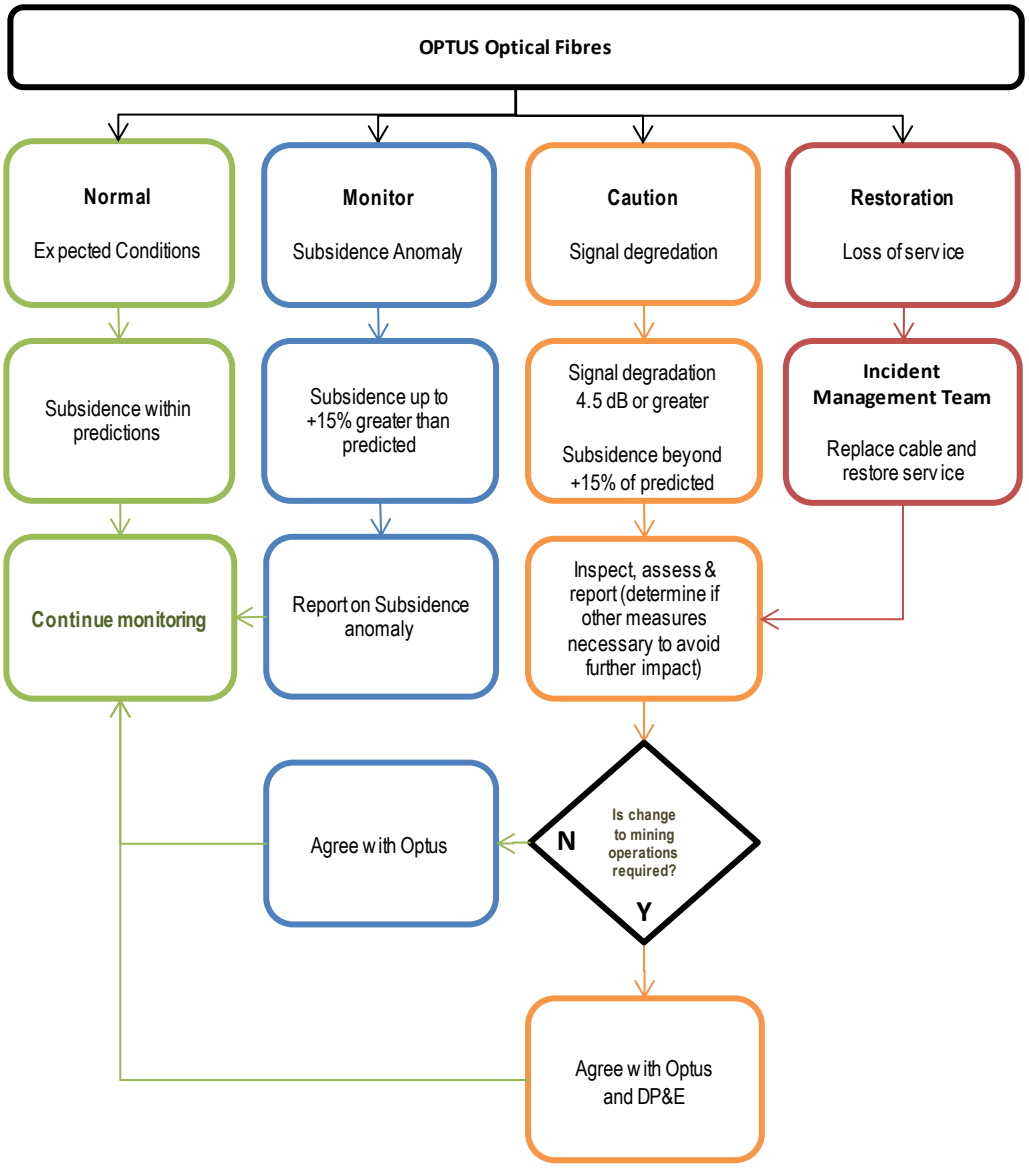
Management or Contingency Measures Implemented:

Effectiveness of Management or Contingency Measures:

APPENDIX 3

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 DPIE
Investigate contributing factors
Develop proposed course of action with asset owner, submit to DPIE 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

APPENDIX 4

OPTUS NETWORK MINE SUBSIDENCE MANAGEMENT PLAN

Optus Network Mine Subsidence Management Plan

OM 38395

Table of Contents Page

1. Introduction

1.1 Purpose

The purpose of this document is to detail procedures for the monitoring and management of Optus assets in areas impacted by underground mining activities. Specifically, those related to long wall mining techniques.

1.2 Scope

This document is applicable to management of Optus assets including but not limited to fibre optic cables, conduits, pits, splices, mobile phone infrastructure, Radio Access Node (RAN) sites and Controlled Environment Vaults (CEV) sites or any other telecommunications infrastructure installed using Optus' statutory rights under the *Telecommunications Act 1991* (Cth) and the *Telecommunications Act 1997* (Cth).

1.3 References

OM 1318	Field Operations External Cable Plant Damages, Investigations and Relocations Work Instruction
MSEC209-SMP Report Longwalls 701-704 Rev E	Illawarra Coal Mine Subsidence Predictions Ref
MSEC342-SMP Report Longwalls 705-710 Rev C	Illawarra Coal Mine Subsidence Predictions Ref
LW301-303 BFMP_OPTUS-R01-F	Metropolitan Coal Built Features Management Plan Longwalls 301-303
Letter report MSEC844-05	Metropolitan Colliery – Proposed Longwalls 301 to 303 - Subsidence Predictions and Impact Assessments for the Optus Infrastructure

1.4 Acronyms

BER	Bit Error Rate
BFMP	Built Features Management Plan
BTS	Optus Mobile Base Station
CEV	Controlled Environmental Vault
DWDM	Dense Wave Division Multiplexing
EMS	Element Management System
IOF	Inter Office Fibre
LOS	Loss of Signal
NMC	Network Management Centre
OnAA	Optus 4 Alpha-numeric site location code
OTDR	Optical Time Domain Reflectometer
RAN	Optus Radio Access Node
RF	Radio Frequency
RMS	Roads & Maritime Services

2. Mining Activities and Mine Subsidence

2.1 Longwall Mining

Mining activities take place across most of the Australian continent and offshore islands. Of particular interest to Optus is where mining is undertaken in close proximity to, or under Optus assets such as optic fibre cable, conduits, pits, splices and CEVs.

Longwall Mining as shown in fig 2.1 below; is an example of underground mining which has potential to impact Optus assets.

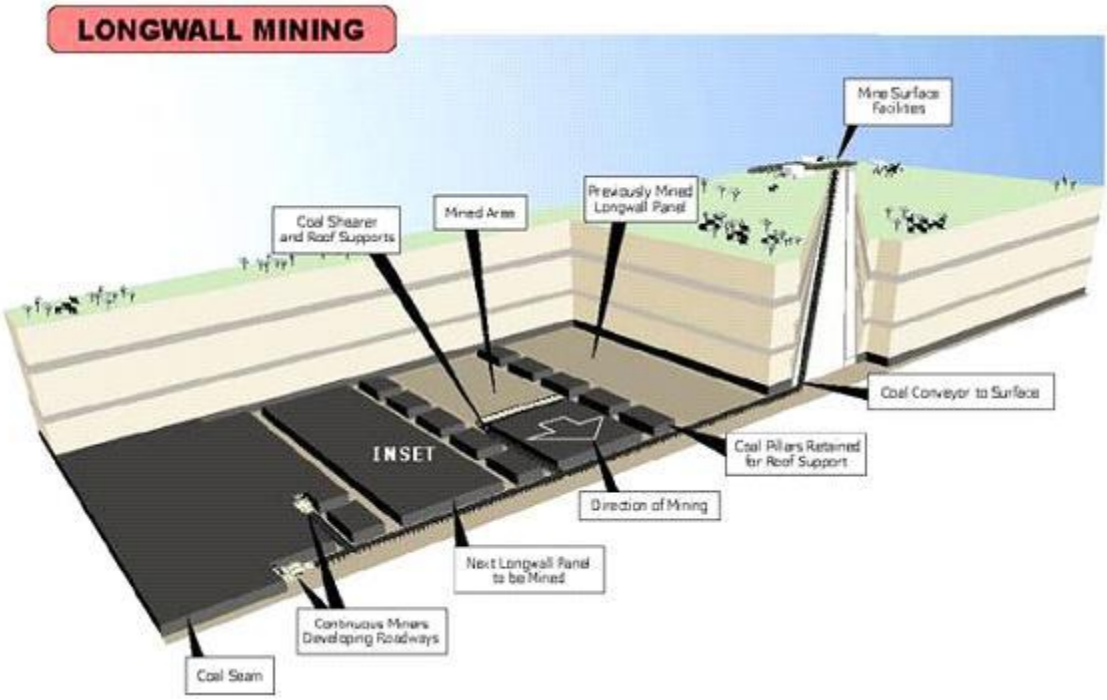


Fig 2.1 Illustration of Longwall Mining

2.2 Mine Subsidence

Optus assets directly above or in close proximity to Longwall Mining activities may be affected when the mined area is collapsed by the mining company as part of its operations as this creates a subsidence trough on the surface above.

Optical fibre cable may be impacted (stretched), conduits may be damaged. pits, CEVs, RANs and mobile phone towers may be moved or damaged in response to these earth movements.

This can cause degradation of optical transmission signal, carried in the optical fibre cables or radio systems attached to CEVs or mobile phone infrastructure, to the point of introducing bit errors or total loss of signal, with consequent impact on the Optus network and customer traffic.

Fig 2.2 below shows a diagram of typical mine subsidence.

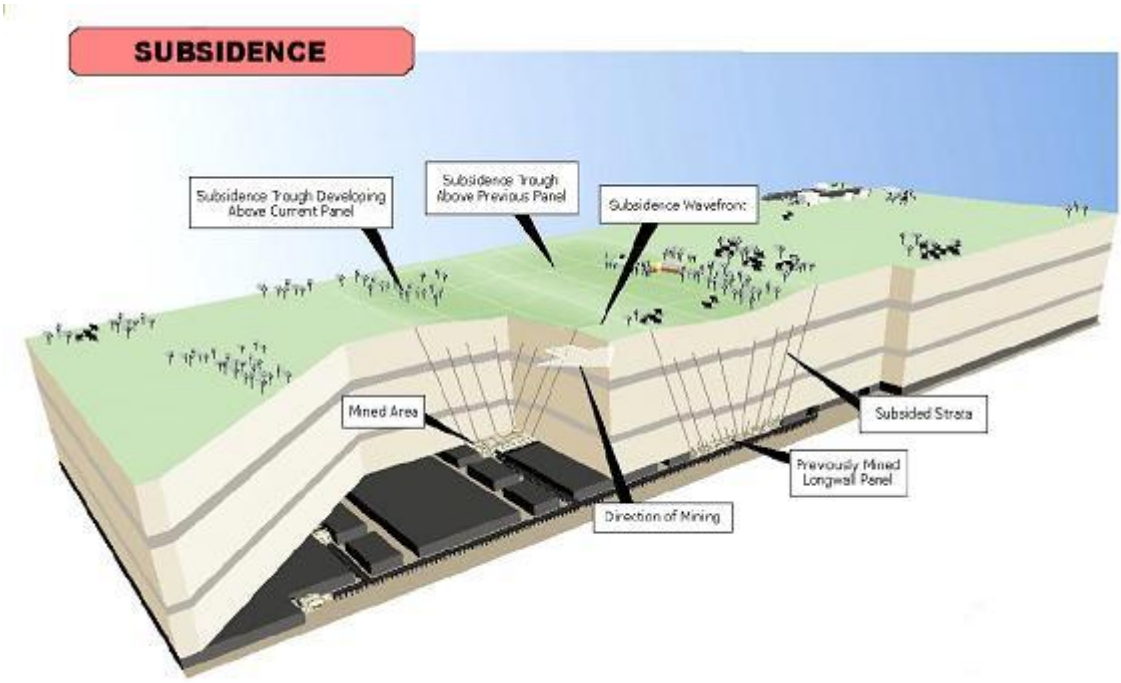


Fig 2.2 Previously Longwall mined area collapsing creating subsidence trough on the surface above

2.3 Mining Progress and Completion

The relevant mining company is responsible for providing advice of the progress of each Longwall Mine that has the potential to impact on Optus assets.

This shall be communicated via an updated spreadsheet at agreed timeframes. The spreadsheet shall indicate the:

- Longwall face position relative to its starting point;
- Progress since the last notification; and
- Average weekly distance travelled since commencement.

This spreadsheet will also be supplemented with a mine workings plan updated at an agreed interval.

The relevant mining company is responsible for issuing notice to Optus of completion of mining activities in the affected area.

Optus is responsible to acknowledge receipt of such notice but retains all rights to claims for future compensation if damage results from previous mining activities.

3. Mining Tenements Covered by this Management Plan

3.1 Illawarra Coal – Appin/Douglas Park Mining Tenement

3.1.1 Mining Tenement Area

Illawarra Coal mining tenement – Appin and Douglas Park areas in Wollondilly Shire NSW

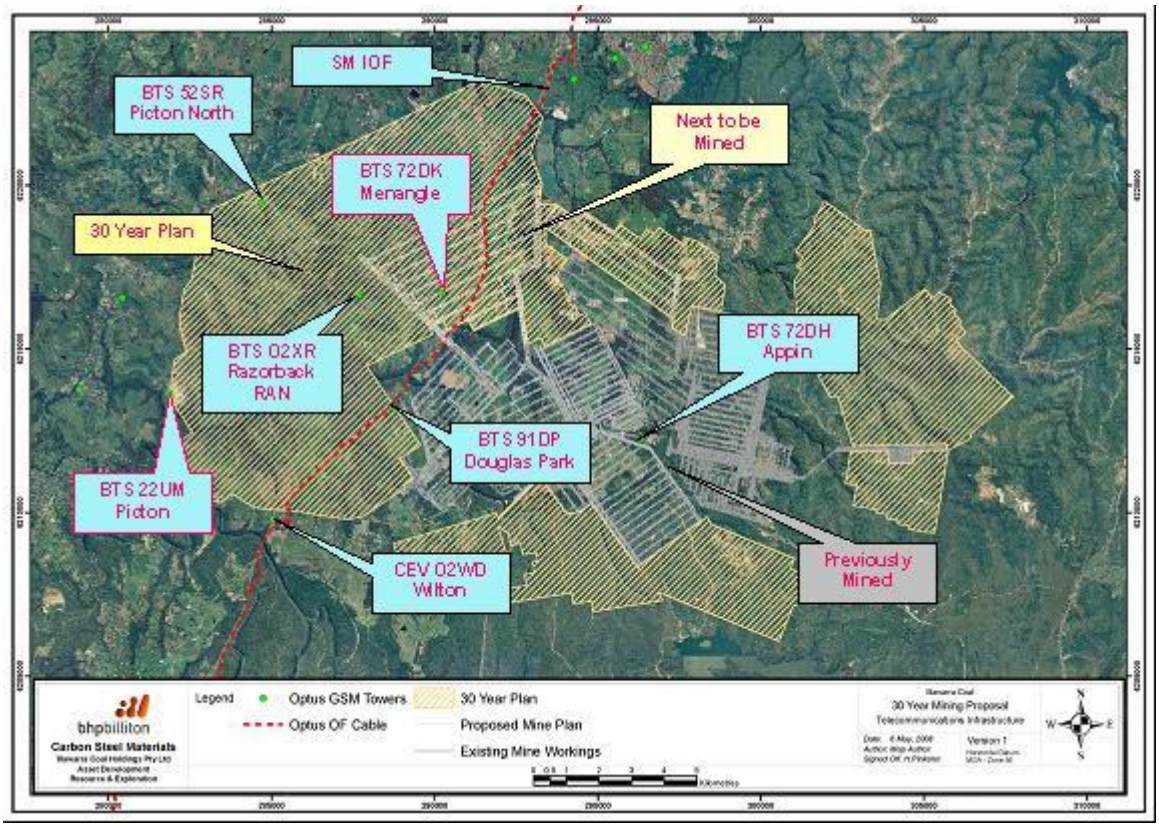


Fig 3.1.1 Impacted area showing Sydney Melbourne 1 IOF, Mobile phone sites, and CEV

3.1.2 Details of Optus Assets within Impacted Area

Fibre Optic Cable

There are two different categories of fibre that could be impacted by the mining activities.

a. Trunk Network Fibre SYD – MELB 1 IOF

Distance ≈ 21km

Cable ≈ 36 SMOF direct buried

Heavy Polyethylene Sheath, manufactured prior to 1993. Installation completed approx. Oct 1993. The cable was manufactured for direct burying by plough. It is not specifically designed for use in areas of mine subsidence.

Conduit ≈ 785m as P100 or G100 bridge crossing and footings.

Splices ≈ 1BS07, 1BS08, 1BS09, 1BS10, 1BS11, 1BS12 & 1BS13

Manholes/Pits ≈ Prefix = 22MH 36, 37, 38, 39, 40, 105, 217, 218, 220, 221, 222, 223, 224, 350, 351 & 352

b. Access Network Fibre

There are limited access network fibre optic cables in the area. 91DP and 72DK have access cables terminated into them from the Trunk Network Fibre.

Other Assets

Other Optus assets located in the impacted area include the following sites (Optus site codes used):

a. CEV Sites

O2WD

b. RAN Sites

O2XR

c. BTS Sites

72DK, 72DH, 91DP, 52SR & 22UM

3.1.3 Mining Activities

It is planned that each Longwall will extract coal working South West from the North Eastern ends of the mining tenement. This covers Longwall Mining in Appin Area 7 in accordance with the attached plan MSEC 209 -16 in Appendix B of this document.

The current schedule of mining is shown in table 3.1.3. The mining schedule is subject to change but was current as at March 2010.

Illawarra Coal shall provide a weekly spreadsheet, indicating the Longwall face position relative to its starting point, the progress for the past week and the average weekly distance travelled since commencement. This spreadsheet will also be supplemented with a mine workings plan updated each week.

Longwall	Scheduled Start Date	Scheduled	Status

		Completion Date	
Longwall 703	October 2009	November 2010	Complete
Longwall 704	December 2010	December 2011	Complete
Longwall 705	January 2012	March 2013	Complete
Longwall 706	April 2014	November 2015	Complete
Longwall 707	January 2016	June 2017	Planned
Longwall 708	June 2017	March 2019	Planned
Longwall 709	April 2019	July 2020	Planned
Longwall 710	August 2020	September 2021	Planned

Table 3.1.3 Schedule of mining

3.1.4 Illawarra Coal Monitoring of Optus Assets

There are a number of fibre optic cables which run along the SH2 freeway corridor in the vicinity of LW702 – 710.

As for all of the assets in this area, the predicted movements from these Longwalls are not expected to cause significant impacts to any of these cables. However, as for the SH2 freeway and ARTC rail assets, longitudinal monitoring lines are installed and baseline surveys performed by Illawarra Coal prior to the commencement of each Longwall.

In all cases these baseline surveys will be in 3D over the full extent of the lines. Follow up surveys are performed at the completion of each Longwall. Weekly 2D monitoring over a localised section of the two SH2 freeway lines is undertaken during times of closest proximity to the surface infrastructure.

As RMS monitoring lines are located directly over the Optus cable locations and the Optus cables are far less sensitive to ground movements than the freeway pavement, it is understood that the monitoring proposed for the RMS assets will also address the Optus cable monitoring requirements.

3.1.5 Details of Known Optus Asset Damage

Table 3.1.5 below summarises known asset damage since mining operations began. This table is to be updated by Optus when asset damage occurs.

Asset	Location	Optus Project No	Damage	Date
Fibre – Trunk	Morton Park Rd Douglas Park	P1021556	Fibre Break	04/11/10
Fibre – Trunk	Morton Park Rd Douglas Park	P1036766	Fibre Break	29/09/14

Table 3.1.5 Known Optus asset damage

3.2 Metropolitan Coal – Helensburgh Mining Tenement

3.2.1 Mining Tenement Area

Metropolitan Coal mining tenement – Helensburgh area in Wollongong NSW Metropolitan Colliery LW301, LW302 and LW303.

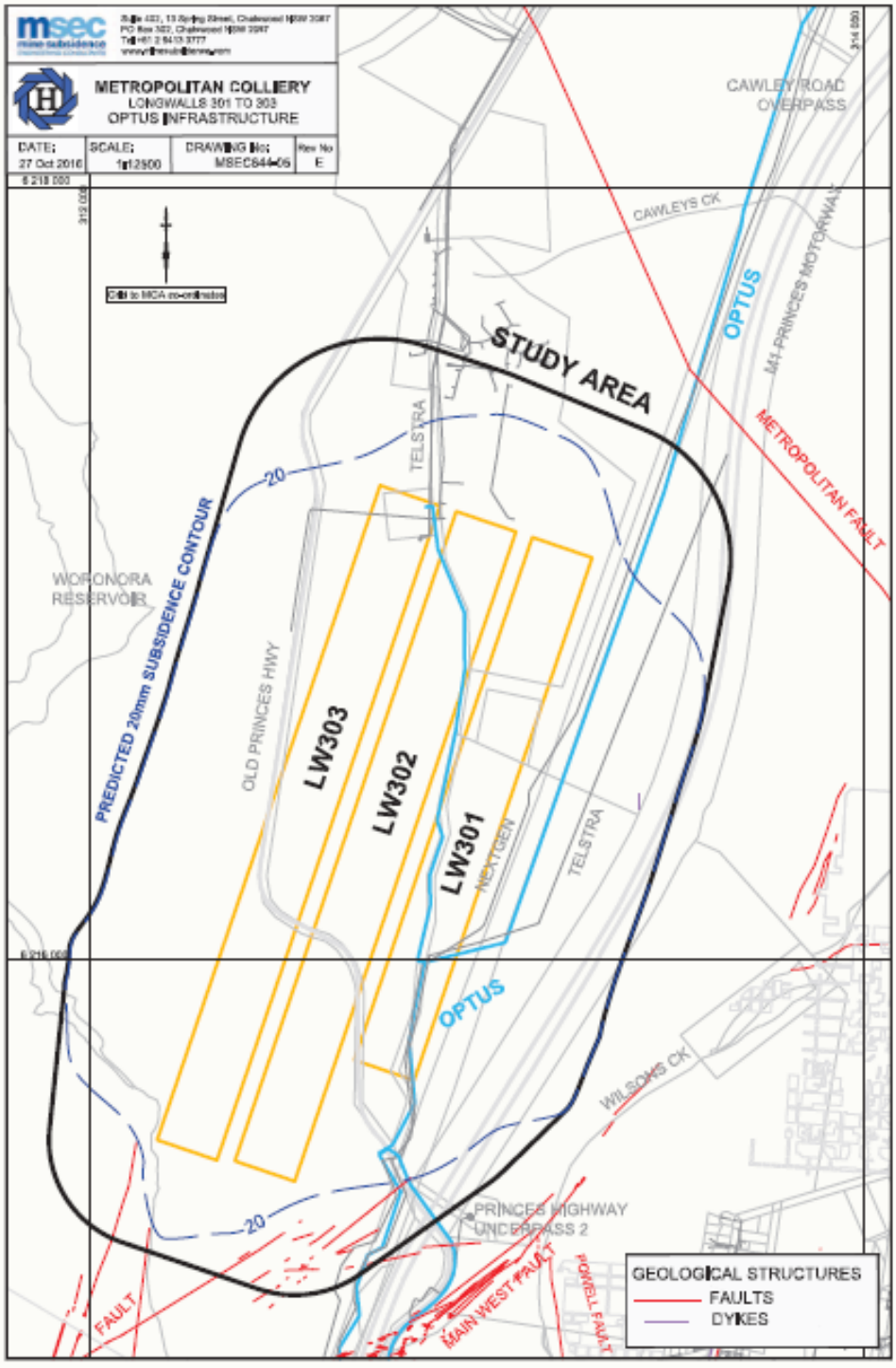


Fig 3.2.1.1 Impacted area showing Sydney Melbourne 2 IOF and other fibre routes

Metropolitan Coal mining tenement – Helensburgh area in Wollongong NSW Metropolitan Colliery LW305, LW306 and LW307.

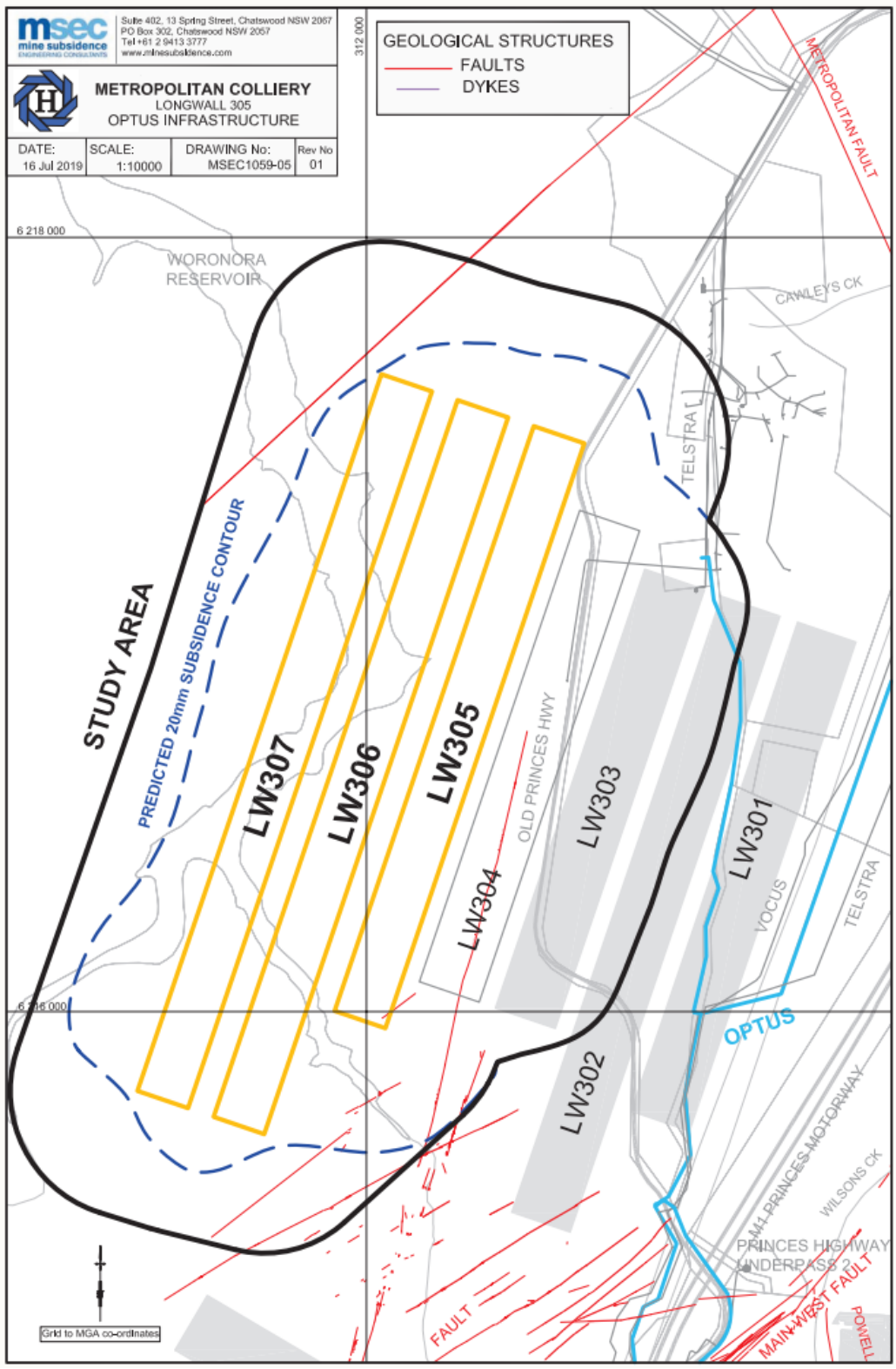


Fig 3.2.1.2 Impacted area showing fibre routes

3.2.2 Details of Optus Assets within Impacted Area

A. LW301, LW302 and LW303

Fibre Optic Cable

There are three different fibres that could be impacted by the mining activities.

a. Trunk Network Fibre – SYD – MELB 2 IOF

Distance	≈	2.5km
Cable	≈	36 SMOF
Conduit	≈	2.5km as Telstra owned P32 within P100
Splices	≈	4BS03 & 22BJL11940
Manholes/Pits	≈	Prefix = TL_MH 19165, 19166, 19167, 19168 & 19169

b. Access Network Fibre – 22BSS23719

Distance	≈	1.5km
Cable	≈	144 SMOF
Conduit	≈	1.5km as P50
Splices	≈	Prefix = 22 BJL11940, BJL9974, AJL10579 & AJL13155
Manholes/Pits	≈	Prefix = 22MH 69867, 69876, 70676, 70677, 70678, 69868 and 84238

c. Access Network Fibre – 22BSS25914

Distance	≈	300m
Cable	≈	72 SMOF
Conduit	≈	300m as P50
Splices	≈	4BS03
Manholes/Pits	≈	TL_MH 19169

Other Assets

Other Optus assets located in the impacted area include the following sites (Optus site codes used):

a. BTS Sites

32HI & O2HE

B. LW305, LW306 and LW307

Fibre Optic Cable

There is one fibre that could be impacted by the mining activities.

a. Access Network Fibre – 22BSS23719

Distance	≈	600m
Cable	≈	144 SMOF
Conduit	≈	600m as P50
Splices	≈	Prefix = 22 BJL9974 & AJL10579
Manholes/Pits	≈	Prefix = 22 MH 70677, 70678, 69868 and 84238

Other Assets

Other Optus assets located in the impacted area include the following site (Optus site code used):

a. BTS Site

O2HE

3.2.3 Mining Activities

Longwalls 301-303 and the area of land within 600m of Longwalls 301-303 secondary extraction are shown on Fig 3.2.3.1 Longwall extraction occurs from north to south. The longwall layout includes 163m panel widths (void) with 45m pillars (solid).

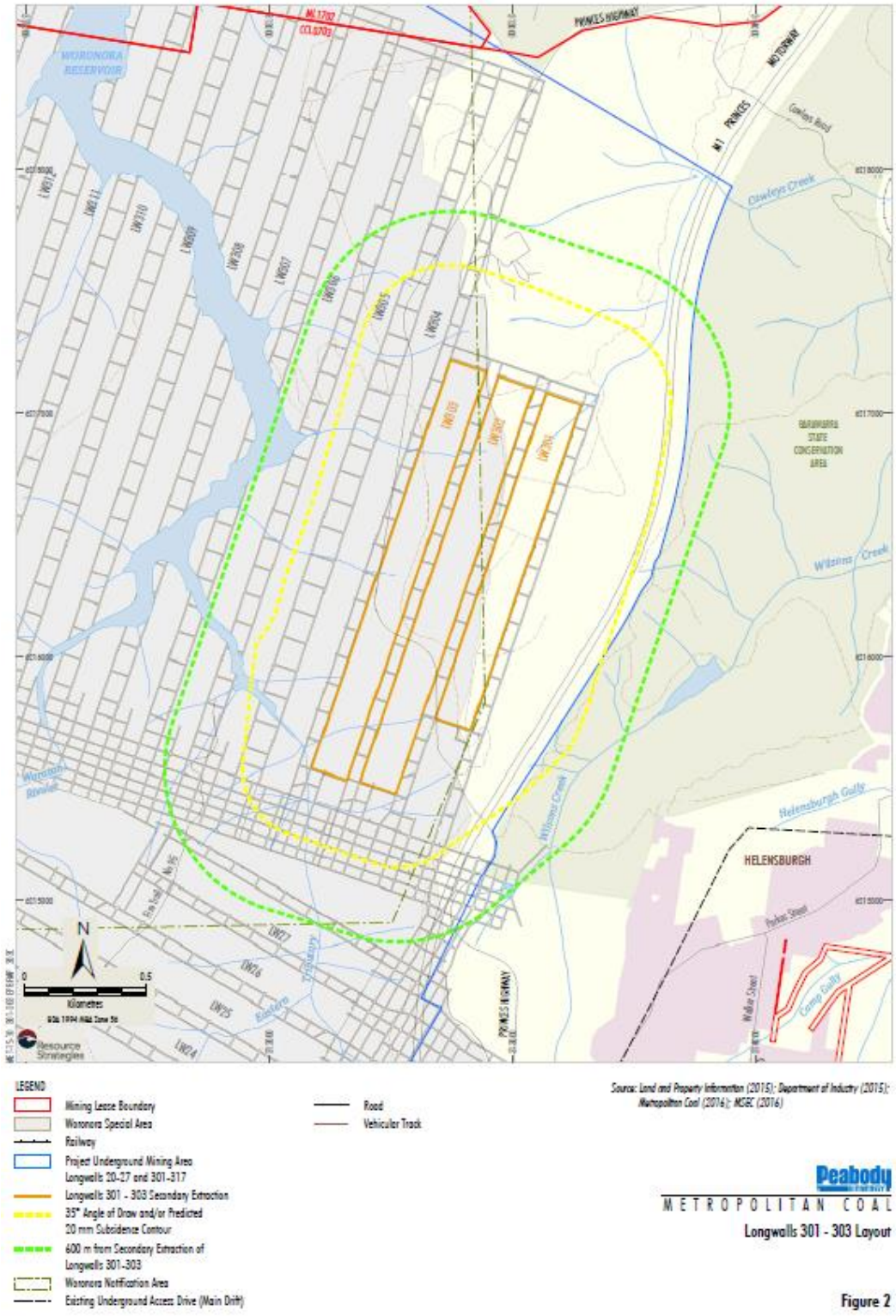


Fig 3.2.3.1

Longwalls 305-307 and the area of land within 600m of Longwalls 305-307 secondary extraction are shown on Fig 3.2.3.2. Longwall extraction occurs from north to south. The longwall layout includes 138m panel widths (void) with 70m pillars (solid).

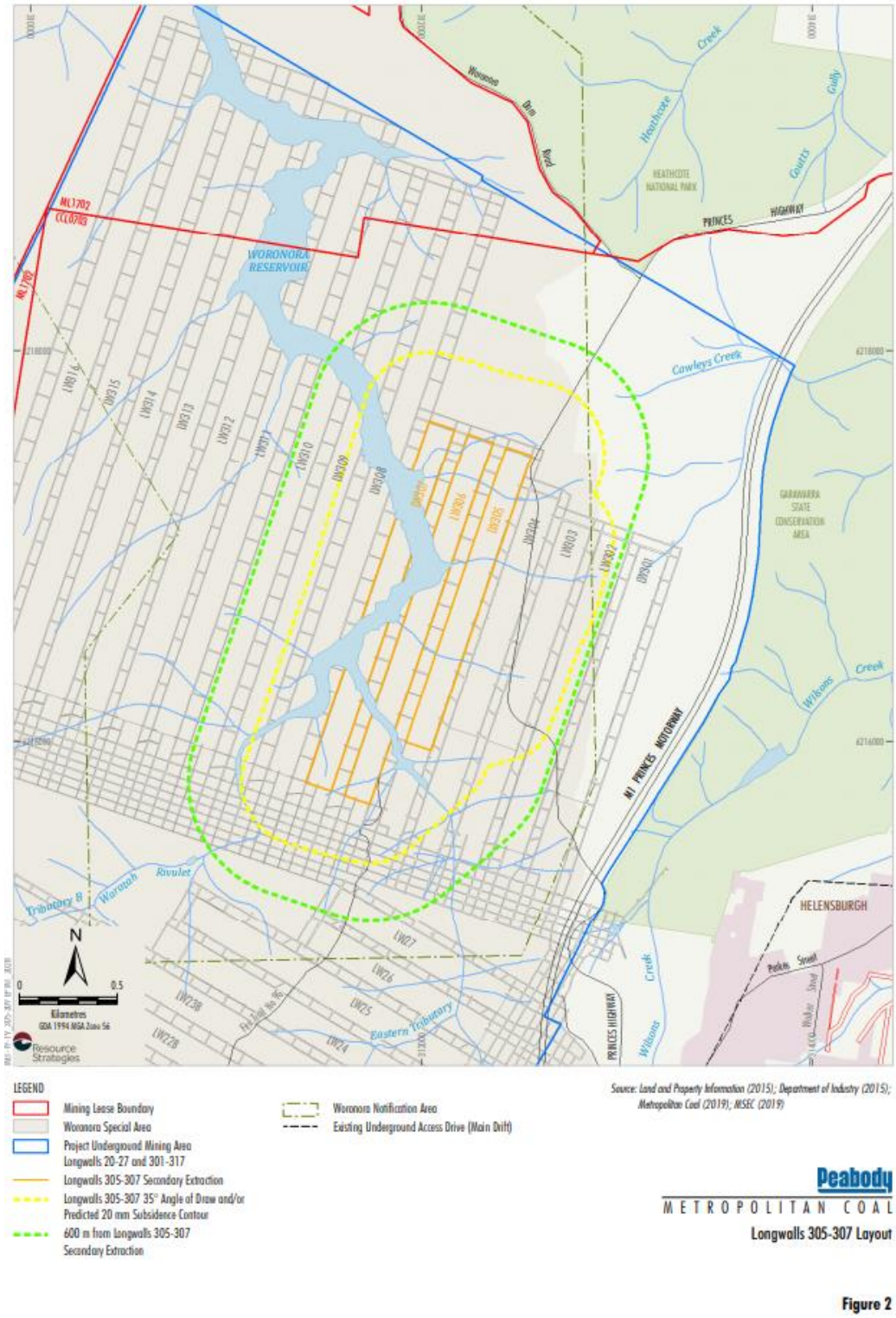


Fig 3.2.3.2

The provisional extraction schedule for Longwalls 301-303 and 305-307 are provided in table 3.2.3. The mining schedule is subject to change but was current as at October 2019.

Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
301	June 2017	8 Months	February 2018
302	March 2018	7 Months	October 2018
303	November 2018	7 Months	June 2019
305	March 2020	7 Months	October 2020
306	November 2020	8 Months	July 2021
307	August 2021	8 Months	April 2022

Table 3.2.3 Schedule of mining

3.2.4 Metropolitan Coal Monitoring of Optus Assets

The following sections have been extracted from Metropolitan Coal's Built Features Management Plan (BFMP) and are included with the permission of Metropolitan Coal.

A. Longwalls 301-303

A monitoring program will be implemented to monitor the impacts of the Project on the Optus assets. Table 3.2.4.1 summarises the Longwalls 301-303 BFMP-OPTUS monitoring components.

The frequency of monitoring will be reviewed either:

- in accordance with the Annual Review outlined in Section 12 of Longwalls 301-303 BFMP-OPTUS; or
- if triggered as a component of the Contingency Plan as outlined in Section 9 of the Longwalls 301-303 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.

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	Once
		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	Once
	Access roads/tracks	Visual inspection (including notes on general condition of access roads/tracks)		Establish condition pre-mining effects	Prior to Longwall 301 extraction	Once
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 Longwalls 301-303 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 Longwall 303	Once per longwall
		RFMS	Optus conducted system monitoring on signal degradation level of 4.5dB	Determine level of impact of mining (if any)	Within 6 months post Longwall 303	Once post Longwall 303
	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

Table 3.2.4.1 – Longwalls 301-303 BFMP-OPTUS Monitoring Program Overview

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 Longwalls 301-303 Subsidence Monitoring Program (Fig 3.2.4.1).

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).

Subsidence Impacts

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 and reported in accordance with the Project Approval conditions.

Access Roads and Tracks

Visual inspection of the access roads/tracks will be conducted by Metropolitan Coal prior to the commencement of Longwall 301 and following extraction of Longwalls 303.

Visual observations of access roads/tracks will also be conducted by Metropolitan Coal as part of routine works and inspections as well as during catchment visits within 600m of Longwalls 301-303 secondary extraction as described in the Metropolitan Coal Longwalls 301-303 Land Management Plan (Longwalls 301-303 LMP).

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 Longwalls 301-303 LMP, initiation of the Contingency Plan as outlined in the Longwalls 301-303 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 Longwalls 301-303 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 Longwalls 301-303 LMP) and to identify required management measures. Management measures are discussed in the Longwalls 301-303 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 Longwalls 301-303 Public Safety Management Plan.

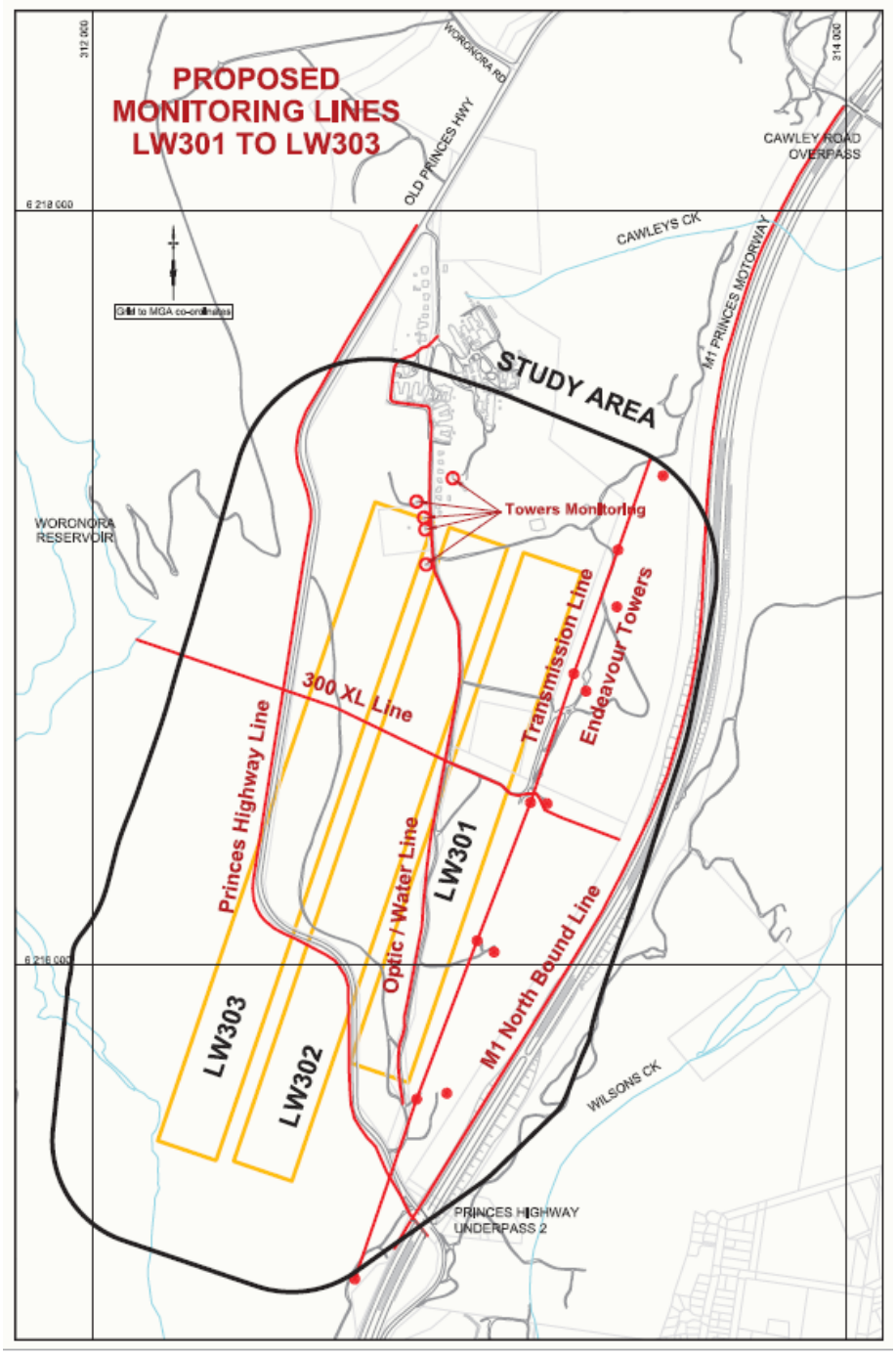


Fig 3.2.4.1

B. Longwalls 305-307

A monitoring program will be implemented to monitor the impacts of the Project on the Optus assets. Table 3.2.4.2 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 delegate 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.

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 Longwalls 305-307 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 Longwall 303	Once per
		RFMS	Optus conducted system monitoring on signal degradation level of 4.5dB	Determine level of impact of mining (if any)	Within 6 months post Longwall 303	Once
	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 Longwall 307	Once

Table 3.2.4.2 – Longwalls 305-307 BFMP-OPTUS Monitoring Program Overview

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 Longwalls 305-307 Subsidence Monitoring Program (Fig 3.2.4.2).

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 corridor, containing Optus 3 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).

Subsidence Impacts

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 and reported in accordance with the Project Approval conditions.

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 each of Longwalls 305-307.

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 305-307 secondary extraction as described in the Metropolitan Coal Longwalls 305-307 Land Management Plan (Longwalls 305-307 LMP).

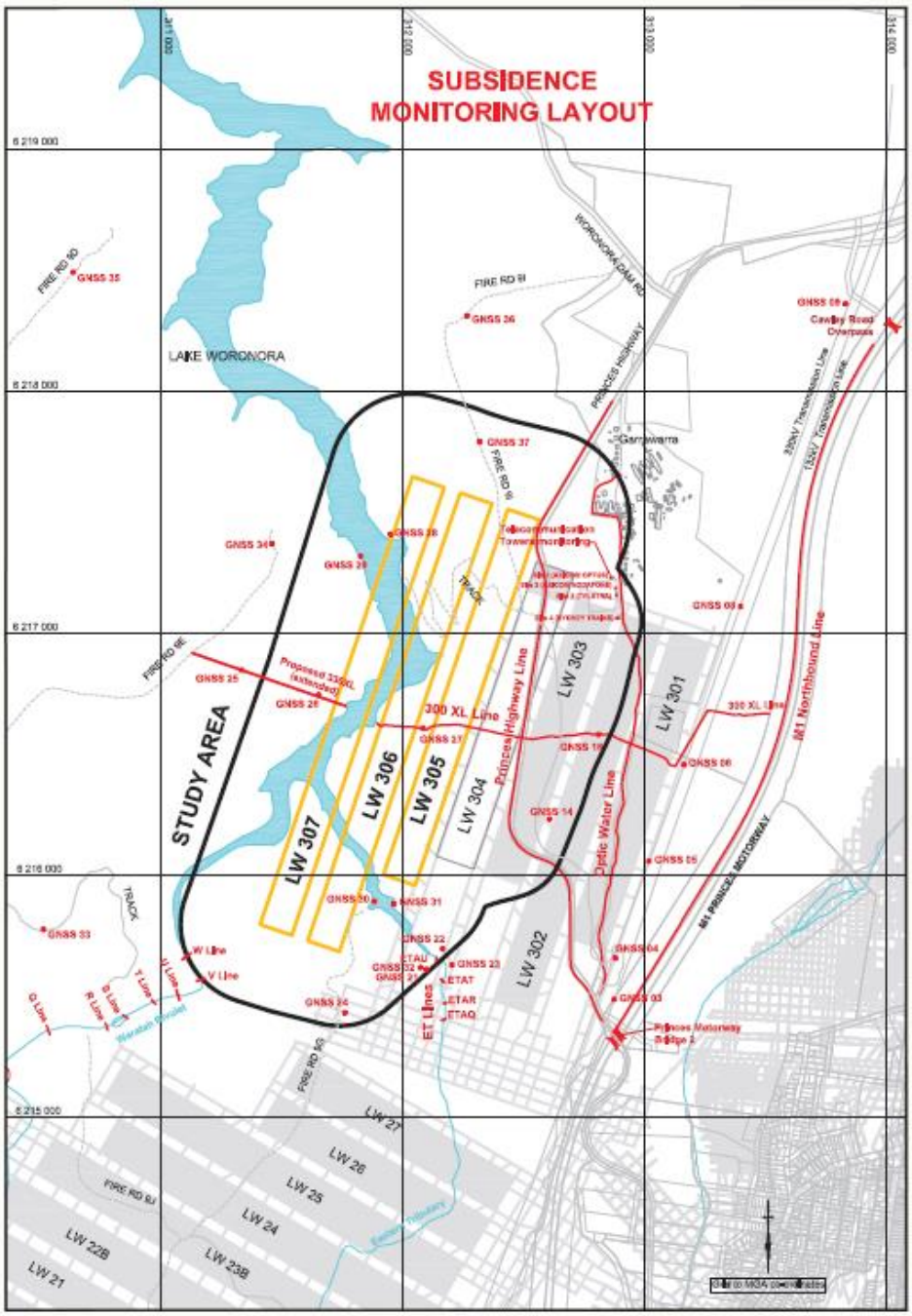


Fig 3.2.4.2

3.2.5 Details of Known Optus Asset Damage

Table 3.2.5 below will summarise any asset damage during mining operations. This table is to be updated by Optus if asset damage occurs.

Asset	Location	Optus Project No	Damage	Date
-	-	-	-	-
-	-	-	-	-

Table 3.2.5 Known Optus asset damage

4. Optus Monitoring and Inspection of Assets

Optus may have a variety of assets in an area of mining that may be potentially impacted by mine subsidence. These assets could include, among others, fibre optic cables, pits, splices, mobile phone, RAN and CEV sites and other assets either above or below ground that are owned, leased or used by Optus.

4.1 Condition of Optus Assets before Mining Activities

Where possible the condition of the Optus assets in an impacted area should be assessed by Optus before mining activities commence to determine the condition of each asset.

The following assessments should be carried out:

- The foundations of all equipment shelters, towers, and all other above ground facilities should be physically inspected and all existing cracks, subsidence, damage, or other structural imperfections measured, recorded, and photographed; and
- Wherever possible all pits, manholes, splice joints, coils, and conduit should be inspected, and all existing cracks, subsidence, damage, or other structural imperfections measured, recorded, and photographed.

In addition to the inspections above, all fibre optic cable splice coils and storage coils should have any bindings removed so as to enable the unravelling of the coil to minimise the possibility of causing stress points or kinking should unexpected lateral strain occur.

4.2 Monitoring of Fibre Optic Cables during & after Mining Activities

Unforeseen fibre optic cable network outages related to mine subsidence in impacted areas have proven that pro-active monitoring of fibre optic cable assets is of little use and provides no advance warning to excessive losses due to fibre optic cable damage (refer to Appendix A for detail on initial pro-active monitoring activities trialled by Optus on the Illawarra Coal mining tenement in Appin/Douglas Park).

As a consequence, pro-active monitoring of fibre optic cable is not carried out by Optus. Semiautomated routine link monitoring will therefore be carried out by Optus using the process detailed below.

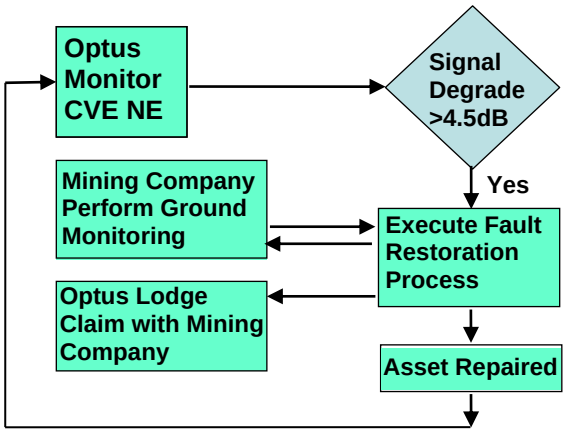


Fig 4.2 Routine link monitoring process flow

1. Monitor CEV NE – to be carried out on a routine basis by the NMC Tier 2;
2. Either signal degraded level of ≥4.5 dB or where requested from the mining company – Execute Fault Restoration process, escalate and communicate to all stakeholders;
3. Escalation and claims process – Optus repairs damaged asset and claims costs against mining company (refer section 5);
4. Mining completed – ongoing automated routine monitoring.

4.3 Costs Related to Inspection & Monitoring Activities

Optus' reasonable costs incurred for any inspections shall be agreed to and paid for by the applicable mining company.

This includes:

- Initial asset inspections before mining starts; and
- Ongoing asset inspections (if requested by the mining company) during mining activities.

There is no charge to the mining company for routine link monitoring as it is a semiautomated process.

5. Escalation, Trigger Events, Claims, Responsibilities & Contact Information

5.1 Escalation and Trigger Events

5.1.1 Escalation Process

The escalation process will be triggered by:

- Service degradation or disruption caused by:
  - The degradation of optical levels on a fibre optic cable; or
  - The degradation of RF levels at a RAN or mobile phone site as a result of earth movement associated to mining activities.
- Physical damage to an asset as a result of earth movement associated to mining activities.

5.1.2 Trigger Event – Optus Fibre Optic Cable Assets

The trigger level for the fault restoration process will either be a degradation of signal level of ≥4.5 dB or where requested by the mining company through their ground monitoring (whichever occurs first).

5.1.3 Trigger Event – Other Optus Assets

Any physical degradation/damage to Optus assets associated to mining activity shall trigger an action response from Optus Service Assurance. Such damage/degradation may become apparent through:

- Comparison with prior inspection reports; and
- Routine or otherwise inspection of an asset.

5.2 Claims for Loss or Damage

Claims for damage to Optus assets will be co-ordinated through Optus Service Assurance. Generally, this will be managed by the Damage & Relocate Team (DART) within Optus Service Assurance. These claims will generally cover the cost of all work required to restore service to its original bench marked levels and may also include the cost of communicating to customers affected by the restoration work.

Optus reserves its right to pursue other claims (e.g. for lost revenue) on a case by case basis.

5.3 Responsibilities

5.3.1 Optus

In the event of service degradation/disruption Optus is responsible to:

- Advise the nominated contact within the relevant mining company of suspected fibre optic cable or other asset damage due to mining activities;
- Request a mining company representative inspect any damage to Optus assets; and
- Prepare a quote for cost of repair of any damage and forward to the relevant mining company for processing.

5.3.2 Mining Company

In the event of service degradation/disruption the relevant mining company is responsible to:

- Provide a resource to inspect any damage caused by mining activities; and
- Provide assistance to process any claim made by Optus for repair of its assets.

5.4 Contact Information

The following sections detail the key contact information for correspondence between organisations.

5.4.1 Optus Contacts

NSW DART email:

DART.NSW@optus.com.au

Ph: 02 80820155

Optus Network Operations Centre

Ph: 1800505777

5.4.2 Illawarra Coal Contacts

Survey Supervisor

Ph: 02 42246354

5.4.3 Metropolitan Coal Contacts

Technical Services Manager

Ph: 02 4294 7200

Ph: 02 4294 7333 – 24hr contact Metropolitan Control Room

6. Document Control

6.1 Authorisation

A. Author Chris Willis

B. Authorised Glen Gordon

C. Approved Steve Minahan
Head of Field
National Field Operations

6.2 Amendment List

Version	Date	Section	Nature of Amendment	Amendment Author
Draft A	02/09/08	All	Document compilation	L Spence
Draft B	18/09/08	All	Deletion of information not pertinent to Optus.	L Spence
1	07/10/08	All	Change from Draft to Version 1	L Spence
2	15/10/08	All	Additions of RAN information and facilities protection.	L Spence
3	13/11/08	Page 14	Grammatical changes.	L Spence
4	17/03/10	7.1 & 8	Update mining schedule and remove reference to previous longwalls. Remove “reference errors” in attachment, change title for Department of Primary Industries.	H. Pinkster
5	01/06/15	1.3, 7.1, 8	Update mining, update schedule & contacts	H. Pinkster
6	05/08/15	8	Update Optus Monitoring and contacts	T Laws
6	12/08/15	3,4,8, Appendix A & B	Amend Document.	L. Spence
7	14/04/16	All	New template used, change title and update entire document to be a generic management plan with specific sections for different mining tenements.	C Willis
8	19/09/16	3	Modify title to include any new mining tenement.	C Willis
9	20/09/18	1.2	Update scope to specifically include infrastructure installed under the Telecommunications Act.	C Willis
9	20/09/18	3.2	Include new section relating to the Metropolitan Colliery in the Wollongong Shire.	C Willis
9	20/09/18	4.2 & 5.1.2	Delete loss of signal data as it is not relevant.	C Willis
9	20/09/18	9	Add new appendix relating to Metropolitan Coal longwalls 301-303.	C Willis

10		3.2	Update entire section to include longwalls 305-307.	
10		10	Add new appendix relating to Metropolitan Coal longwalls 305-307.	

7. Appendix A – Initial Monitoring of Optus Fibre Optic Cable Assets in the Illawarra Coal Appin/Douglas Park Tenement

The following sections have been included with the permission of Illawarra Coal and summarise the pro-active monitoring plan for Optus fibre optic cable assets that was established and maintained during the initial phase of mining activities in the Illawarra coal Appin/Douglas Park mining tenement.

Subsequent fibre optic cable network outages related to mine subsidence in the impacted area have since proven that pro-active monitoring of fibre optic cable assets is of little use and provides no advance warning to excessive losses.

As a consequence, pro-active monitoring is no longer carried out by Optus. Automated routine link monitoring is now carried out (refer section 4.2).

Content removed for Commercial in Confidence reasons

8. Appendix B – Illawarra Coal Mine Subsidence Predictions – Appin/Douglas Park

The following report has been included with the permission of Illawarra Coal.

Content removed for Commercial in Confidence reasons

9. Appendix C – Metropolitan Coal Mine Subsidence Predictions – Metropolitan Colliery Longwalls 301, 302 & 303

The following report has been included with the permission of Metropolitan Coal.

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.

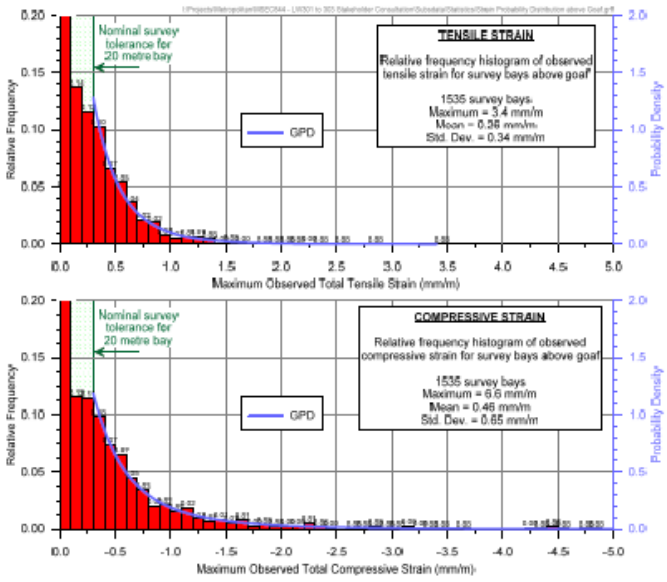


Figure 1 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

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 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 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.

10. Appendix C – Metropolitan Coal Mine Subsidence Predictions – Metropolitan Colliery Longwalls 305, 306 & 307

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 305 to 307 at Metropolitan Colliery.

The locations of the Optus infrastructure and the proposed longwalls are shown in the attached Drawing No. MSEC1059-05. A Study Area is also shown in Drawing No. MSEC1059-05 and is based on the outer limits of a 35° angle of draw line from Longwalls 305 to 307 and the predicted 20mm subsidence contour for Longwalls 305 to 307.

The Optus infrastructure includes two optical fibre cables that are located within and adjacent to the Study Area but not directly above the proposed Longwalls 305 to 307. 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 Longwalls 305 to 307. Optical Fibre Cable 1 is over 770 m from Longwall 305. A second optical fibre cable is located to the east of the proposed Longwall 305, above extracted Longwalls 301 and 302 (Optical Fibre Cable 2).

The northern end of Optical Fibre Cable 2 is 380 m from Longwall 305.

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 304 and after the extraction of Longwall 305 to 307. 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 770 m to the east of Longwall 305 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 Longwalls 305 to 307. 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 305 to 307.

The predicted profiles of total conventional subsidence, tilt and curvature along the alignment of Optical Fibre Cable 2, following the extraction of Longwall 304 and after the extraction of Longwall 305 to 307, are shown in the attached Fig. A.01. 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 within the Study Area Boundary for Optical Fibre Cable 2, following the extraction of Longwall 304 and after the extraction of Longwall 305 to 307, are provided in Table 1. The curvature 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 within the Study Area Boundary for the Optus Optical Fibre Cable 2 after the Extraction of Longwalls 304 to 307

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 LW304	700	3.0	0.03	0.03
After LW305	725	3.0	0.03	0.03
After LW306	725	3.0	0.03	0.03
After LW307	725	3.0	0.03	0.03

It can be seen from Table 1 that the predicted total subsidence within the Study Area Boundary increases by 25mm following the extraction of Longwall 305. The maximum predicted total tilt and curvatures do not increase as a result of the extraction of Longwalls 305 to 307.

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 extracted Longwalls 301 and 302 but not directly above the proposed Longwalls 305 to 307. 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.

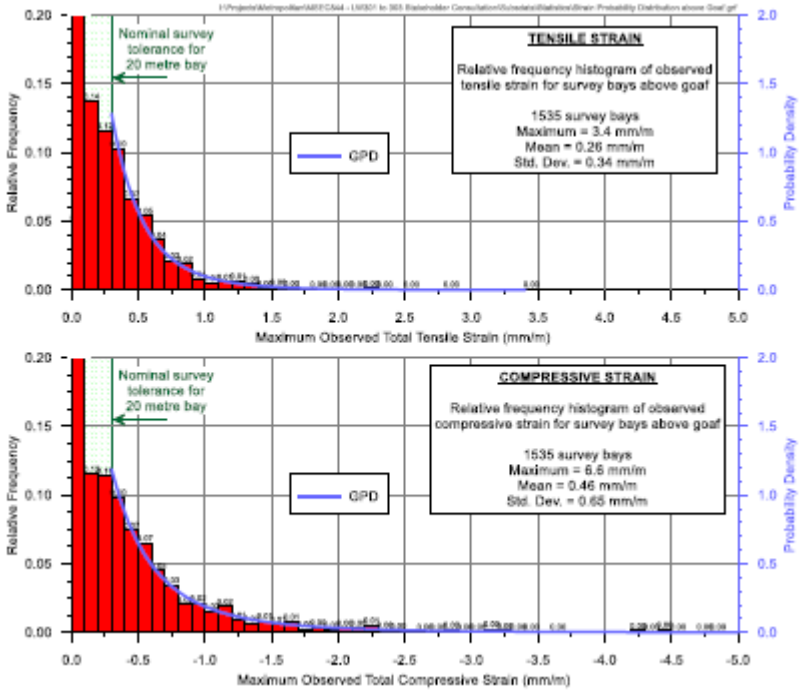


Figure 1 Distributions of the Measured Maximum Tensile and Compressive Strains during the Extraction of Previous Longwalls in the Southern Coalfield Above Goaf

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. MSEC1059-05. 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 to 303. 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 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 Longwalls 305 to 307.

The cables are likely to experience minor vertical subsidence and horizontal movements resulting from the extraction of Longwalls 305 to 307. The predicted tilt and curvatures at the cables do not change as a result of the extraction of Longwalls 305 to 307. The optical fibre cables are unlikely to experience adverse impacts as a result of conventional subsidence movements.

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.

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.

Comprehensive monitoring of subsidence movements has been undertaken during the extraction of LW301 to 303 with magnitudes of observed differential movements consistent with predictions and no observed anomalous movements encountered. It is therefore considered unlikely that non-conventional movements would be observed at the Optus optical fibre cable during the extraction of LW305 to 307.

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 nonconventional 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 revised and continued, in consultation with Optus, to manage the optical fibre cables for potential nonconventional ground movements. Given the increasing distance of the longwall extraction from the optical fibre cables, it is considered that monitoring developed for the extraction of Longwalls 301 to 304 could be relaxed for the extraction of future longwalls from LW305 onwards. Consideration could be given to reducing the frequency of ground survey monitoring to monthly during the extraction of Longwall 305 then to end of panel survey for Longwalls 306 and 307 after confirmation that no significant subsidence movements or impacts were observed during Longwall 305.

Summary

The Optus optical fibre cables are located to the south and east of the Study Area (Cable 1) and above extracted Longwall 302 within the Study Area (Cable 2) but not directly above the proposed Longwalls 305 to 307. 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 possible that the optical fibre cables could experience localised and elevated strains due to the presence of geological structures (known or unknown). Non-conventional subsidence movements have not been observed during the extraction of Longwalls 301 to 303 and the likelihood of non-conventional subsidence movements at the optical fibre cables due to Longwalls 305 to 307 is considered to be very low.

Based on monitoring data observed during Longwalls 301 to 303 and the increased distance to the optical fibre cables, a revision of the monitoring and management strategies is recommended in consultation with Optus with a view to reducing the frequency of monitoring. It is expected that the potential impacts on the Optus infrastructure can be managed with the implementation of the appropriate monitoring and management strategies.