

METROPOLITAN COAL LONGWALL 304

SUBSIDENCE MONITORING PROGRAM



METROPOLITAN COAL

LONGWALL 304

SUBSIDENCE MONITORING PROGRAM

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&E Approval Date
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April 2019

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1 INTRODUCTION

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

The Project comprises the continuation, upgrade and extension of underground coal mining operations (Longwalls 20-27 and Longwalls 301-317) and surface facilities at Metropolitan Coal (Figure 1). Longwall 304 is situated west of Longwalls 301-303 and to the north of completed Longwalls 20-27 (Figures 1 to 3). Longwall 305 on will be subject to future Extraction Plans.

This Subsidence Monitoring Program (SMP) describes the subsidence monitoring program (subsidence effects and subsidence impacts) that forms part of the overall management of the consequential environmental impacts associated with the extraction of Longwall 304. Where relevant, this SMP includes the post-mining requirements for Longwalls 20-22, Longwalls 23-27 and Longwalls 301-303. The Longwalls 301-303 Subsidence Monitoring Program will be superseded by this document following the completion of Longwall 303 consistent with the recommended approach in the NSW Department of Planning & Environment (DP&E) and NSW Division of Resources and Energy (DRE) (2015) *Guidelines for the Preparation of Extraction Plans*.

1.1 PURPOSE AND SCOPE

Condition 6, Schedule 3 of the Project Approval requires the preparation of various documents as a component of Extraction Plan(s) for second workings. Condition 6(e), 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:*

...

(e) *include the following to the satisfaction of DRE:*

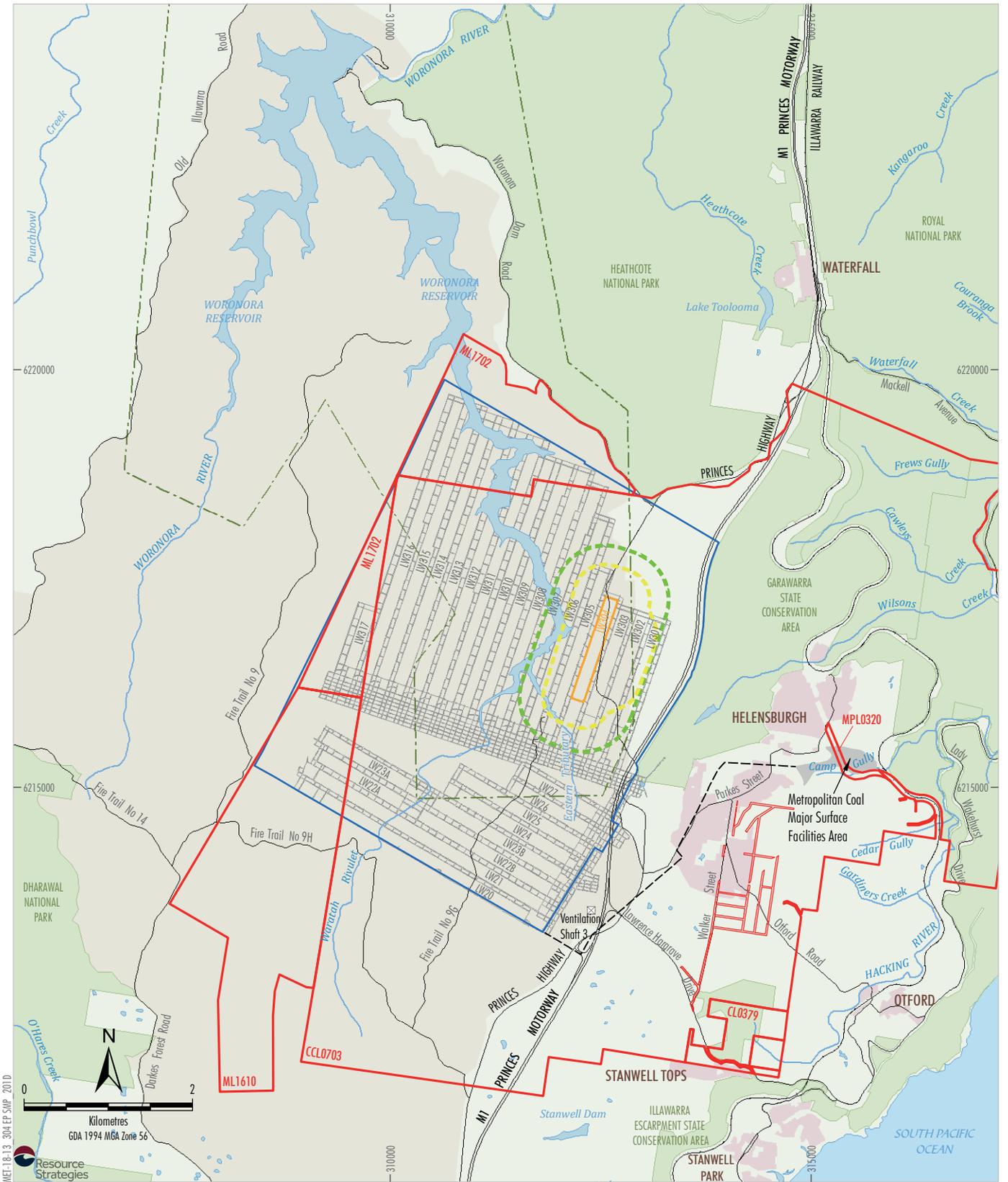
...

- *a Subsidence Monitoring Program to:

 - *validate the subsidence predictions; and*
 - *analyse the relationship between the subsidence effects and subsidence impacts of the Extraction Plan and any ensuing environmental consequences;**

...

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Resource Strategies

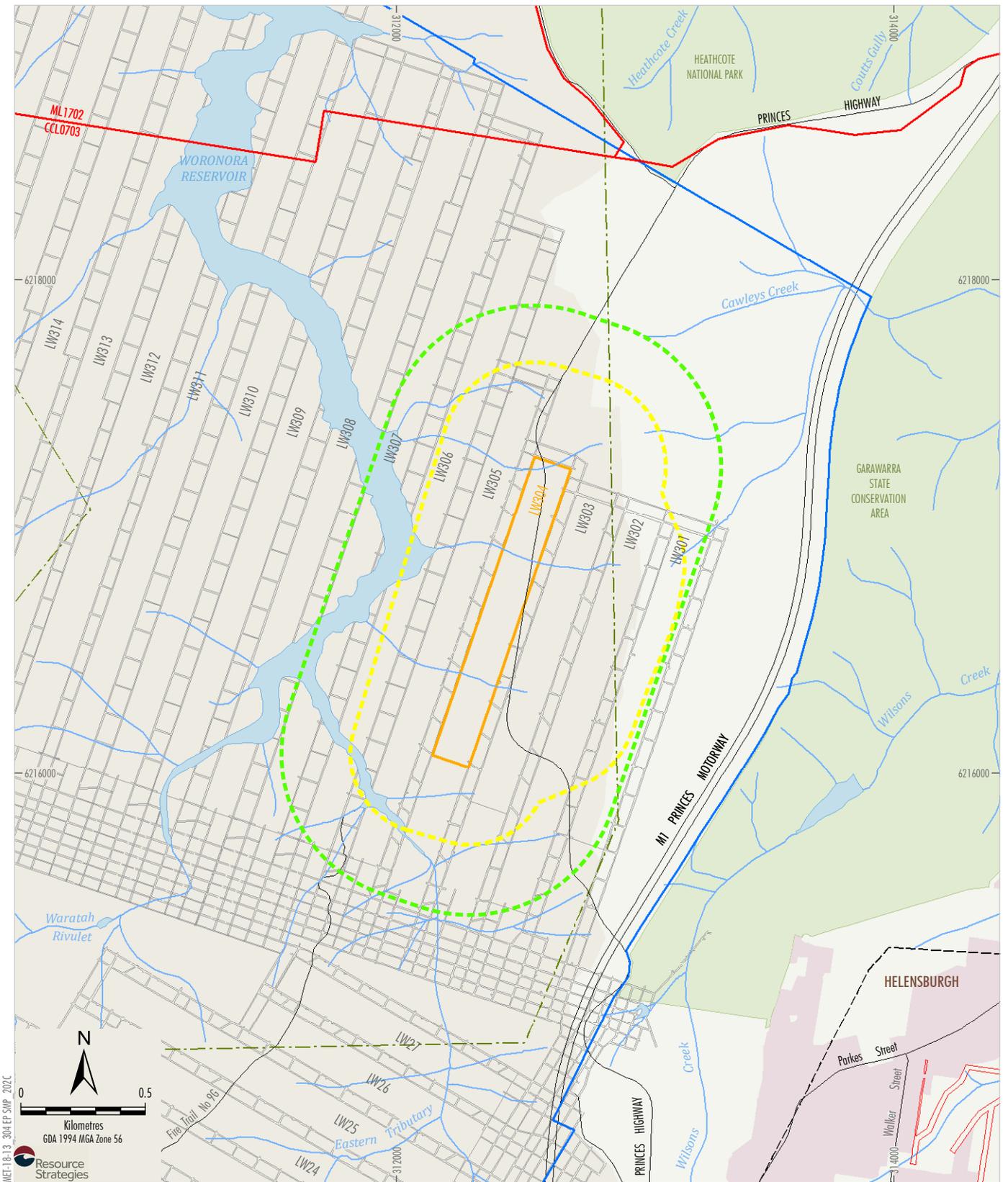
LEGEND

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

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

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METROPOLITAN COAL
Longwall 304 and
Project Underground Mining Area

Figure 1

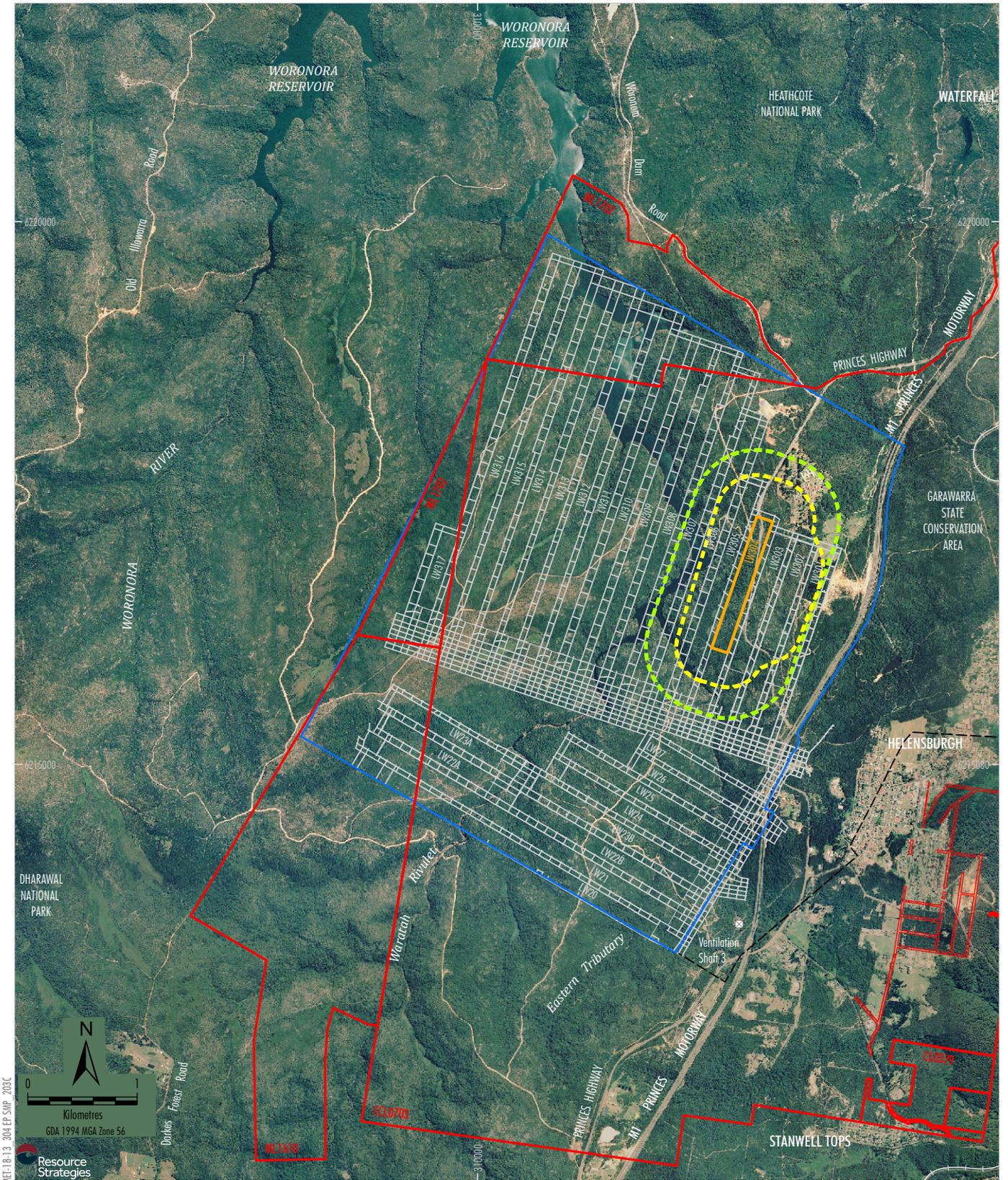


- LEGEND**
- Mining Lease Boundary
 - Woronora Special Area
 - Project Underground Mining Area
Longwalls 20-27 and 301-317
 - Longwall 304 Secondary Extraction
 - 35° Angle of Draw and/or Predicted
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 - Existing Underground Access Drive (Main Drift)

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

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Longwall 304 Layout

Figure 2



MEF-18-13-304 EP SMP-203C

LEGEND

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

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

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Longwall 304 and
Project Underground Mining Area -
Aerial Photograph

Figure 3

The following graphical plans have been prepared in accordance with DP&E and DRE (2015) *Guidelines for the Preparation of Extraction Plans* and are provided separately in the Longwall 304 Coal Resource Recovery Plan (CRRP, Appendix H of the Longwall 304 Extraction Plan):

- Plan 1: Existing, Proposed and Future Workings.
- Plan 2: Surface Features.
- Plan 3: Geological and Seam Data.
- Plan 5: Mining Titles and Land Ownership.
- Plan 6: Geological Section and Geotechnical Logs.

Plan 7 (Subsidence Monitoring Locations) referred to in the DP&E and DRE (2015) *Guidelines for the Preparation of Extraction Plans* is included as Attachment 1 to this SMP.

The document *Metropolitan Mine - Longwall 304 Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan* has been prepared by Mine Subsidence Engineering Consultants (MSEC) (2019) (Appendix I of the Longwall 304 Extraction Plan) includes revised predictions of the conventional and non-conventional subsidence effects and subsidence impacts of the Extraction Plan, incorporating any relevant information that has been obtained since Project Approval.

This SMP outlines the subsidence monitoring program prepared to satisfy that component of Condition 6(e), Schedule 3 of the Project Approval relating to subsidence monitoring. The SMP is, among other things, designed to compare and validate the subsidence predictions outlined in MSEC (2019).

The relationship of this SMP to the Metropolitan Coal Environmental Management Structure and to the Metropolitan Coal Longwall 304 Extraction Plan is shown on Figure 4.

In accordance with Condition 6, Schedule 3 of the Project Approval, this SMP has been prepared by Metropolitan Coal, with assistance from MSEC.

1.2 STRUCTURE OF THE SMP

The remainder of the SMP is structured as follows:

- Section 2: Describes the SMP revision status and distribution list.
- Section 3: Describes the Longwall 304 extraction layout.
- Section 4: Describes the natural and built features.
- Section 5: Summarises the revised predicted subsidence parameters and impacts for the longwalls.
- Section 6: Describes the monitoring program.
- Section 7: Describes the program to analyse subsidence effects, subsidence impacts, and environmental consequences.
- Section 8: Lists the references cited.

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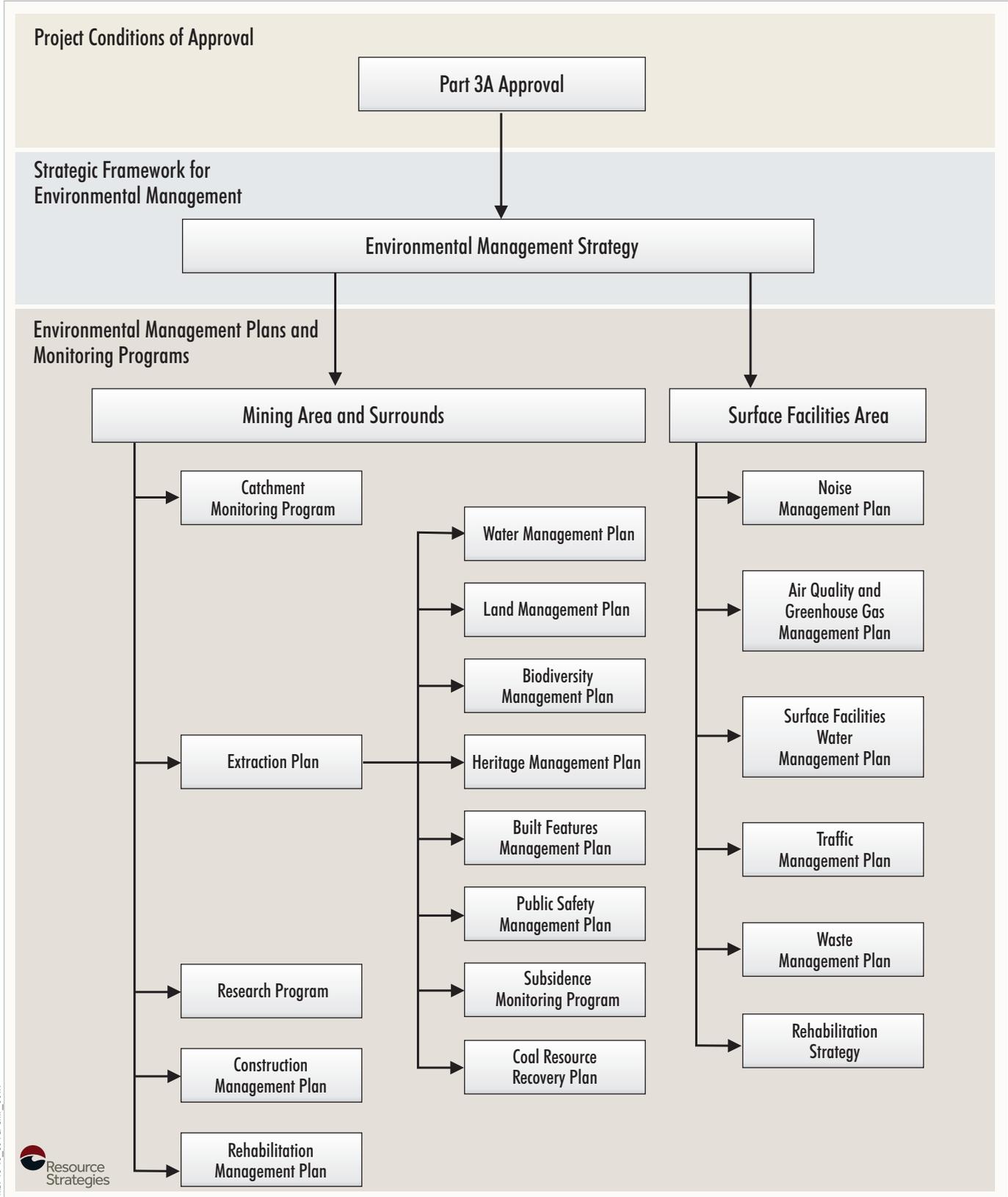


Figure 4

2 SMP REVIEW AND UPDATE

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

- (a) an audit under Condition 8, Schedule 7;
- (b) an incident report under Condition 6, Schedule 7;
- (c) an annual review under Condition 3, Schedule 7; and

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

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

Certain details of the monitoring program will be reviewed and amended as required in consultation with the NSW Resources Regulator, to the satisfaction of the Director-General (now Secretary) of DP&E.

The revision status of this plan is indicated on each copy of the SMP. The distribution register for controlled copies of the SMP is described in Section 2.1.

Revisions to any documents listed within this SMP 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 SMP publicly available on the Peabody website. A hard copy of the SMP will also be maintained at the Metropolitan Coal site.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format.

An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom the Metropolitan Coal plans and programs, such as the SMP, 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 SMP 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.

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3 LONGWALL 304 EXTRACTION LAYOUT

Longwall 304 and the area of land within 600 metres (m) of Longwall 304 secondary extraction is shown on Figures 1, 2 and 3. A summary of the longwall dimensions for Longwall 304 is provided in Table 1. The longwall layout includes a 163 m panel width (void) and 45 m pillars (solid).

Table 1
Summary of Longwall Dimensions for Longwall 304

Longwall	Longwall Length (m)	Total Void Width (m)	Tailgate Chain Pillar Width (m)
LW304	1,286	163	45

m = metres.

Longwall extraction will occur from north to south. The provisional extraction schedule for Longwall 304 is provided in Table 2.

Table 2
Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
LW304	July 2019	6 months	December 2019

The dimensions of the headings would be approximately 5.2 m wide and 3.2 m in height. The headings are connected approximately every 120 m by driving a cut-through from one heading to another which forms pillars of coal along the length of the gate road.

The geology, seam structure, and depth of cover are described in the Longwall 304 CRRP.

The depth of cover within the Longwall 304 35 degree (°) angle of draw and/or 20 millimetres (mm) subsidence contour varies between a minimum of 400 m at the southern end and a maximum of 550 m at the northern end of Longwall 304.

The seam floor within the proposed mining area generally dips from the south-east to the north-west. The seam thickness within the Longwall 304 goaf area varies between 2.7 m to 2.9 m. The longwall equipment will extract a minimum cut height of 2.8 m and the proposed longwall will extract the full height of the seam.

4 SURFACE FEATURES INCLUDED IN MONITORING PROGRAM

4.1 THE STUDY AREA

The Study Area in MSEC (2019) was defined as the surface area that is likely to be affected by the mining of Longwall 304 in the Bulli Seam at Metropolitan Colliery. The surface features included in the Study Area are those features within areas bounded by the following limits:

- a 35° angle of draw line from the extent of Longwall 304; and
- the predicted limit of vertical subsidence, taken as the predicted incremental 20 mm subsidence contour resulting from the extraction of Longwall 304.

Natural features identified within the Study Area include:

- streams (including small first and second order tributaries);
- cliffs and overhangs, steep slopes and land in general (including ledges and rock outcrops);
- upland swamps; and
- other natural vegetation.

Aboriginal heritage sites have also been identified within the Longwall 304 Study Area. The full supply level of the Woronora Reservoir is also located within the Longwall 304 Study Area.

Built features identified within the Longwall 304 Study Area include:

- Old Princes Highway;
- telecommunication towers and compounds;
- optical fibre cables;
- water pipelines and water storage tanks;
- Garrawarra Centre Complex buildings, structures and services (southern areas);
- Waterfall General (Garrawarra) Cemetery;
- fire trails and four wheel drive tracks;
- exploration bores; and
- survey control marks.

There are features that lie outside the Study Area that are expected to experience either far-field movements, or valley related movements. The surface features which are sensitive to such movements have been identified and have been included in the assessments provided in MSEC (2019).

MSEC (2019) also considered natural features and built features that lay outside the Study Area that may experience far-field movements. The features included within the assessment beyond the extent of the Study Area include:

- the Eastern Tributary;
- M1 Princes Motorway;
- M1 Princes Motorway bridge (Bridge 2 – Old Princes Highway Underpass);
- M1 Princes Motorway bridge (Cawley Road Overbridge);
- 330 kV and 132 kV transmission lines and towers;
- Illawarra Railway;
- Woronora Dam;
- Garrawarra Centre Complex buildings, structures and services (northern areas);

These are discussed in detail in MSEC (2019) and summarised below.

The surface features are shown on Plan 2 in Attachment 1 of the Longwall 304 CRRP.

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4.1.1 Streams

Streams in the Study Area for Longwall 304 include small first and second order streams.

These streams consist of shallow drainage lines from the topographical high point above Longwalls 301-303, forming streams where valley heights increase and drain into the Woronora Reservoir to the west of Longwall 304. Three drainage lines/streams are located over Longwall 304.

The Eastern Tributary flows into the full supply level of the Woronora Reservoir to the south of the Longwall 304 Study Area.

The Waratah Rivulet is located outside the Study Area, approximately 1.1 kilometres (km) south-west of Longwall 304 at its closest point to Longwall 304 secondary extraction.

4.1.2 Cliffs and Associated Overhangs

A new cliff and overhang site (COH17) was identified below the full supply level of the Eastern Tributary arm of the Woronora Reservoir in August 2018. Detailed baseline recording for this site has been conducted.

The next nearest cliffs and overhang sites are located more than 600 m to the west of Longwall 304. At these distances, the cliffs are not expected to experience any measurable vertical subsidence resulting from the extraction of Longwall 304.

4.1.3 Steep Slopes and Land in General

Steep slopes have been identified to highlight areas where existing ground slopes may be marginally stable. However, no significant slope failures have been observed in the Southern Coalfield as a result of longwall mining. Land in general refers to the general landscape other than cliffs and steep slopes and includes rock ledges/rock outcrops and minor cliffs.

4.1.4 Upland Swamps

The mapped extents of the upland swamps are based on field inspection and validation by Eco Logical Australia (2016, 2018). There are 11 swamps located within the Study Area. Detailed descriptions of the swamps within the Study Area are provided in the Metropolitan Coal Longwall 304BMP.

4.1.5 Other Natural Vegetation

The vegetation within the Study Area generally consists of native bushland. A summary of the vegetation communities present is provided in the Metropolitan Coal Longwall 304 BMP.

4.2 PUBLIC UTILITIES

4.2.1 Railways

There are no railways within the Study Area. The Illawarra Railway is located to the east of the Study Area. The Illawarra Railway (which links Sydney and Wollongong) is located more than 1.9 km from Longwall 304.

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4.2.2 Roads and Culverts

The locations of roads including the M1 Princes Motorway, Old Princes Highway, private roads, access roads, fire trails and four-wheel drive tracks within and adjacent to the Study Area are shown on Plan 2 in the Longwall 304 CRRP.

The M1 Princes Motorway is located more than 800 m from Longwall 304. A series of culverts of varying diameters from 375 mm to 1,800 mm cross the M1 Princes Motorway.

The total length of the Old Princes Highway that is located within the Study Area is approximately 1.9 km, of which approximately 660 m is located directly above Longwall 304.

A network of private roads also services the Garrawarra Centre Complex.

All other roads within the Study Area are unsealed fire trails or access roads which are used by WaterNSW and other asset owners and groups for firefighting and other activities.

4.2.3 Bridges

The features along the M1 Princes Motorway considered to be most sensitive to relative movements arising from far-field effects are Bridge 2 (at the location where the Old Princes Highway passes below the M1 Princes Motorway) and Cawley Road Overbridge.

Bridge 2 (Old Princes Highway Underpass) is located outside the Study Area and approximately 880 m from the finishing end of Longwall 304.

The Cawley Road Overbridge is located approximately 1.67 km from the northern end of Longwall 304.

4.2.4 Electrical Services

There are aboveground and buried electrical services within the Study Area, the locations of which are shown on Plan 2 in the Longwall 304 CRRP and on Drawing No. MSEC1009-08 in MSEC (2019).

A 330 kilovolt (kV) transmission line, which is owned by TransGrid, and a 132 kV power line, which is owned by Endeavour Energy, are located outside of the Study Area and to the east of Longwall 301. The 330 kV transmission line and 132 kV power line and towers were not directly undermined by previous longwalls. All 330 kV and 132 kV transmission towers located adjacent to Longwall 301 are suspension towers.

Endeavour Energy own aerial powerlines which service the Garrawarra Centre Complex to the north-east of Longwall 304. The feeder aerial powerline that runs between Helensburgh and the Garrawarra Centre Complex is referred to as Powerline 1 and is outside the Study Area. Underground powerlines are also present within the Garrawarra Centre Complex.

4.2.5 Telecommunications Services

There are underground telecommunication lines within the Study Area consisting of both optical fibre and copper cables, the locations of which are shown on Plan 2 in the Longwall 304 CRRP and on Drawing No. MSEC1009-08 in MSEC (2019).

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There are three main optical fibre cables that cross the southern end of Longwall 301 owned by Telstra, Optus and Vocus (previously Nextgen). A second optical fibre cable owned by Telstra crosses above the northern end of Longwall 303 and a second optical fibre cable owned by Optus crosses above the northern end of Longwall 303 and is situated above Longwalls 301 and 302. No optical fibre cables are located directly above Longwall 304.

Copper telecommunications cables owned by Telstra are located to the north of Longwalls 301-303 and these cables service the Garrawarra Centre Complex. A portion of one of the copper telecommunication cables is situated above Longwall 304.

There are also a number of telecommunications towers and compounds that are located above and to the north of Longwall 303 and east of Longwall 304. These towers and compounds are owned by Telstra, Axicom and Sydney Trains.

4.2.6 Dams, Reservoirs and Associated Works

The closest dam to Longwall 304 is the Woronora Dam. The Woronora Dam wall is located approximately 7.0 km from the commencing end of Longwall 304. The distance from the labyrinth spillway (south of the dam wall) is approximately 6.6 km from the nearest point of Longwall 304. Monitoring of the Woronora Dam wall is not included in this SMP due to the large distance of the Dam wall from extraction.

The whole of Longwall 304 extraction is within the Woronora Notification Area and a portion of the full supply level of the Woronora Reservoir is located inside the Study Area. Longwall 304 does not extend beneath the Woronora Reservoir full supply level.

4.3 MINE INFRASTRUCTURE

There is one exploration drill hole (borehole) within the Study Area, the location of which is shown on Plan 2 in the Longwall 304 CRRP and on Drawing No. MSEC1009-09. Borehole (S225) is located adjacent to Longwalls 301 and 302.

4.4 GARRAWARRA CENTRE COMPLEX

The location of the Garrawarra Centre Complex and buildings, structures and other services are shown in Drawings No. MSEC1009-08, MSEC1009-09 and MSEC1009-10 in MSEC (2019). There is a total of 86 building structures on the complex, comprising 57 buildings (hospital/aged care/houses) and 29 ancillary structures.

There are also nine water storage tanks, a gas storage tank and a number of telecommunication towers located within the complex. A network of bitumen sealed private roads services the complex. NSW Health manages the Garrawarra Centre Complex. Further details are provided in the Built Features Management Plan (BFMP)-Garrawarra.

4.5 ITEMS OF ARCHAEOLOGICAL SIGNIFICANCE

4.5.1 Aboriginal Heritage Sites

The locations of known Aboriginal heritage sites within the Study Area are shown in Drawing No. MSEC1009-09 in MSEC (2019). Detailed baseline recordings of Aboriginal heritage sites are provided in baseline reports prepared by Niche Environment and Heritage and are described in the Metropolitan Coal Longwall 304 Heritage Management Plan (HMP).

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4.5.2 Local Heritage Sites

The *Wollongong Local Environmental Plan, 2009* lists items of heritage significance at the Garrawarra Centre Complex including the Garrawarra Hospital Heritage Conservation Area, Gates and Gatehouse, Administration, Kitchen and Store Block, Staff Cafeteria, Nurses Hostel and Residential Houses. Howard Tanner and Associates (1993) also lists additional items of varying significance at the Garrawarra Centre Complex. NSW Health manages the Garrawarra Centre Complex. Further details are provided in the BFMP-Garrawarra.

The Waterfall General [Garrawarra] Cemetery, also referred as the Garrawarra Hospital Cemetery or Waterfall Cemetery, is currently listed as an item of local significance under the *Wollongong Local Environmental Plan, 2009* (Item 61028). The Waterfall Cemetery site is under the management of the Wollongong City Council (WCC). Further details are provided in the BFMP-Cemetery.

4.6 PERMANENT SURVEY CONTROL MARKS

The locations of survey control marks are shown on Plan 2 in the Longwall 304 CRRP and on Drawing No. MSEC1009-09 in MSEC (2019).

5 REVISED SUBSIDENCE PARAMETERS AND SUBSIDENCE IMPACTS DUE TO LONGWALL 304 EXTRACTION

MSEC (2019) provides a detailed description of the development of mine subsidence and the method used to predict the mine subsidence movements resulting from the extraction of Longwall 304. The report includes the maximum predicted conventional subsidence parameters for Longwall 304 (Chapter 4 of MSEC [2019]) including:

- Incremental Subsidence Parameters, which are the predicted subsidence parameters due to the extraction of a single Longwall.
- Total Subsidence Parameters, which include the accumulated subsidence parameters after the completion of each longwall within a series of longwalls.

The maximum predicted incremental conventional subsidence from the extraction of Longwall 304 is 625 mm, and the maximum predicted total conventional subsidence from the extraction of Longwall 304 is 1,050 mm, which represents approximately 38% of the seam thickness.

A comparison of the maximum predicted conventional total subsidence parameters, for the Extraction Plan Layout and the Preferred Project Layout for Longwall 304, is provided in Table 4.3 of MSEC (2019). The Extraction Plan Layout maximum predicted total subsidence, tilt and curvature are similar to or less than the predicted values based on the Preferred Project Layout.

5.1 PREDICTED SUBSIDENCE PARAMETERS AND IMPACTS FOR THE NATURAL AND BUILT FEATURES WITHIN THE STUDY AREA

MSEC (2019) provides a comprehensive description of revised (since the Project Environmental Assessment [Helensburgh Coal Pty Ltd, 2008] and Preferred Project Report [Helensburgh Coal Pty Ltd, 2009]) site specific predicted subsidence parameters and impact assessments for each of the natural and built features that are located within the Study Area, due to the extraction of Longwall 304. Additionally, natural and built features that are located outside the Study Area, which may be subjected to far-field movements and may be sensitive to the predicted subsidence parameters, were also included in the revised assessments.

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In particular, the following surface features were assessed:

- Waratah Rivulet (*located approximately 1.1 km south-west of Longwall 304*).
- Eastern Tributary.
- Other Streams.
- Woronora Reservoir and Woronora Dam (*the latter being located approximately 7.0 km away*).
- Cliffs and Associated Overhangs.
- Steep Slopes and Land in General.
- Upland Swamps and other Natural Vegetation.
- Illawarra Railway (*located more than 1.9 km away*).
- M1 Princes Motorway.
- Old Princes Highway.
- Fire Trails and Four Wheel Drive Tracks.
- Bridges (Bridge 2 [*located approximately 880 m away*]).and Cawley Road Overbridge [*located approximately 1.67 km away*]).
- Electrical Services.
- Sydney Water Infrastructure (water mains).
- Optical Fibre Cables.
- Telecommunication Towers and Compounds.
- Copper Telecommunications Cables.
- Garrawarra Centre Complex (including buildings, structures and services).
- Waterfall General (Garrawarra) Cemetery.
- Archaeological Sites (Aboriginal heritage and local heritage).
- Exploration Holes.
- Survey Control Marks.

The monitoring program described below was developed in consideration of the predicted subsidence parameters and subsidence impacts outlined in MSEC (2019).

6 MONITORING

6.1 INTRODUCTION

The objectives of the monitoring program are:

- To monitor the subsidence effects associated with Longwall 304 extraction and where relevant, previous Longwalls 301-303 and Longwalls 20-27.
- To summarise and consolidate the various environmental monitoring programs presented in each of the key component plans of the Longwall 304 Extraction Plan which focus on the monitoring of subsidence impacts and environmental consequences of mine subsidence. These include:
 - the Water Management Plan (WMP);
 - the Biodiversity Management Plan (BMP);
 - the Land Management Plan (LMP);
 - the Heritage Management Plan (HMP);
 - the Built Features Management Plan (BFMP); and
 - the Public Safety Management Plan (PSMP).
- To analyse the relationship between the subsidence effects and subsidence impacts of the Extraction Plan and any ensuing environmental consequences.
- To validate subsidence predictions.
- To provide subsidence data to improve the predictive methods and provide a better understanding of the underlying factors contributing to ground movement.

The subsidence monitoring program is composed of subsidence parameter monitoring that is summarised in Table 3 and subsidence impact/environmental consequence monitoring as summarised in Table 4.

Table 3
Subsidence Parameter Monitoring Components

Monitoring Component	Description	Frequency	Relevant Management Plan
300 XL Line	Main monitoring line traversing approximately perpendicular across 300 series longwalls	<ul style="list-style-type: none"> Prior to Longwall 304. Within 3 months following completion of Longwall 304. 	General – all plans
[Old] Princes Highway Line	Along the Old Princes Highway from Survey Mark 116 (near M1 Princes Motorway) to Garrawarra Centre Complex entrance road.	<ul style="list-style-type: none"> Prior to Longwall 304. Weekly for area within 400 m of active longwall face passing under highway until subsidence reduces below level of survey accuracy. Following the completion of Longwall 304. 	BFMP-WCC BFMP-Sydney Water
Optic/Water Line	Along an unsealed track and Garrawarra Centre Complex internal roads from Survey Mark 21 (near the Old Princes Highway) to beyond the 35° angle of draw line within Garrawarra Centre Complex.	<ul style="list-style-type: none"> Prior to Longwall 304. Weekly for portions of line within 400 m of active longwall face until subsidence reduces below level of survey accuracy. Following completion of Longwall 304. 	BFMP-Optus BFMP-Vocus BFMP-Telstra BFMP-Sydney Water BFMP-Garrawarra BFMP-Axicom BFMP-Sydney Trains
M1 North Bound Line	Along the M1 Princes Motorway from Bridge 2 to Cawley Road Overbridge.	<ul style="list-style-type: none"> Prior to Longwall 304. Following the completion of Longwall 304. 	BFMP-RMS BFMP-Sydney Trains
Transmission Line	Along the transmission lines between Tower TL11-108 and TL11-104.	<ul style="list-style-type: none"> Prior to Longwall 304. Within 3 months following the completion of Longwall 304. 	BFMP-TransGrid BFMP-Endeavour Energy BFMP-Vocus BFMP-Telstra BFMP-Optus BFMP-Sydney Trains BFMP-Cemetery
Transmission Towers	Towers; TL11-104 to TL11-108 and F9132B-T8 to F9132B-T12 including: <ul style="list-style-type: none"> Each of the four tower legs. Four ground points adjacent to each leg. Real time absolute 3D monitoring at TransGrid Towers, sites #4 through #8 corresponding with TL11-104 to TL11-108. 	<ul style="list-style-type: none"> Prior to Longwall 304. Monthly (relative) at each tower during extraction of Longwall 304. Within 3 months following the completion of Longwall 304. Real-time (continuous) absolute 3D monitoring on TransGrid towers. 	BFMP-TransGrid BFMP-Endeavour Energy BFMP-RMS BFMP-Vocus BFMP-Telstra BFMP-Optus
Telecommunication Towers	Lattice (Truss) Towers including: <ul style="list-style-type: none"> Each of the tower legs. Ground points adjacent each tower leg Pole Tower including: <ul style="list-style-type: none"> Ground points adjacent to tower. 	<ul style="list-style-type: none"> Prior to Longwall 304. Weekly on commencement of Longwall 304 until subsidence effects are no longer detectable. Within 3 months following the completion of Longwall 304. 	BFMP-Telstra BFMP-Axicom BFMP-Sydney Trains BFMP-Garrawarra

Table 3 (Continued)
Subsidence Parameter Monitoring Components

Monitoring Component	Description	Frequency	Relevant Management Plan
Bridge 2 (Old Princes Highway Underpass)	<ul style="list-style-type: none"> Absolute 3D movement of the survey reference pillar. Relative 3D movements of bridge monitoring points Fibre Optic monitoring system. Real time absolute 3D monitoring site #3. 	<ul style="list-style-type: none"> Real-time (continuous) absolute 3D monitoring. Weekly Fibre Bragg Grating (FBG) sensor monitoring from the commencement of Longwall 304 extraction for the duration of Longwall 304 extraction. 	BFMP- RMS
Cawley Road Overbridge	<ul style="list-style-type: none"> Absolute 3D movement of the survey reference pillar. Relative 3D movements of bridge monitoring points. Absolute real time 3D monitoring site #9. 	<ul style="list-style-type: none"> Real-time (continuous) absolute 3D monitoring. Following the completion of Longwall 304. 	BFMP- RMS
Illawarra Railway Line	<ul style="list-style-type: none"> Relative 3D movements of culvert monitoring points. Real time absolute 3D monitoring for Valley Closure. Sites 17, 18, 19, 20. 	<ul style="list-style-type: none"> Real-time (continuous) absolute 3D monitoring for valley closure at Wilsons Creek and Cawleys Creek for duration of Longwall 304 extraction. Following the completion of Longwall 304. 	BFMP-Sydney Trains
Eastern Tributary	<p>Cross lines at ETAU, ETAT, ETAR and ETAQ.</p> <p>High Resolution Survey lines A, B, C at ETAU for valley closure.</p> <p>Realtime absolute 3D monitoring sites 21, 22, 23.</p>	<ul style="list-style-type: none"> Prior to Longwall 304. For ETAU and high-resolution lines A, B, C, measurements are fortnightly on commencement of Longwall 304 until 900 m void, then weekly until 1,230 m void and beyond 1,230 m at no greater than 3 day intervals until completion. Real-time (continuous) absolute 3D monitoring at 3 sites ETAU. Following the completion of Longwall 304. 	WMP (Pools/rock bars ETAU, ETAT, ETAR and ETAQ and functionality of gauging station)
Waratah Rivulet Cross Line	Cross Line Q (WaterNSW gauging station).	<ul style="list-style-type: none"> Annually. 	WMP (Rock Bar Q)
Valley Closure Ridge top monitoring	<p>Eastern Tributary (2 x GPS Monitoring Points).</p> <p>Waratah Rivulet (7 x GPS Monitoring Points).</p> <p>Realtime absolute 3D monitoring sites 24, 25.</p>	<ul style="list-style-type: none"> Prior to Longwall 304. At 500 m longwall retreat intervals after Longwall 304 commences. Following the completion of Longwall 304. 	General

**Table 4
Subsidence Impact and Environmental Consequences Monitoring Components**

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
LMP	Cliffs and overhangs	<ul style="list-style-type: none"> Cliff site COH17. 	<ul style="list-style-type: none"> Visual inspection following the completion of Longwall 303. Monthly when Longwall 304 extraction is within 400 m of the site. Following the completion of Longwall 304. 	<ul style="list-style-type: none"> Cliff instabilities – length of cliff/overhang that experiences mining-induced rock fall (i.e. the exposure of a fresh face of rock and debris scattered around the base of the cliff or overhang), compared against the land subsidence impact performance indicator and subsidence impact performance measure.
	Steep slopes and land in general	<ul style="list-style-type: none"> Steep slopes and other land within 600 m of Longwalls 20-27 and Longwalls 301-304 secondary extraction. 	<ul style="list-style-type: none"> Visual observations during catchment visits. 	<ul style="list-style-type: none"> Sandstone fracturing and rock falls (nature and extent of surface tension cracks and rock ledge collapse, compared against the land subsidence impact performance indicator).
BMP	Upland Swamps – Vegetation	<ul style="list-style-type: none"> Swamps 16, 17, 18, 19, 20, 24, 25, 28, 30, 31, 32, 33, 34, 35, 36 and 94 (overlying or adjacent to Longwalls 20-27). Swamps 40, 41, 46, 47, 48, 49, 50, 51/52, 53 and 58 (overlying or adjacent to Longwalls 301-303). All swamps located within the 35° angle of draw and/or predicted 20 mm subsidence contour for Longwall 304 will be subject to visual inspections as a component of the existing Longwalls 301-303 upland swamp vegetation monitoring program. Control Swamps 101, 111a, 125, 135, 136, 137a, 137b, 138, Bee Creek Swamp, Woronora River 1, Woronora River south arm and Dahlia Swamp. 	<ul style="list-style-type: none"> Visual inspections bi-annually in spring and autumn. 	<ul style="list-style-type: none"> Cracking of exposed bedrock areas and/or swamp substrate. Areas of increased erosion, particularly along any existing drainage line. Any changes in water colour, particularly evidence of iron precipitation. Changes in vegetation condition, including areas of stressed vegetation (i.e. plants that demonstrate symptoms of stress) and dead/dying plants that appear unusual. Whether the amount of seepage (at the terminal step/over exposed surfaces of the swamp) at the time of inspection appears unusual (relative to recent rainfall).
		<ul style="list-style-type: none"> Swamps 16, 17, 18, 20, 24 and 25 (Longwalls 20-22). Swamps 28, 30, 33, 35 and 94 (Longwalls 23-27). Swamps 40, 41, 46, 51/52 and 53 (Longwalls 301-303). Swamps 48 and 50 (Longwall 304). Control Swamps 101, 111a, 125, 135, 136, 137a, 137b, 138, Bee Creek Swamp, Woronora River 1, Woronora River south arm and Dahlia Swamp. 	<ul style="list-style-type: none"> Transect and quadrat monitoring bi-annually in spring and autumn. 	<ul style="list-style-type: none"> Vegetation structure. Dominant species. Estimated cover and height for each stratum. Full floristics. Estimated cover abundance for each species using seven point Braun-Blanquet scale. Condition/health rating for each species in the quadrat.
		<ul style="list-style-type: none"> Twenty tagged individuals (<i>Epacris obtusifolia</i>) in each of Swamps 18, 24 and 25 (Longwalls 20-22) and Control Swamps 101, 111a and 125. Twenty tagged individuals (<i>Epacris obtusifolia</i>) in each of Swamps 19, 30, 33, 35 and 94 (Longwalls 23-27) and Control Swamps 135, 136, 137a, 137b and 138. Twenty tagged individuals (<i>Epacris obtusifolia</i>) in each of Swamps 40 and 53 (Longwalls 301-303) and Control Swamps 101, 136 and 137a. Twenty tagged individuals (<i>Sprengelia incarnata</i>) in each of Swamps 24 (Longwalls 20-22) and Control Swamps 101 and 125. Twenty tagged individuals (<i>Sprengelia incarnata</i>) in each of Swamps 19, 33, 35 and 94 (Longwalls 23-27) and Control Swamps 135, 136, 137a and 138. Twenty tagged individuals (<i>Sprengelia incarnata</i>) in each of Swamps 40 and 53 (Longwalls 301-303) and Control Swamps 101, 136 and 137b. Twenty tagged individuals (<i>Pultenaea aristata</i>) in each of Swamps 18, 24 and 25 (Longwalls 20-22) and Control Swamps 101 and 111a. Twenty tagged individuals (<i>Pultenaea aristata</i>) in each of Swamps 19, 30, 33, 35 and 94 (Longwalls 23-27) and Control Swamps 135, 136, 137a and 138. Twenty tagged individuals (<i>Banksia robur</i>, <i>Callistemon citrinus</i> and <i>Leptospermum juniperinum</i>) in each of Swamps 20 (Longwalls 20-22) and Control Swamps Woronora River 1, Woronora River south arm and Dahlia Swamp. Twenty tagged individuals (<i>Banksia robur</i> and <i>Callistemon citrinus</i>) in each of Swamps 28 (Longwalls 23-27) and Control Swamps Woronora River 1, Woronora River south arm and Dahlia Swamp. 	<ul style="list-style-type: none"> Indicator species monitoring bi-annually in spring and autumn. 	<ul style="list-style-type: none"> Population monitoring data including condition/health rating for each plant and reproductive rating

Table 4 (Continued)
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
BMP (Cont.)	Upland Swamps - Groundwater	<ul style="list-style-type: none"> Includes paired piezometers (i.e. one swamp substrate piezometer to a depth of approximately 1 m and one sandstone piezometer to a depth of approximately 10 m). Swamp 50. Swamps 20 and 25 (Longwalls 20-22). Swamps 28, 30, 33 and 35 (Longwalls 23-27). Swamps 40, 41, 46, 51, 52 and 53 (Longwalls 301-303). Swamp 50 (Longwall 304). Control Swamps 101, 137a, 137b, Bee Creek Swamp and Woronora River 1. 	<ul style="list-style-type: none"> Datalogger (continuous). 	<ul style="list-style-type: none"> Groundwater levels.
	Riparian Vegetation	<ul style="list-style-type: none"> Sites MRIP01 to MRIP12. 	<ul style="list-style-type: none"> Visual inspections bi-annually in spring and autumn. 	<ul style="list-style-type: none"> Areas of new water ponding. Any cracking or rock displacement. Changes in vegetation condition, including areas of stressed vegetation that appear unusual.
		<ul style="list-style-type: none"> Sites MRIP01 to MRIP08, MRIP11 and MRIP12. 	<ul style="list-style-type: none"> Permanent quadrat (20 m x 2 m) monitoring bi-annually in spring and autumn. 	<ul style="list-style-type: none"> Vegetation structure. Dominant species. Estimated cover and height for each stratum. Full floristics. Estimated cover abundance for each species using seven point Braun-Blanquet scale. Condition/health rating for each species in the quadrat.
		<ul style="list-style-type: none"> Existing tagged individuals (<i>Prostanthera linearis</i>, <i>Schoenus melanostachys</i> and <i>Lomatia myricoides</i>) at sites MRIP01 to MRIP12. 	<ul style="list-style-type: none"> Indicator species monitoring bi-annually in spring and autumn. 	<ul style="list-style-type: none"> Population monitoring data including condition/health rating for each plant and reproductive rating.
	Aquatic Biota and their Habitats	<ul style="list-style-type: none"> Surface water resources and watercourses in accordance with the WMP. 	<ul style="list-style-type: none"> In accordance with the WMP. 	<ul style="list-style-type: none"> Monitoring of aquatic habitats in accordance with the WMP.
		<ul style="list-style-type: none"> Stream monitoring at following Locations (if sufficient aquatic habitat is available for sampling); <ul style="list-style-type: none"> WT3, WT4, WT5, ET1, ET2, ET3 and ET4. Control Locations: WR1 and OC. 	<ul style="list-style-type: none"> Biannually in spring (15 September to 15 December) and autumn (15 March to 15 June). 	<ul style="list-style-type: none"> Impacts on aquatic ecology: <ul style="list-style-type: none"> Habitat Characteristics. Water Quality. Aquatic Macroinvertebrates. Aquatic Macrophytes.
		<ul style="list-style-type: none"> Larger pools ETAH on the Eastern Tributary and control Pool WP on the Woronora River and Pool OC on O'Hares Creek. Smaller pools ETAG, ETAI and ETAK on the Eastern Tributary and control Pools WP-A, WP-B and WP-C on the Woronora River and Pools OC-A, OC-B and OC-C on O'Hares Creek. 	<ul style="list-style-type: none"> Monitoring of Pools ETAG and ETAH will recommence subsequent to the conduct of stream remediation activities at Pool ETAH and will be conducted bi-annually in spring (15 September to 15 December) and autumn (15 March to 15 June). Monitoring of Pools ETAI and ETAK will recommence subsequent to the conduct of stream remediation activities at Pool ETAK and will be conducted bi-annually in spring (15 September to 15 December) and autumn (15 March to 15 June). 	<ul style="list-style-type: none"> The response of aquatic ecosystems to the implementation of stream remediation works: <ul style="list-style-type: none"> Habitat Characteristics. Water Quality. Aquatic Macroinvertebrates. Aquatic Macrophytes.
	Amphibian Monitoring	<ul style="list-style-type: none"> Sites 1-6 (Longwalls 20-22), 13-17 (Longwalls 23-27) and 23-28 (Longwalls 301-303). Control Sites 7, 8, 9, 10, 11, 12, 18, 19, 20, 21 and 22. 	<ul style="list-style-type: none"> Survey annually in spring/summer (i.e. October to February) during suitable weather conditions. 	<ul style="list-style-type: none"> Species assigned to relative abundance categories for tadpole and adult stages.

Table 4 (Continued)
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
WMP	Stream Features	<ul style="list-style-type: none"> The Eastern Tributary from full supply level of the Woronora Reservoir to the maingate of Longwall 26. The Waratah Rivulet from Pool P to the full supply level of the Woronora Reservoir. 	<ul style="list-style-type: none"> Visual inspection and photographic survey of the Eastern Tributary conducted monthly when mining is within 450 m of the stream. Visual inspection and photographic survey within 3 months of the completion of Longwall 304. Weekly monitoring at pools observed with gas releases t, until no gas releases have been observed at the pool for three consecutive weeks. 	<ul style="list-style-type: none"> Location, approximate dimensions (length, width and depth), and orientation of surface cracks (specifically whether cracks are developed perpendicular to the stream flow or are controlled by rock joints or other factors, etc.). Nature of iron staining (e.g. whether isolated or across the entire streambed). Extent of iron staining (e.g. the length of stream affected). Description of gas release (e.g. isolated bubbles or continuous stream, and type of gas [methane or carbon dioxide]). Nature of scouring, for example the depth of scouring, type of soil exposed, any obvious vegetation impact, potential for severe erosion, etc. Water discoloration or opacity if present. Rock bar characteristics such as extent of cracking, seepage, underflow.
	Surface Water Flow	<ul style="list-style-type: none"> Eastern Tributary (GS 300078). Waratah Rivulet (GS 2132102). Woronora Reservoir Sub-catchment I (GS 300092). Woronora Reservoir Sub-catchment K (GS 300093). Woronora River (GS 2132101). Honeysuckle Creek (GS 300077). O'Hares Creek (GS 213200). 	<ul style="list-style-type: none"> Continuous (downloaded monthly). 	<ul style="list-style-type: none"> Stream flow data.
	Pool Water Levels and Drainage Behaviour	<ul style="list-style-type: none"> Eastern Tributary Pools ETG, ETJ, ETM, ETO, ETU, ETW, ETAF, ETAG, ETAH, ETAI/ETAJ/ETAK, ETAL, ETAM, ETAN, ETAO, ETAP, ETAQ, ETAR, ETAS/ETAT³ and ETAU. Waratah Rivulet Pools A, F, J, K, L, M, N, O, P, Q, R, S, T, U, V and W. Woronora River Control Pools WRP1, WRP2, WRP3 and WRP4. 	<ul style="list-style-type: none"> Continuous water level sensor and logger (downloaded monthly at all sites). Pools ETAS/ETAT and ETAU - continuous water level sensor and logger (downloaded weekly when Longwall 304 extraction is within 450 m of the Eastern Tributary).. 	<ul style="list-style-type: none"> Pool water levels.
		<ul style="list-style-type: none"> Waratah Rivulet Pools B, C, E, G, G1, H and I. 	<ul style="list-style-type: none"> Manually monitored daily, until such time that continuous sensors are installed. 	<ul style="list-style-type: none"> Pool water levels.
		<ul style="list-style-type: none"> Pools ETAS, ETAT and ETAU on the Eastern Tributary. 	<ul style="list-style-type: none"> Visual inspections conducted weekly when mining is within 450 m of the stream. 	<ul style="list-style-type: none"> Evidence of new cracking within the stream bed or rock bar. Whether the pools continue to flow over, through and/or below the rock bars (where relevant). Whether surface flow is evident along the length of the pools prior to flowing over/through/below the rock bars or boulder fields.
		<ul style="list-style-type: none"> Pools on the Waratah Rivulet from Pool P to the full supply level of the Woronora Reservoir. 	<ul style="list-style-type: none"> Visual inspections conducted at the time of download (monthly). 	
	Stream Water Quality	<ul style="list-style-type: none"> Eastern Tributary sites ETWQ F, ETWQ J, ETWQ N, ETWQ U, ETWQ W, ETWQ AF, ETWQ AH, ETWQ AQ and ETWQ AU. Waratah Rivulet sites WRWQ 2, WRWQ 6, WRWQ 8, WRWQ 9, WRWQ M, WRWQ N, WRWQ P, WRWQ R, WRWQ T, WRWQ U, WRWQ V, and WRWQ W. Tributary B site RTWQ 1. Tributary D site UTWQ 1. Far Eastern Tributary site FEWQ 1. Honeysuckle Creek site HCWQ 1. Bee Creek site BCWQ1. Woronora River sites WOWQ1 and WOWQ 2. 	<ul style="list-style-type: none"> Monthly. 	<ul style="list-style-type: none"> Water quality parameters as described in the WMP (samples collected for metal analysis to be field filtered).
		<ul style="list-style-type: none"> Eastern Tributary sites ETWQ F, ETWQ J, ETWQ N, ETWQ AF and ETWQ AQ. Waratah Rivulet sites WRWQ 2, WRWQ 6, WRWQ 8, WRWQ 9, WRWQ M, WRWQ N and WRWQ P. Woronora River site WOWQ 2. 	<ul style="list-style-type: none"> Monthly. 	<ul style="list-style-type: none"> Unfiltered water quality samples analysed for total iron.

Table 4 (Continued)
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
WMP (Cont.)	Stream Water Quality (Cont.)	<ul style="list-style-type: none"> Eastern Tributary sites ETWQ AQ and ETWQ AU. Woronora River site WOWQ 2. 	<ul style="list-style-type: none"> Fortnightly at the commencement of Longwall 304. 	<ul style="list-style-type: none"> Water quality parameters as described in the WMP (samples collected for metal analysis to be field filtered). Unfiltered water quality samples analysed for total iron and total manganese.
		<ul style="list-style-type: none"> Site ETAU, and at a minimum of three downstream sites (site ETFSL 0, site ETFSL 20, site ETFSL 40, site ETFSL 60, site ETFSL 80, site ETFSL 100, ETFSL 200, site ETFSL 300, site ETFSL 400, site ETFSL 500, site CONFLU1, site WDFS1 and/or site WDFS1+100). Site WARARM5. 	<ul style="list-style-type: none"> Site ETAU, and at a minimum of three downstream sites - weekly (until the site ETWQ AU monitoring results are at Level 1 or Level 2 of the WMP Trigger Action Response Plan (TARP) for the quality of water resources reaching the Woronora Reservoir for four consecutive assessment periods. Site ETAU, and at a minimum of three downstream sites - fortnightly (once the site ETWQ AU monitoring results have returned to Level 1 or Level 2 TARP levels for four consecutive assessment periods, unless the TARP level returns to Level 3). Site WARARM5 - at the same frequency described above when the sites downstream of site CONFLU can be accessed for sampling (i.e. when the Woronora Reservoir water levels are suitably low). 	<ul style="list-style-type: none"> Water quality parameters as described in the WMP (samples collected for metal analysis to be field filtered). Unfiltered water quality samples analysed for total iron and total manganese.
	Woronora, Nepean and Cataract Reservoir Water Quality	<ul style="list-style-type: none"> Woronora Reservoir (site DW01). Nepean Reservoir. Cataract Reservoir. 	<ul style="list-style-type: none"> As made available by Water NSW. 	<ul style="list-style-type: none"> Total iron, total manganese and total aluminium.
	Shallow Groundwater Levels Near Streams	<ul style="list-style-type: none"> Eastern Tributary sites ETGW1 and ETGW2. Waratah Rivulet sites WRGW1, WRGW2 and WRGW7. 	<ul style="list-style-type: none"> Data downloaded monthly at all sites; analysis on a six-monthly basis. Sites ETGW1 and ETGW2 downloaded weekly when Longwall 304 extraction is within 450 m of the Eastern Tributary. 	<ul style="list-style-type: none"> Groundwater levels.
	Groundwater Levels/Pressures	<ul style="list-style-type: none"> Transect sites T1, T2, T3, T5 and T6. Groundwater standpipes TBS02-90, TBS02-15, TBS03-15 and TBS02-190. Site 9HGW0 (Longwall 10 Goaf Hole). Site 9EGW1B. Site 9FGW1A. Site 9GGW2B. Site 9HGW1B. Site PM02. Site 9GGW1-80. Site PM01 (9DGW1B). Site 9EGW2A. Site 9EGW2-4. Site PM03. Site PHGW1B. Site PHGW2A. Site F6GW3A. Site F6GW4A. Site TBS02-250R. Site TBS03-230. 	<ul style="list-style-type: none"> Data downloaded/reading monthly. Analysis at the frequency described in the WMP. 	<ul style="list-style-type: none"> Groundwater levels.
	Groundwater Quality	<ul style="list-style-type: none"> Eastern Tributary site ETGW2. Waratah Rivulet sites WRGW1, WRGW2 and WRGW7. 	<ul style="list-style-type: none"> Monthly. 	<ul style="list-style-type: none"> Water quality parameters as described in the WMP.
	Mine Water Make	Underground	<ul style="list-style-type: none"> Mine water balance inputs (as described in the WMP). Weekly statutory inspections. 	<ul style="list-style-type: none"> Groundwater inflow to the mine (20-day average).

Table 4 (Continued)
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
HMP	Aboriginal Heritage	<ul style="list-style-type: none"> Sites MET 1, FRC 176, FRC 28, FRC 29, FRC 34, FRC 60 and FRC 117. 	<ul style="list-style-type: none"> Within three months of the completion of Longwall 303. Sites that show continued change due to mining induced subsidence during this monitoring will also be monitored within three months of the completion of Longwall 304. 	<ul style="list-style-type: none"> Inspections of rock surfaces for cracking and/or exfoliation and/or blockfall. Inspection of art motifs for damage or deterioration. Identification of any natural weathering processes that may result in deterioration (e.g. fire, vegetation growth and water seepage). Comparison of the physical characteristics of the site at the time of monitoring against the previous monitoring and the baseline record.
		<ul style="list-style-type: none"> Sites FRC 76, FRC 77, FRC 78, FRC 86, FRC 90 and FRC 309 	<ul style="list-style-type: none"> Within three months of the completion of Longwall 304. 	
BFMP-RMS	M1 Princes Motorway - Pavement	Visual inspection for impacts on: <ul style="list-style-type: none"> Asphaltic concrete surface. Kerbs, gutters and pits. Signs or other road infrastructure. 	<ul style="list-style-type: none"> Following the completion of Longwall 304. Greater frequency if determined in consultation with the Technical Committee Network Safety Inspection twice weekly during the extraction of Longwall 304. 	To identify development of, or changes in existing: <ul style="list-style-type: none"> Asphaltic concrete surface including cracks, buckling and stepping. Kerbs and gutters including cracking, buckling and joint movement.
	M1 Princes Motorway - Cuttings	Visual inspection for impacts on: <ul style="list-style-type: none"> Cuttings along the M1 Princes Motorway as described in the BFMP-RMS. 	<ul style="list-style-type: none"> Following the completion of Longwall 304. Greater frequency if determined in consultation with the Technical Committee Network Safety Inspection twice weekly during the extraction of Longwall 304. 	To identify: <ul style="list-style-type: none"> Changes in cutting condition, including opening of cracks, spalling. Changes in groundwater seepage or surface water flows. Rockfalls. Changes in RMS risk ranking.
	M1 Princes Motorway - Culverts	<ul style="list-style-type: none"> Closed circuit television (CCTV) inspection for impacts on internal surfaces. 	<ul style="list-style-type: none"> Following the completion of Longwall 304 or more frequent if determined in consultation with the RMS Technical Committee. 	<ul style="list-style-type: none"> To identify changes to the visible surfaces of the culverts including cracking, buckling, shearing, and collapse.
	Bridge 2 (Old Princes Highway Underpass)	Visual inspection for impacts on: <ul style="list-style-type: none"> Abutments. Pier frames. Elastomeric bearings. Soffits of girders. Deck expansion joints. Steel traffic barrier joints. Other areas of substructure and adjoining areas including concrete paths, stairs, and slope protection. 	<ul style="list-style-type: none"> Following the completion of Longwall 304. Greater frequency if determined in consultation with the Technical Committee. 	To identify development of, or changes in existing: <ul style="list-style-type: none"> Surface cracks. Closing or opening of joints. Distortion or damage to elastomeric bearings.
	Cawley Road Overbridge	Visual inspection for impacts on: <ul style="list-style-type: none"> Abutments. Pier blade wall. Tetron bearings. Deck expansion joints. Steel traffic barrier and safety screen joints. 	<ul style="list-style-type: none"> Following completion of Longwall 304. Greater frequency if determined in consultation with the RMS Technical Committee. 	To identify development of, or changes in existing: <ul style="list-style-type: none"> Surface cracks. Closing or opening of joints. Distortion or damage to Tetron bearings.
BFMP-WCC	Old Princes Highway - Pavement	From the Old Princes Highway Underpass (Bridge 2) to the entrance to the Garrawarra Centre Complex.	<ul style="list-style-type: none"> Progress monitoring (visual inspections) to occur weekly as longwall face within 400 m of passing under asset. Following completion of Longwall 304. 	<ul style="list-style-type: none"> Impacts to the surface including cracks, buckling and stepping.
	Old Princes Highway – Drainage Structures (Pipe/Culverts) and Other Furniture	Drainage structures and other furniture within the Study Area.	<ul style="list-style-type: none"> Progress monitoring (visual inspections) to occur weekly as longwall face within 400 m of passing under asset. Within 3 months following the completion of extraction of Longwall 304. 	<ul style="list-style-type: none"> Impacts to the visible surfaces of pipes/culverts including cracking, buckling, shearing, and collapse. Visible impacts to furniture.

Table 4 (Continued)
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
BFMP- Endeavour Energy	132 kV Towers external to study area	<ul style="list-style-type: none"> Towers T8 to T12. 	<ul style="list-style-type: none"> Monthly survey of tower legs during extraction of Longwall 304. Endeavour Energy inspections (annual ground inspection, six yearly climbing inspection). At any time in case of fault or emergency. 	<ul style="list-style-type: none"> Degradation of tower structure. Degradation of tower foundations/footings. Movement of insulator strings.
	Local Powerlines – poles and wires	<ul style="list-style-type: none"> Timber poles and wires within the Study Area. 	<ul style="list-style-type: none"> Within 3 months following the completion of Longwall 304. Routinely as per Endeavour Energy inspections. At any time in case of fault or emergency. 	<ul style="list-style-type: none"> Degradation of structure. Movement of conductors. Vegetation clearance. Land clearance. Road clearance. Integrity and function of support clamps or other items.
	Access Roads/Tracks	<ul style="list-style-type: none"> Within 600 m of Longwall 304 extraction. 	<ul style="list-style-type: none"> Monthly during Longwall 304 extraction (field observations recorded by surveyors accessing towers). Within 3 months following the completion of Longwall 304. Routinely as per Endeavour Energy inspections. 	<ul style="list-style-type: none"> Surface cracks, buckling and general safety.
BFMP- TransGrid	330 kV Towers	<ul style="list-style-type: none"> Towers TL11-104 to TL11-108. 	<ul style="list-style-type: none"> Monthly survey of tower legs during extraction of Longwall 304. Within 3 months following the completion of Longwall 304. Routinely as per TransGrid inspections (annual ground inspection, six yearly climbing inspection). At any time in case of fault or emergency. 	<ul style="list-style-type: none"> Calculation of differential leg movement. Degradation of tower structure. Degradation of tower foundations/footings. Movement of insulator strings. Visual check by TransGrid of earthwire/OPGW and conductor movement.
	330 kV Transmission Lines	<ul style="list-style-type: none"> Conductor lines strung from Towers TL11-104 to TL11-108. Ground survey. Climbing inspection. 	<ul style="list-style-type: none"> Routinely as per TransGrid inspections (annual ground inspection, six yearly climbing inspection). At any time in case of fault or emergency. 	<ul style="list-style-type: none"> Vegetation clearance. Land clearance. Road clearance. Integrity and function of support clamps or other items.
	Access Roads/Tracks	<ul style="list-style-type: none"> Within 600 m of Longwall 304 extraction. 	<ul style="list-style-type: none"> Within 3 months following the completion of Longwall 304. Routinely as per TransGrid inspections. 	<ul style="list-style-type: none"> Surface cracks, buckling and general safety.
BFMP-Telstra	Fibre Optic Cable line 1 and associated pits	<ul style="list-style-type: none"> Point loss or area of loss within 600 m of Longwall 304 extraction. 	<ul style="list-style-type: none"> Monthly during extraction of Longwall 304 Remote Fibre Monitoring System (RFMS) records loss event that exceeds ± 1.0 decibels (dB). 	<ul style="list-style-type: none"> Movement of conduit, degree of freedom of cable in conduit, ground compression / tension.
	Fibre Optic Cable line 2 and associated pits	<ul style="list-style-type: none"> Point loss or area of loss within 600 m of Longwall 304 extraction. 	<ul style="list-style-type: none"> Monthly during extraction of Longwall 304 RFMS records loss event that ± 1.0 dB. 	<ul style="list-style-type: none"> Movement of conduit, degree of freedom of cable in conduit, ground compression / tension.
	Telecommunications Tower (and compound)	<ul style="list-style-type: none"> Tower 	<ul style="list-style-type: none"> Weekly survey on commencement of mining Longwall 304 until subsidence no longer detectable. Within 3 months following the completion of Longwall 304. 	<ul style="list-style-type: none"> Structural integrity of the telecommunications tower and compound.
	Access Roads/Tracks	<ul style="list-style-type: none"> Within 600 m of Longwall 304 extraction. 	<ul style="list-style-type: none"> Following the completion of Longwall 304. Visual observations during catchment visits as per the LMP. 	<ul style="list-style-type: none"> Surface cracks, buckling and general safety.
BFMP- Axicom	Telecommunications Towers (and compounds)	<ul style="list-style-type: none"> Towers and compounds. 	<ul style="list-style-type: none"> Weekly on commencement of Longwall 304 until subsidence no longer detectable Within 3 months following the completion of Longwall 304. 	<ul style="list-style-type: none"> Structural integrity of compounds.
	Access Roads/Tracks	<ul style="list-style-type: none"> Within 600 m of Longwall 304 extraction. 	<ul style="list-style-type: none"> Weekly on commencement of Longwall 304 until effects of subsidence no longer detectable. Following the completion of Longwall 304. Visual observations during catchment visits as per the LMP. 	<ul style="list-style-type: none"> Surface cracks, buckling and general safety.
BFMP- Sydney Trains	Telecommunications Tower (and compound)	<ul style="list-style-type: none"> Tower and compound. 	<ul style="list-style-type: none"> Weekly on commencement of Longwall 304 until subsidence reduces below level of survey accuracy Within 3 months following the completion of Longwall 304. 	<ul style="list-style-type: none"> Structural integrity of the telecommunications tower, compound and cable entries.

Table 4 (Continued)
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
BFMP-Sydney Water	Water pipelines	<ul style="list-style-type: none"> Water Main 1 Water Main 2 	<ul style="list-style-type: none"> Routinely as per Sydney Water inspections. Weekly when active longwall face within 400m of passing under pipeline for Longwall 304 Following the completion of Longwall 304. 	<ul style="list-style-type: none"> Surface ground cracks. Cracks or leaks in the pipelines. Fittings can be accessed beneath surface covers and are operable.
BFMP-Vocus	Fibre Optic Cable line and/or joint housing pit	<ul style="list-style-type: none"> Areas within 600 m of Longwall 304 extraction. 	<ul style="list-style-type: none"> Monthly during extraction of Longwall 304 RFMS records loss event ± 0.3 dB; ± 0.5 dB; or exceeds ± 1.0 dB. 	<ul style="list-style-type: none"> Movement of conduit, degree of freedom of cable in conduit, ground compression / tension.
	Access Roads/Tracks	<ul style="list-style-type: none"> Within 600 m of Longwall 304 extraction. 	<ul style="list-style-type: none"> Following the completion of Longwall 304. 	<ul style="list-style-type: none"> Surface cracks, buckling and general safety.
BFMP-Optus	Fibre Optic Cables	<ul style="list-style-type: none"> Within 600 m of Longwall 304 extraction. 	<ul style="list-style-type: none"> Weekly on commencement of Longwall 304 until movement stabilises. Within 3 months following the completion of Longwall 304. 	<ul style="list-style-type: none"> Ground compression / tension.
	Cable lines and associated pits	<ul style="list-style-type: none"> Within 600 m of Longwall 304 extraction. 	<ul style="list-style-type: none"> If Optus detects a fault or loss of signal integrity 	<ul style="list-style-type: none"> Movement of conduit, degree of freedom of cable in conduit. (Optus to inspect)
	Access Roads/Tracks	<ul style="list-style-type: none"> Within 600 m of Longwall 304 extraction. 	<ul style="list-style-type: none"> Visual observations as part of routine works and inspections. Following the completion of Longwall 304. 	<ul style="list-style-type: none"> Surface cracks, buckling and general safety.
BFMP-Garrawarra	Garrawarra Centre Complex - House Structures	<ul style="list-style-type: none"> Houses (B04a-B09a). Palmer House (A09a). 	<ul style="list-style-type: none"> External inspection only due to degraded state of derelict buildings. Following the completion of Longwall 304. 	<ul style="list-style-type: none"> Structural integrity changes. Fresh cracking.
	Garrawarra Centre Complex – Aged Care Buildings	<ul style="list-style-type: none"> Building structures (B01a-B01e). Administration / Kitchen Group (Buildings B02a and B02b). 	<ul style="list-style-type: none"> Following the completion of Longwall 304. 	<ul style="list-style-type: none"> Structural integrity. Cracking at pre-existing rock joints.
	Garrawarra Centre Complex – Water Storage Tanks	<ul style="list-style-type: none"> Water storage tanks (B14t01, B14t02, B16t01-B16t03, B17t01 and B18t01) and trickle filter tank (B15t01). 	<ul style="list-style-type: none"> Weekly visual inspection for B14t02 on commencement of Longwall 304 until wall has retreated 400 m. Within 3 months following the completion of Longwall 304. 	<ul style="list-style-type: none"> Structural integrity. New Leaks. Cracking in columns, elevated ring beam or central access shaft (B14t02). B14t02 is derelict structure and does not hold water.
	Garrawarra Centre Complex – Gas Storage Tank	<ul style="list-style-type: none"> Gas storage tank (B01t03). 	<ul style="list-style-type: none"> Within 3 months following the completion of Longwall 304. 	<ul style="list-style-type: none"> Structural integrity. Leaks.
	Garrawarra Centre Complex – Other Services (Powerlines and Poles)	<ul style="list-style-type: none"> Timber poles and powerlines. 	<ul style="list-style-type: none"> Following the completion of Longwall 304. At any time in case of fault or emergency. 	<ul style="list-style-type: none"> Degradation of structure. Movement of conductors. Vegetation clearance. Land clearance. Road clearance. Integrity and function of support clamps or other items.
	Garrawarra Centre Complex – Other Services (Water Pipelines)	<ul style="list-style-type: none"> Water pipelines within the Study Area. 	<ul style="list-style-type: none"> Following the completion of Longwall 304. 	<ul style="list-style-type: none"> Surface ground cracks. Cracks or leaks in the pipelines. Fittings can be accessed beneath surface fittings and are operable.
BFMP-Cemetery	Garrawarra Centre Complex – Private Roads and Access Roads/Tracks	<ul style="list-style-type: none"> Within 600 m of Longwall 304 extraction. 	<ul style="list-style-type: none"> Following the completion of Longwall 304. As per the LMP. 	<ul style="list-style-type: none"> Surface cracks, buckling and general safety.
	Waterfall General (Garrawarra) Cemetery site	<ul style="list-style-type: none"> Waterfall General (Garrawarra) Cemetery site. 	<ul style="list-style-type: none"> Following the completion of Longwall 304. A follow up audit be undertaken two years after Longwall 303 (in 2021) to review any longer-term effects. 	<ul style="list-style-type: none"> Structural integrity of headstones and fencing. Surface cracks, buckling and general safety.
	Access Roads/Tracks	<ul style="list-style-type: none"> Within 600 m of Longwall 304 extraction. 	<ul style="list-style-type: none"> Following the completion of Longwall 304. As per the LMP. 	<ul style="list-style-type: none"> Surface cracks, buckling and general safety.

6.2 SUBSIDENCE PARAMETER MONITORING COMPONENTS

The components of the program to monitor subsidence parameters are illustrated in the Subsidence Monitoring Locations (Plan 7 prepared in accordance with the DP&E and DRE (2015) *Guidelines for the Preparation of Extraction Plans*) provided in Attachment 1 and described below.

6.2.1 '300 XL Line'

The location of '300 XL Line' is shown in Attachment 1. The line is located across and perpendicular to Longwalls 301 to 305 extending from the M1 Princes Motorway to the Woronora Reservoir full supply level.

The '300 XL Line' is composed of survey marks established at a spacing of approximately 20 m (being less than 1/20th the mining depth). Survey marks are comprised of either:

- concrete nails set in rock; or
- galvanised iron pipes capped and punched.

Due to the practicalities of following existing tracks and steep terrain, bends in the survey line are incorporated.

Prior to installation of new survey marks, consideration will be given to the presence of Aboriginal heritage sites and if detected the survey marks will be located so as to avoid these heritage sites.

The purpose of the '300 XL Line' is to measure the subsidence parameters (subsidence, tilt, strain) associated with extraction of each longwall panel and the cumulative subsidence parameters associated with overall extraction.

The frequency of monitoring the '300 XL Line' will be:

- within 3 months of the completion of Longwall 304; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resources Regulator.

Monitoring of the '300 XL Line' will provide information of relevance to each of the management plans listed in Section 6.1.

6.2.2 'Princes Highway Line'

The location of 'Princes Highway Line' is shown in Attachment 1. The line follows the alignment of the Old Princes Highway from the M1 Princes Motorway to the Garrawarra Centre Complex entrance road.

The 'Princes Highway Line' is composed of survey marks established at a spacing of approximately 20 m which are comprised of either:

- concrete nails set in rock or asphaltic concrete; or
- galvanised iron pipes capped and punched.

Due to the practicalities of following the road, bends in the survey line are incorporated.

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The purpose of ‘Princes Highway Line’ is to:

- provide monitoring of ground movements about the Old Princes Highway; and
- obtain subsidence information ahead of longwall panels to validate, and if necessary, better calibrate, the MSEC subsidence prediction methods.

The frequency of monitoring ‘Princes Highway Line’ will be:

- within 3 months of the completion of Longwall 304; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resources Regulator.

The ‘Princes Highway Line’ is a monitoring component of BFMP-WCC. Subsidence parameters measured along the ‘Princes Highway Line’ are also relevant to the BFMP-Sydney Water.

6.2.3 ‘Optic / Water Line’

The location of ‘Optic/Water Line’ is shown in Attachment 1. The line follows the alignment of an unsealed track and the Garrawarra Centre Complex internal roads, extending from the Old Princes Highway to beyond the 35° angle of draw line within the Garrawarra Centre Complex.

The ‘Optic/Water Line’ is composed of survey marks established at a spacing of approximately 20 m which area comprised of either:

- concrete nails set in rock or asphaltic concrete; or
- galvanised iron pipes capped and punched.

Due to the practicalities of following the unsealed track and road, bends in the survey line are incorporated.

The purpose of the ‘Optic/Water Line’ is to:

- provide monitoring of ground movements about the Sydney Water pipelines, fibre optic cable lines (Optus, Telstra and Vocus), telecommunication towers and compounds (Telstra, Axicom and Sydney Trains) and other buildings, structures and roads at the Garrawarra Centre Complex; and
- obtain subsidence information ahead of longwall panels to validate, and if necessary, better calibrate, the MSEC subsidence prediction methods.

The frequency of monitoring ‘Optic/Water Line’ will be:

- weekly at commencement of Longwall 304 within 400m of the active longwall face until subsidence reduces below level of survey accuracy;
- within 3 months of the completion of Longwall 304; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resources Regulator.

The ‘Optic/Water Line’ is a monitoring component of BFMP-Sydney Water, BFMP-Optus, BFMP-Telstra, BFMP-Vocus, BFMP-Axicom, BFMP-Sydney Trains and BFMP-Garrawarra.

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6.2.4 ‘Transmission (Subsidence) Line’

The location of ‘Transmission (Subsidence) Line’ is shown in Attachment 1. The line is located along the easement containing the 330 kV TransGrid and 132 kV Endeavour Energy transmission lines and also runs generally parallel to the fibre optic cables, M1 Princes Motorway and the eastern boundary of the Waterfall General (Garrawarra) Cemetery. The line extends from TL11-108 south to TL11-104 south of the Longwall 301. The transmission survey line is located outside the Study Area.

The ‘Transmission (Subsidence) Line’ is composed of survey marks established at a spacing of approximately 20 m which are comprised of either:

- concrete nails set in rock; or
- galvanised iron pipes capped and punched.

Due to the practicalities of following the terrain and access tracks, bends in the survey line are incorporated.

The purpose of ‘Transmission (Subsidence) Line’ is to:

- provide monitoring of ground movements about the transmission lines, towers, fibre optic cables, M1 Princes Motorway and Waterfall General (Garrawarra) Cemetery; and
- obtain subsidence information ahead of longwall panels to validate, and if necessary, better calibrate, the MSEC subsidence prediction methods.

The frequency of monitoring ‘Transmission (Subsidence) Line’ for Longwall 304 will be:

- prior to the commencement of Longwall 304;
- following the completion of Longwall 304; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resources Regulator.

The ‘Transmission (Subsidence) Line’ monitoring is a component of BFMP-TransGrid, BFMP-Endeavour Energy; BFMP-Vocus; BFMP-Telstra; BFMP-Optus; BFMP-Sydney Trains and BFMP-Cemetery.

6.2.5 ‘M1 North Bound Line’

The location of ‘M1 North Bound Line’ is shown in Attachment 1. The line extends from south¹ of M1 Princes Motorway Bridge 2 (Old Princes Highway Underpass) to Cawley Road Overbridge along the verge of the M1 Princes Motorway.

The ‘M1 North Bound Line’ is composed of survey marks established at a spacing of approximately 20 m which are comprised of concrete nails set in rock, asphaltic concrete or concrete kerb.

Due to the practicalities of following the road, bends in the survey line are incorporated.

¹ A distance determined in consultation with the RMS Technical Committee.

The purpose of 'M1 North Bound Line' is to:

- provide monitoring of ground movements about the M1 Princes Motorway; and
- obtain subsidence information ahead of longwall panels to validate, and if necessary, better calibrate, the MSEC subsidence prediction methods.

The frequency of monitoring 'M1 North Bound Line' will be:

- following the completion of Longwall 304; and
- more frequently if directed by the RMS Technical Committee or the Principal Subsidence Engineer NSW Resources Regulator.

The 'M1 North Bound Line' is a monitoring component of BFMP-RMS and BFMP-Sydney Trains.

6.2.6 'Transmission Towers Monitoring'

The locations of 'Transmission Towers Monitoring' are shown in Attachment 1.

While outside the Study Area, monitoring of towers TL11-104 to TL11-108 of the 330 kV TransGrid transmission line and towers F9132B-T8 to F9132B-T12 of the 132 kV Endeavour Energy transmission line will continue for Longwall 304.

The 'Transmission Towers Monitoring' is composed of:

- survey marks (prisms) established at each of the four tower legs;
- ground survey marks established adjacent to each of the four tower legs; and
- top of towers F9132B-T8 to F9132B-T12 fixed points.

The ground survey marks are comprised of either:

- concrete nails set in rock; or
- galvanised iron pipes capped and punched.

The purpose of the 'Transmission Towers Monitoring' is to:

- provide monitoring of ground movements and tower movements for the transmission towers; and
- obtain subsidence information ahead of longwall panels to validate, and if necessary, better calibrate the MSEC subsidence prediction methods.

The frequency of 'Transmission Towers Monitoring' will be:

- monthly relative survey at each tower (TL11-04 to TL11-08 & F9132-T8 to F9132-T12) during the extraction of Longwall 304;
- following the completion of Longwall 304; and
- more frequently if directed by the asset owner or the Principal Subsidence Engineer NSW Resources Regulator.

The 'Transmission Towers Monitoring' is a monitoring component of BFMP-TransGrid; BFMP-Endeavour Energy; BFMP-RMS; BFMP-Vocus; BFMP-Telstra and BFMP-Optus.

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6.2.7 ‘Telecommunication Towers Monitoring’

The locations of ‘Telecommunication Towers Monitoring’ are shown in Attachment 1.

The ‘Telecommunication Towers Monitoring’ is composed of survey marks (prisms) established at each of the tower legs, and corresponding ground-based prisms outside each leg. Due to the practicalities of survey mark installation, prisms cannot be used at the tops of the towers.

Tower monitoring of the mono-pole tower comprises fixed ground prisms at the base of the tower.

The purpose of the ‘Telecommunication Towers Monitoring’ is to:

- provide monitoring of ground movements and tower movements for the telecommunication towers; and
- obtain subsidence information ahead of longwall panels to validate, and if necessary, better calibrate the MSEC subsidence prediction methods.

The frequency of ‘Telecommunication Towers Monitoring’ will be:

- weekly on commencement of Longwall 304 until subsidence no longer detectable;
- within 3 months of the completion of Longwall 304; and
- more frequently if directed by the asset owner or the Principal Subsidence Engineer NSW Resources Regulator.

The ‘Transmission Towers Monitoring’ is a monitoring component of BFMP-Telstra; BFMP-Axicom; BFMP-Sydney Trains; and BFMP-Garrawarra.

6.2.8 ‘Bridge 2 Monitoring’

The location of Bridge 2 (Old Princes Highway Underpass) is shown in Attachment 1. Monitoring will include the structural elements of the bridge as described in detail in the BFMP-RMS.

The ‘Bridge 2 Monitoring’ is composed of a survey reference pillar, survey marks (prisms) established at structural elements of the bridge, a fixed absolute 3D real time monitor and a fibre optic monitoring system.

The purpose of the ‘Bridge 2 Monitoring’ is to:

- provide monitoring of ground movements and bridge structural element movements for the bridge; and
- obtain subsidence information ahead of longwall panels to validate, and if necessary, better calibrate the MSEC subsidence prediction methods.

The frequency of ‘Bridge 2 Monitoring’ will be:

- real-time (continuous) absolute 3D monitoring;
- weekly Fibre Bragg Grating (FBG) sensor monitoring from the commencement of Longwall 304 extraction for the duration of Longwall 304; and
- greater frequency or commencing earlier if determined in consultation with the RMS Technical Committee or the Principal Subsidence Engineer NSW Resources Regulator.

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The 'Bridge 2 Monitoring' is a monitoring component of the BFMP-RMS.

6.2.9 'Cawley Road Overbridge Monitoring'

The location of the Cawley Road Overbridge is shown in Attachment 1. Monitoring will include the structural elements of the bridge.

The 'Cawley Road Overbridge Monitoring' is composed of a survey reference pillar, a fixed absolute 3D real time monitor and survey marks (prisms) established at structural elements of the bridge.

The purpose of the 'Cawley Road Overbridge Monitoring' is to:

- provide monitoring of ground movements and bridge structural element movements for the bridge; and
- obtain subsidence information ahead of longwall panels to validate, and if necessary, better calibrate the MSEC subsidence prediction methods.

The frequency of 'Cawley Road Overbridge Monitoring' will be:

- real-time (continuous) absolute 3D monitoring; and
- following the completion of Longwall 304.

The 'Cawley Road Overbridge Monitoring' is a monitoring component of the BFMP-RMS.

6.2.10 'Illawarra Railway Monitoring'

The location of the Illawarra Railway is shown in Attachment 1. Monitoring will include the relative structural elements of the culverts at Wilsons Creek and Cawley Creek and absolute ground movements at each creek valley.

The 'Culvert Monitoring' is composed of 5 rings of 3 survey marks established at intervals inside each culvert.

The purpose of the Culvert Monitoring is to provide monitoring of ground movements and culvert structural element movements.

The frequency of 'Culvert Monitoring' is following the completion of Longwall 304.

The Railway Valley Closure Monitoring will be composed of 2 real time (continuous) absolute 3D monitors at each valley, being Wilsons Creek and Cawley Creek.

The frequency of Railway Valley Closure Monitoring will be:

- throughout extraction of Longwall 304; and
- real-time (continuous) absolute 3D monitoring.

The 'Illawarra Railway Monitoring' is a monitoring component of the BFMP-SYD TRAINS.

6.2.11 Eastern Tributary Cross Lines

Cross lines established across the Eastern Tributary at Pools ETAU, ETAT, ETAR and ETAQ will be monitored for relative subsidence movement. High resolution relative closure lines A, B, C are established at ETAU. Absolute valley closure monitoring at ETAU is comprised of 3 real time (continuous) absolute 3D monitors.

The frequency of monitoring of the cross lines will be:

- prior to Longwall 304;
- specifically, at ETAU and high-resolution lines A, B, C, on commencement of extraction of Longwall 304 monitoring at fortnightly intervals up to 900 m void, then weekly until 1,230 m void, and beyond 1,230 m at no greater than 3 day intervals until completion of extraction; and
- following the completion of extraction of Longwall 304.

6.2.12 Waratah Rivulet Cross Line

Although Waratah Rivulet is approximately 1.1 km from Longwall 304, monitoring for any subsidence movements during and following the extraction of Longwall 304 will include the cross line downstream of the maingate of Longwall 23 at Pool Q (WaterNSW Gauging Station).

The frequency of monitoring of the cross line will be annually.

6.2.13 Ridge to Ridge

GPS monitoring points have been established at ridge top locations across the Eastern Tributary and at ridge top locations across the Waratah Rivulet.

The purpose of the ridge to ridge survey points is to measure total valley closure and compare predicted values with measured to assist in providing a better understanding of the mechanism of valley closure and/or better inform the prediction methods.

Monitoring of the ridge to ridge survey points will occur within three months of the completion of Longwall 304.

6.2.14 Parameters to be Measured

Surveys will measure subsidence movements in three dimensions using a total station survey instrument.

6.2.15 Monitoring Methods and Accuracy

Longwall subsidence measurements will be surveyed in accordance with the relevant specifications and legislation as applied in NSW. These include:

- Survey and Drafting Directions for Mine Surveyors 2015 (NSW – Mines); and
- Inter-government Committee on Surveying and Mapping Standards and Practices for Control Surveys (SP1) Version 1.7 Sept 2007 ICSM Publication No.1 (ICSM SP1).

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The Survey and Drafting Directions for Mine Surveyors 2015 *Section 3.4 Correlation of Surface and Underground Surveys* will be consistent with Class 'D' survey as prescribed in ICSM SP1. It is intended that all Control Surveys for mine subsidence of the Longwall 304 to be surveyed to Class 'D' using prescribed methods as described in ICSM SP1. In 2000, ICSM adopted POSITIONAL UNCERTAINTY and LOCAL UNCERTAINTY as new, easily understood methods of classifying the accuracy of coordinates.

POSITIONAL UNCERTAINTY is a new concept which caters for positions obtained independent of the survey network (e.g. GPS results from Wide Area Differential GPS (WADGPS) or Geoscience Australia's on-line positioning service). POSITIONAL UNCERTAINTY is the uncertainty of the coordinates or height of a point, in metres at the 95% confidence level, with respect to the defined reference frame. LOCAL UNCERTAINTY is the average measure, in metres at the 95% confidence level, of the relative uncertainty of the coordinates, or height, of a point(s), with respect to the survey connections to adjacent points in the defined frame.

CLASS is a function of the precision of a survey network, reflecting the precision of observations as well as suitability of network design, survey methods, instruments and reduction techniques used in that survey. Preferably the CLASS is verified by an analysis of the minimally constrained least squares adjustment of the network.

Survey Accuracy

Each control survey and subsidiary survey must be planned and surveyed to satisfy the conditions to achieve a standard of accuracy of Class 'D' or better as prescribed in ICSM SP1. The allocation of CLASS to a survey on the basis of the results of a successful minimally constrained least squares adjustment may generally be achieved by assessing whether the semi-major axis of each relative standard error ellipse or ellipsoid (i.e. one sigma), is less than or equal to the length of the maximum allowable semi-major axis (r) using the following formula:

$$r = c (d + 0.2)$$

Where;

- r = length of maximum allowable semi-major axis in mm.
- c = an empirically derived factor represented by historically accepted precision for a particular standard of survey.
- d = distance to any station in km.

The values of 'c' assigned to various CLASSES of survey are shown in Table 5.

**Table 5
Classification of Horizontal Control Survey**

Class	C (for one sigma)	Typical Applications
3A	1	Special high precision surveys
2A	3	High precision National geodetic surveys
A	7.5	National and State geodetic surveys
B	15	Densification of geodetic survey
C	30	Survey coordination projects
D	50	Lower CLASS projects
E	100	Lower CLASS projects

The radius of a 95% circle of uncertainty is readily calculated from the standard (1σ) error ellipse produced by most least squares adjustment software. However, as the Positional Uncertainty is in terms of the national geodetic datum (not just the local control for a particular survey) the error ellipse used also must be in terms of the national geodetic datum. In Australia the national geodetic datum is the Geocentric Datum of Australia 1994 (GDA94).

In Australia, this means that the Positional Uncertainty must be calculated from a standard error ellipse that refers to the Australian Fiducial Network (AFN) or the Australian National Network (ANN) that were held fixed in the original national GDA94 adjustment.

In essence the subsidence accuracy for POSITIONAL UNCERTAINTY is related to the Positional uncertainty of the controlling survey stations used to co-ordinate the subsidence survey. Controlling survey stations used to co-ordinate the subsidence survey will be of a higher class and survey techniques used will reflect recommended methods of achieving higher class survey.

LOCAL UNCERTAINTY is basically the relationship of the accuracy between the survey subsidence monitoring points. It is expected that the results will be far superior to Class 'D', with monitoring points having a 95% confidence major error ellipse in order of 17 mm.

A total station survey instrument will be used to achieve a survey target accuracy of ± 5 mm between marks and ± 20 mm relative to external survey reference.

6.3 SUBSIDENCE IMPACTS/ENVIRONMENTAL CONSEQUENCES MONITORING COMPONENTS

The subsidence impact/environmental consequences monitoring components are summarised in Table 4. All subsidence impact/environmental consequence monitoring is included in a relevant management plan within the Longwall 304 Extraction Plan as summarised in Table 4. Each management plan within the Extraction Plan includes:

- detailed baseline data;
- a description of:
 - the relevant statutory requirements (including any relevant approval, licence or lease conditions);
 - any relevant limits or performance measures/criteria; and
 - the specific performance indicators that are to be used to judge the performance of, or guide the implementation of, the Project or any management measures;
- a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;
- a program to monitor and report on the:
 - impacts and environmental performance of the project; and
 - effectiveness of any management measures;
- a contingency plan to manage any unpredicted impacts and their consequences;
- a program to investigate and implement ways to improve the environmental performance of the Project over time;

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- a protocol for managing and reporting any:
 - incidents;
 - complaints;
 - non-compliances with statutory requirements;
 - exceedances of the impact assessment criteria and/or performance criteria; and
- a protocol for periodic review of the plan.

The subsidence impacts/environmental consequences monitored as part of each management plan are summarised in the following sections.

6.4 LAND MANAGEMENT PLAN

The Longwall 304 LMP has been prepared to manage the potential environmental consequences of the Longwall 304 Extraction Plan on cliffs and overhangs, steep slopes and land in general.

6.4.1 Cliffs and Overhangs

One cliff and overhang site (COH17) has recently (August 2018) been identified below the full supply level on the Eastern Tributary arm of the Woronora Reservoir. As detailed in the LMP, detailed baseline recording of this newly identified cliff and overhang site has been undertaken.

Visual inspections for subsidence impacts on cliff site COH17 will be conducted to record subsidence impacts on a monthly basis when Longwall 304 extraction is within 400 m of the site. Following completion of Longwall 304 extraction, cliff site COH17 will be inspected to record any subsidence impacts.

In the event subsidence impacts are identified on cliff and overhang site COH17, the following details will be noted and/or photographed:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- the location of the cliff instability (i.e. freshly exposed rock face and debris scattered around the base of the cliff or overhang) relative to the cliff face or overhang;
- the nature and extent of the cliff instability (including an estimate of volume);
- the length of the cliff instability;
- other relevant aspects such as water seepage (which can indicate weaknesses in the rock);
- whether any actions are required (for example – implementation of appropriate safety controls, review of public safety etc); and
- any other relevant information.

6.4.2 Steep Slopes and Land in General

Visual inspections for subsidence impacts on steep slopes and land in general within 600 m of Longwalls 20-27 and Longwalls 301-304 extraction will be conducted by Metropolitan Coal and its contractors during catchment visits, sampling and routine works conducted in the catchment.

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In the event subsidence impacts are identified within 600 m of Longwalls 20-27 or Longwalls 301-303 (that were not previously recorded during the mining of Longwalls 20-27 or Longwalls 301-303), or within 600 m of Longwall 304, the following details will be noted and/or photographed:

- the location, approximate dimensions (length, width and depth), and orientation of surface tension cracks;
- the location of the surface tension crack in relation to fire trails or vehicular tracks;
- the location and approximate dimensions of rock falls (e.g. rock ledges);
- whether any actions are required (for example – implementation of appropriate safety controls, review of public safety etc.); and
- any other relevant information.

6.5 BIODIVERSITY MANAGEMENT PLAN

The Longwall 304 BMP has been prepared to manage the potential environmental consequences of the Longwall 304 Extraction Plan on aquatic and terrestrial flora and fauna, with a specific focus on swamps.

6.5.1 Upland Swamps - Vegetation

Longwall 304

Upland swamp vegetation monitoring for Longwall 304 will include visual and quadrat/transect monitoring consistent with the methods used for the monitoring of Longwalls 20-22, Longwalls 23-27 and Longwalls 301-303 upland swamp vegetation.

All swamps located within the 35° angle of draw and/or predicted 20 mm subsidence contour for Longwall 304 will be subject to visual inspections as a component of the existing Longwalls 301-303 upland swamp vegetation monitoring program.

Transect and quadrat monitoring will be conducted in Swamp 50 overlying Longwall 304 and Swamp 48 adjacent to Longwall 304.

The data collected for each quadrat will be consistent with the data collected for the Longwalls 20-22, Longwalls 23-27 and Longwalls 301-303 upland swamp monitoring programs described in the Longwall 304 BMP. Surveys will be conducted biannually in autumn and spring.

Previous Longwalls 20-22, Longwalls 23-27 and Longwalls 301-303

Visual inspections of Swamps 16, 17, 18, 19, 20, 24, 25, 28, 30, 31, 32, 33, 34, 35, 36, 40, 41, 46, 47, 48, 49, 50, 51/52, 53, 58 and 94 will continue to be conducted biannually during the extraction of Longwall 304. These swamps are also subject to biannual transect/quadrat and/or indicator species monitoring as described below.

Swamps 40, 41, 46, 47, 48, 49, 50, 51/52, 53 and 58 are located within the 35° angle of draw and/or predicted 20 mm subsidence contour for Longwall 304.

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Transect and quadrat monitoring will continue to be conducted biannually in Swamps 16, 17, 18, 20, 24 and 25 overlying Longwalls 20-22, Swamps 28, 30, 33, 35 and 94 overlying or adjacent to Longwalls 23-27, Swamps 40, 41, 46, 51/52 and 53 overlying Longwalls 301-303 and in control Swamps 101, 111a, 125, 135, 136, 137a, 137b, 138, Bee Creek Swamp, Woronora River 1, Woronora River south arm and Dahlia Swamp for Longwalls 20-27.

Population monitoring will continue to be conducted for Longwalls 20-22, Longwalls 23-27 and Longwalls 301-303 during the extraction of Longwall 304 as described in Table 4. Indicator species monitored include *Epacris obtusifolia*, *Sprengelia incarnata*, *Pultenaea aristata*, *Callistemon citrinus*, *Leptospermum juniperinum* and *Banksia robur*.

6.5.2 Upland Swamps - Groundwater

Groundwater monitoring of upland swamps includes the monitoring of paired piezometers (i.e. one swamp substrate piezometer to a depth of approximately 1 m and one sandstone piezometer to a depth of approximately 10 m). Each piezometer has been equipped with a data logger for continuous water level monitoring.

Monitoring of swamp groundwater levels will be conducted in Swamp 50. Swamp groundwater monitoring will continue to be conducted in Swamps 20 and 25 for Longwalls 20-22, Swamps 28, 30, 33 and 35 for Longwalls 23-27, Swamps 40, 41, 46, 51, 52 and 53 for Longwalls 301-303 and in control Swamps 101, 137a, 137b, Bee Creek Swamp and Woronora River 1 (WRSWAMP 1) during the extraction of Longwall 304.

6.5.3 Riparian Vegetation

No additional riparian vegetation monitoring sites have been established for Longwall 304. Riparian areas along Waratah Rivulet and the Eastern Tributary monitored for Longwalls 20-22 and Longwalls 23-27 will continue to be monitored at sites MRIP01 to MRIP12 during the mining of Longwall 304.

Riparian vegetation monitoring will include visual and quadrat monitoring consistent with the methods detailed in the Longwall 304 BMP.

Visual inspections of riparian areas will continue to be conducted in locations adjacent to riparian vegetation monitoring sites (sites MRIP01 to MRIP12), and areas traversed whilst accessing the monitoring sites during the extraction of Longwall 304 to record evidence of subsidence impacts.

The existing permanent quadrat (20 m x 2 m) will continue to be used to monitor riparian vegetation at sites MRIP01 to MRIP08 and sites MRIP11 and MRIP12.

The three-indicator species will continue to be monitored within the riparian vegetation of the Eastern Tributary and Waratah Rivulet, namely, *Prostanthera linearis*, *Schoenus melanostachys* and *Lomatia myricoides* at sites MRIP01 to MRIP12.

6.5.4 Aquatic Biota and Habitat

Metropolitan Coal will assess the subsidence impacts and environmental consequences on surface water resources and watercourses (aquatic habitats) in accordance with the Metropolitan Coal Longwall 304 WMP.

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The aquatic ecology monitoring programs include the monitoring of aquatic habitat characteristics, water quality, macroinvertebrates and aquatic macrophytes. Observations of surface cracking, iron staining and gas releases will also be made during the conduct of the aquatic ecology surveys.

Stream Monitoring

Monitoring of aquatic biota (macroinvertebrates and macrophytes) will continue to be conducted (if sufficient habitat is available for sampling) at two sampling sites (approximately 100 m long) at stream sampling Locations WT3, WT4 and WT5 on the Waratah Rivulet, Locations ET1, ET2, ET3 and ET4 on the Eastern Tributary and at control Location WR1 on the Woronora River and control Location OC on O'Hares Creek.

Monitoring of the stream sampling sites on the Waratah Rivulet, Eastern Tributary, Woronora River and O'Hares Creek will be conducted biannually in spring (15 September to 15 December) and autumn (15 March to 15 June), consistent with the timing required by the Australian River Assessment System (AUSRIVAS) protocol.

Pool Monitoring

A number of pools will be monitored to assess the response of aquatic ecosystems to the implementation of stream remediation works, namely:

- Larger pools (i.e. >40 m in length) ETAH on the Eastern Tributary, control Pool WP on Woronora River and control Pool OC on O'Hares Creek.
- Smaller pools (i.e. <40 m in length) ETAG, ETAI and ETAK on the Eastern Tributary and control Pools WP-A, WP-B and WP-C on Woronora River and three control Pools OC-A, OC-B and OC-C on O'Hares Creek.

Monitoring of Pools ETAG and ETAH will recommence subsequent to the conduct of stream remediation activities at Pool ETAH and will be conducted bi-annually in spring (15 September to 15 December) and autumn (15 March to 15 June).

Monitoring of Pools ETAI and ETAK will recommence subsequent to the conduct of stream remediation activities at Pool ETAK and will be conducted bi-annually in spring (15 September to 15 December) and autumn (15 March to 15 June).

6.5.5 Terrestrial Fauna and their Habitats

Terrestrial fauna habitats (upland swamps, riparian vegetation, slopes and ridgetops, and aquatic habitats) will be monitored as described in the Longwall 304 BMP. Observations of any surface cracking and loss of flow in streams will also be noted at amphibian monitoring sites during the conduct of the amphibian surveys.

Amphibians were selected as the appropriate representative of terrestrial vertebrate fauna because they are widespread across the Study Area, include at least two threatened species that are sensitive to changes in surface hydrology, and because this group is represented by 14 species that appear to have viable populations.

The amphibian monitoring programs for Longwalls 20-22, 23-27 and 301-303 includes six test sites (sites 1-6) and six control sites (sites 7-12) for Longwalls 20-22, five test sites (sites 13-17) and five control sites (sites 18-22) for Longwalls 23-27 and six text sites (sites 23-28) for Longwalls 301-303. No additional amphibian monitoring sites have been established for Longwall 304.

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The amphibian monitoring sites will be surveyed annually in spring/summer (i.e. October to February) during suitable weather conditions.

Species will be assigned to relative abundance categories for tadpole and adult stages.

6.6 WATER MANAGEMENT PLAN

The Longwall 304 WMP has been prepared to manage the potential environmental consequences of the Longwall 304 Extraction Plan on water resources (including the Woronora Reservoir) and watercourses.

6.6.1 Stream Features

Visual and photographic surveys of the Eastern Tributary from the full supply level of the Woronora Reservoir to the maingate of Longwall 26 will be conducted monthly when mining is within 450 m of the stream and within three months of the completion of Longwall 304.

The Waratah Rivulet is located approximately 1.1 km south-west of Longwall 304. At this distance, the Waratah Rivulet is not predicted to experience any measurable subsidence or valley related movements resulting from the extraction of Longwall 304.

Notwithstanding, visual inspections and photographic surveys will also be conducted along the Waratah Rivulet from Pool P to the full supply level of the Woronora Reservoir within three months of the completion of Longwall 304.

The visual and photographic surveys will record:

- the location, approximate dimensions (length, width and depth), and orientation of surface cracks (specifically whether cracks are developed perpendicular to the stream flow or are controlled by rock joints or other factors, etc.);
- the nature of iron staining (e.g. whether isolated or across the entire streambed);
- the extent of iron staining (e.g. the length of stream affected);
- a description of gas release (e.g. isolated bubbles or continuous stream, and type of gas [methane or carbon dioxide]);
- the nature of scouring, for example the depth of scouring, type of soil exposed, any obvious vegetation impact, potential for severe erosion, etc.;
- water discoloration or opacity if present;
- rock bar characteristics such as extent of cracking, seepage, underflow;
- whether any actions are required (e.g. implementation of management measures, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

The monthly visual inspections on the Eastern Tributary will record the above parameters by exception (i.e. where they differ to the baseline visual and photographic record).

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Any gas releases identified as occurring on the Waratah Rivulet and Eastern Tributary to the full supply level by the visual inspections during the mining of Longwall 304 (either during the visual and photographic surveys or other catchment monitoring) will be monitored weekly to determine the nature of the gas releases, gas concentration (samples taken for the analysis for carbon dioxide and methane content) and any observable environmental effects (e.g. impacts to riparian vegetation or fish kills).

Weekly monitoring will be conducted at pools observed with gas releases, until no gas releases have been observed at the pool for three consecutive weeks.

6.6.2 Surface Water Flow

Surface water flow monitoring will include continuous flow monitoring at:

- the Metropolitan Coal owned gauging station on the Eastern Tributary, close to the inundation limits of the Woronora Reservoir (GS 300078);
- the WaterNSW owned gauging station on the Waratah Rivulet, close to the inundation limits of the Woronora Reservoir (GS 2132102);
- the WaterNSW owned gauging station on the Woronora River, close to the inundation limits of the Woronora Reservoir (GS 2132101) (control site);
- the Metropolitan Coal owned gauging station on Honeysuckle Creek (GS 300077) (control site);
- the Department of Industry – Water gauging station on O’Hares Creek at Wedderburn (GS 213200) (control site);
- the Metropolitan Coal owned gauging station on a tributary of the Woronora Reservoir (Sub-catchment I (GS 300092);
- the Metropolitan Coal owned gauging station on a tributary of the Woronora Reservoir (Sub-catchment K (GS 300093).

6.6.3 Eastern Tributary Gauging Station

Metropolitan Coal will monitor subsidence movements at the Eastern Tributary gauging station (in a similar manner to the monitoring undertaken for the Waratah Rivulet gauging station during the mining of Longwalls 25 and 26 and for the Eastern Tributary during the mining of Longwall 303) to assess the functionality of the gauging station.

In the event differential survey data indicates vertical and horizontal movements have occurred at the Eastern Tributary gauging station, Metropolitan Coal will assess whether the movement has altered the stream flow rating curve.

In the event subsidence movements that alter the stream flow rating curve occur, Metropolitan Coal will update the stream flow rating curve to reflect the changes in surface levels resulting from subsidence. Metropolitan Coal will validate the updated stream flow rating curve and continue to monitor subsidence movements.

6.6.4 Pool Water Levels and Drainage Behaviour

Pool water levels and drainage behaviour will be monitored using a continuous water level sensor and logger in:

- Pools ETG, ETJ, ETM, ETO, ETU, ETW, ETAF, ETAG, ETAH, ETAI/ETAJ/ETAK, ETAL, ETAM, ETAN, ETAO, ETAP, ETAQ, ETAR, ETAS/ETAT and ETAU on the Eastern Tributary;
- Pools A, F, J, K, L, M, N, O, P, Q, R, S, T, U, V and W on Waratah Rivulet; and
- control Pools WRP1, WRP2, WRP3 and WRP4 on the Woronora River.

Data from these devices will be downloaded monthly.

The water level in Pools B, C, E, G, G1, H and I on Waratah Rivulet will be manually monitored daily.

Data from Pools ETAS/ETAT and ETAU on the Eastern Tributary will be downloaded weekly when Longwall 304 extraction is within 450 m of the Eastern Tributary.

Pools ETAS, ETAT and ETAU on the Eastern Tributary will be visually inspected weekly when mining of Longwall 304 is within 450 m of the Eastern Tributary.

Pools situated on the Waratah Rivulet from Pool P to the full supply level of the Woronora Reservoir will be visually inspected at the time of download of the pool water level data (i.e. monthly) to observe whether the pool water level has fallen below the cease to flow level or whether any changes to the natural drainage behaviour have occurred.

Visual observations will include:

- evidence of new cracking within the stream bed or rock bar;
- whether the pools continue to flow over, through and/or below the rock bars (where relevant); and
- whether surface flow is evident along the length of the pools prior to flowing over/through/below the rock bars or boulder fields.

6.6.5 Surface Water Quality

Surface water quality will be sampled monthly at the following sites:

- sites ETWQ F, ETWQ J, ETWQ N, ETWQ U, ETWQ W, ETWQ AF, ETWQ AH, ETWQ AQ and ETWQ AU on the Eastern Tributary;
- sites WRWQ 2, WRWQ 6, WRWQ 8, WRWQ 9, WRWQ M, WRWQ N, WRWQ P, WRWQ R, WRWQ T, WRWQ U, WRWQ V, and WRWQ W on the Waratah Rivulet;
- site RTWQ 1 on Tributary B;
- site UTWQ 1 on Tributary D;
- site FEWQ 1 on the Far Eastern Tributary;
- site HCWQ 1 on Honeysuckle Creek;
- site BCWQ 1 along Bee Creek; and
- control sites WOWQ 1 and WOWQ 2 on the Woronora River.

Water quality parameters will include electrical conductivity (EC), pH, redox potential (Eh), dissolved oxygen (DO), turbidity, calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), chloride (Cl), sulphate (SO₄), bicarbonate (HCO₃), total nitrogen (N_{tot}), total phosphorous (P_{tot}), nitrate (NO₃), barium (Ba), strontium (Sr), manganese (Mn), iron (Fe), zinc (Zn), cobalt (Co) and aluminium (Al). Samples collected for metal analysis will be field filtered.

At the commencement of Longwall 304, fortnightly monitoring will be conducted at sites ETWQ AQ, ETWQ AU and WOWQ2.

Unfiltered water quality samples will also be collected monthly at the following sites and analysed for total iron:

- sites ETWQ F, ETWQ J, ETWQ N, ETWQ AF and ETWQ AQ on the Eastern Tributary;
- sites WRWQ 2, WRWQ 6, WRWQ 8, WRWQ 9, WRWQ M, WRWQ N and WRWQ P on the Waratah Rivulet; and
- control site WOWQ 2 on the Woronora River.

Metropolitan Coal will also monitor site ETAU and a minimum of three downstream sites (site ETFSL 0, site ETFSL 20, site ETFSL 40, site ETFSL 60, site ETFSL 80, site ETFSL 100, ETFSL 200, site ETFSL 300, site ETFSL 400, site ETFSL 500, site CONFLU1, site WDFS1 and/or site WDFS1+100) weekly until the site ETWQ AU monitoring results are at Level 1 or Level 2 of the Longwall 304 WMP TARP for the quality of water resources reaching the Woronora Reservoir for four consecutive assessment periods. The downstream sites will be selected in consideration of the Woronora Reservoir water level.

Sampling of site ETAU and three downstream sites will continue fortnightly once the site ETWQ AU monitoring results have returned to Level 1 or Level 2 Longwall 304 WMP TARP levels for four consecutive assessment periods, unless the TARP level returns to Level 3.

Metropolitan Coal will also monitor WARARM5 at the same frequency described above when the sites downstream of site CONFLU can be accessed for sampling (i.e. when the Woronora Reservoir water levels are suitably low).

6.6.6 Woronora, Nepean and Cataract Reservoir Water Quality

Metropolitan Coal will source water quality data for the Woronora Reservoir (site DW01, measurements taken from 0 to 9 m below the water surface level), the Nepean Reservoir and the Cataract Reservoir from WaterNSW in accordance with a data exchange agreement.

6.6.7 Shallow Groundwater Levels near Streams

Continuous water level monitoring of shallow groundwater will be conducted at:

- sites ETGW1 and ETGW2 along the Eastern Tributary; and
- sites WRGW1, WRGW2 and WRGW7 along Waratah Rivulet.

Data will be downloaded monthly and analysis will be conducted on a six monthly basis. Data from sites ETGW1 and ETGW2 on the Eastern Tributary will be downloaded weekly when Longwall 304 extraction is within 450 m of the Eastern Tributary.

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6.6.8 Groundwater Levels/Pressures

Groundwater level monitoring will be conducted at an approximately east-west transect of bores (sites T1, T2, T3, T5 and T6) located to the west of Longwall 304. Data from the divers in the standpipes will be downloaded monthly and the measured water levels at these bores will be compared against the water level at the Woronora Reservoir.

Additional groundwater standpipes have been installed as a component of the Woronora Reservoir Impact Strategy, namely bores TBS02-90 (post-mining Longwall 302), TBS02-15 (pre-mining Longwall 302), TBS02-190 (post-mining Longwall 302) and bore TBS03-15 (pre-mining Longwall 303).

Continuous groundwater level/pressure monitoring will be conducted at:

- site 9HGW0 (Longwall 10 Goaf Hole);
- site 9EGW1B;
- site 9FGW1A;
- site 9GGW2B;
- site 9HGW1B;
- site PM02;
- site 9GGW1-80;
- site PM01 (9DGW1B);
- site 9EGW2A;
- site 9EGW2-4;
- site PM03;
- site PHGW1B;
- site PHGW2A;
- site F6GW3A;
- site F6GW4A;
- site TBS02-250R; and
- site TBS03-230.

Data from the piezometers will be downloaded monthly and assessed in accordance with the WMP.

6.6.9 Groundwater Quality

Shallow groundwater quality sampling will be conducted monthly at the following sites:

- site ETGW2 along the Eastern Tributary; and
- sites WRGW1, WRGW2 and WRGW7 along the Waratah Rivulet.

Water quality parameters will include EC, pH, Eh, Ca, Mg, Na, K, Cl, SO₄, HCO₃, Ba, Sr, Mn, Fe, Zn, Co and Al. The samples collected for the analysis of metals will be field filtered.

Unfiltered water quality samples will also be collected monthly at site WRGW7 on the Waratah Rivulet and site ETGW2 on the Eastern Tributary and analysed for total iron.

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6.6.10 Mine Water Make

Monitoring of the mine water balance will comprise:

- Metered water reticulated into the mine (recorded continuously and downloaded monthly).
- Backfill water used to assist pumping into the mine (recorded continuously and downloaded monthly).
- Metered water reticulated out of the mine (recorded continuously and downloaded monthly).
- Manual measurement of moisture content into and out of the mine through the mine ventilation system using a digital psychrometer. The frequency of readings will be as follows:
 - every hour over a 9 hour period on two occasions during a 12 month period;
 - daily (week day) except public holidays or other circumstances (access, fan maintenance, etc.) that prevent readings to be taken; and
 - once per week as a minimum.
- Measurement of the *in-situ* moisture content of the coal during channel sampling for coal quality.
- Measurement of the moisture content of run-of-mine (ROM) coal conveyed out of the mine at the drift portal using an automated moisture scanner. A automated data acquisition system records and stores the data.

The inferred water make (i.e. groundwater that has seeped into the mine through the strata) will be calculated from the difference between total mine inflows (reticulated water into the mine, moisture in the downcast ventilation, and the *in-situ* coal moisture content) and total mine outflows (reticulated water out of the mine, moisture in the exhaust ventilation, and moisture in the ROM coal).

Given the large fluctuations in daily water usage and the cycle period for water entering the mine, being used by machinery, and draining to sumps for return pumping to the surface, a 20 day average will be used to provide a more reliable estimate of water make.

Metropolitan Coal will also monitor the water balance for the 300 area (i.e. a localised water balance underground in and about the 300 series longwalls) using a series of underground water meters. Metropolitan Coal will provide the results of the localised water balance, with the results of the overall mine water balance to the Dams Safety Committee monthly.

In addition to shift inspections conducted by statutory officials that report on any abnormal conditions at the working face and in outbye areas, Metropolitan Coal conducts statutory weekly inspections of development workings to identify water accumulations. A weekly audit of the statutory inspections is conducted by the shift undermanager.

6.7 HERITAGE MANAGEMENT PLAN

The Longwall 304 HMP has been prepared to manage the potential environmental consequences of the Longwall 304 Extraction Plan on Aboriginal heritage sites or values.

Aboriginal heritage sites FRC 28, FRC 29, FRC 34, FRC 60, FRC 76, FRC 117, FRC 176 and MET 1 will be monitored within three months of the completion of Longwall 303. Sites that show continued change due to mining induced subsidence during this monitoring will be monitored within three months of the completion of Longwall 304.

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Monitoring of the following Aboriginal heritage sites will also be undertaken for Longwall 304, within three months of the completion of Longwall 304:

- FRC 76 (sandstone overhang with art only).
- FRC 77 (sandstone overhang with art, artefacts and deposit).
- FRC 78 (sandstone overhang with art only).
- FRC 86 (sandstone overhang with art only).
- FRC 90 (sandstone overhang with artefacts and deposit).
- FRC 309 (sandstone overhang with artefacts and deposit).

The monitoring team will include a suitably qualified archaeologist (with experience in rock art recording and management) and representatives of the Aboriginal stakeholders (where available). Specific details that will be recorded during the monitoring program include (but are not limited to):

- the date of monitoring;
- the location of longwall extraction (i.e. the longwall chainage) at the time of monitoring;
- comparison of the physical characteristics of the site at the time of monitoring against the previous monitoring and the baseline record (detail/quantify any changes observed);
- inspections of rock surfaces for cracking and/or exfoliation and/or blockfall since the previous monitoring and against the baseline record;
- inspection of art motifs for damage or deterioration since the previous monitoring and against the baseline record;
- identification of any natural weathering processes that may result in deterioration (e.g. fire, vegetation growth and water seepage);
- detailed description and quantification of any changes noted during the completion of the above tasks;
- a photographic record of any changes noted during monitoring (taken at the same position and distance as baseline record to allow comparison over time);
- whether any follow-up actions are required to be considered (e.g. implementation of management or initiation of the Contingency Plan, etc.); and
- any other relevant information.

6.8 BUILT FEATURES MANAGEMENT PLAN

Several component plans have been prepared to manage the potential environmental consequences of the Longwall 304 Extraction Plan on built features including:

- Garrawarra Centre Complex buildings and services (BFMP-Garrawarra [BFMP-GAR]).
- M1 Princes Motorway including bridges (BFMP-Roads and Maritime Services [BFMP-RMS]).
- Old Princes Highway (BFMP-Wollongong City Council [BFMP-WCC]).
- Waterfall General [Garrawarra] Cemetery (BFMP-Cemetery [BFMP-CEM]).
- Water mains (BFMP-Sydney Water [BFMP-SYDWATER]).
- Transmission lines and towers (BFMP-Endeavour Energy [BFMP-END] and BFMP-TransGrid [BFMP-TRA]).

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- Telecommunication cables (BFMP-Telstra [BFMP-TELSTRA], BFMP-Vocus [BFMP-VOCUS] and BFMP-Optus [BFMP-OPTUS]).
- Telecommunication towers and compounds (BFMP-TELSTRA, BFMP-Axicom [BFMP-AXICOM] and BFMP-Sydney Trains [BFMP-SYDTRAINS]).
- Illawarra Railway (BFMP-SYDTRAINS).

Each plan has been developed in consultation with the relevant asset owner in accordance with Project Approval Condition 6(f), Schedule 3.

Any subsidence impacts will be recorded in the relevant BFMP - Subsidence Impact Register.

6.8.1 Garrawarra Centre Complex (BFMP-GAR)

Visual inspections will be conducted at the Garrawarra Centre Complex at the buildings and structures, and private roads as described in the BFMP-GAR or as otherwise determined in consultation with NSW Health.

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

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

House Structures

External inspections of house structures will be conducted prior to the commencement of Longwall 304 extraction (as agreed with NSW Health internal inspection is not possible with safety hazards presented by the particularly degraded state of buildings) and within three months following the completion of extraction of Longwall 304 to identify any subsidence impacts to the structural integrity:

- Houses (B04a-B09a); and
- Palmer House (A09a).

Aged Care Buildings

Inspections of aged care buildings will be conducted prior to the commencement of Longwall 304 extraction (as agreed with NSW Health) and within 3 months following the completion of Longwall 304 to identify any subsidence impacts to the structural integrity, and more specifically if any cracking at pre-existing rock joints:

- Building structures (B01a-B01e); and
- Administration / Kitchen Group (Buildings B02a and B02b).

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Water Storage Tanks

External inspections of the water storage tanks (B14t01, B14t02, B16t01-B16t03, B17t01 and B18t01) and trickle filter tank (B15t01) will be conducted prior to the commencement of Longwall 304 extraction and within 3 months following the completion of extraction of Longwall 304 to identify any subsidence impacts to the structural integrity and leaks.

In addition, weekly visual inspections will be conducted for B14t02 on commencement of Longwall 304 until the longwall face has retreated away 400 m from the tanks. Recording of any cracking in columns, elevated ring beam or central access shaft of the elevated water storage tank (B14t02) would also occur at these times.

Gas Storage Tank

Inspections of the gas storage tank (B01t03) will be conducted prior to the commencement of Longwall 304 extraction (or as otherwise agreed with NSW Health) and within 3 months following the completion of extraction of Longwall 304 to identify any subsidence impacts to the structural integrity and leaks.

Telecommunication Towers

As described in Section 6.8.8.

Other Services (Powerlines and Poles, Water Pipelines)

Inspections of the powerlines and timber poles will be conducted prior to the commencement of Longwall 304 extraction (or as otherwise agreed with NSW Health) and within 3 months following the completion of extraction Longwall 304, or at any time in case of fault or emergency, to identify any degradation of structures, movement of conductors, vegetation clearance, land clearance, road clearance and integrity and function of support clamps or other items.

Inspections of the water pipeline routes will be conducted prior to the commencement of Longwall 304 extraction (or as otherwise agreed with NSW Health) and within 3 months following the completion of extraction of Longwall 304 to identify any surface ground cracks, cracks or leaks in the pipelines, and to confirm that fittings can be accessed beneath surface fittings and are operable.

Private Roads and Access Roads/Tracks

As described in Section 6.9.

6.8.2 M1 Princes Motorway including Bridges (BFMP-RMS)**Pavement and Roadside Furniture of M1 Princes Motorway**

The condition of the M1 Princes Motorway pavement will be monitored by 'Roadcrack', an optical system that detects and records pavement cracks. The system will be operated by RMS personnel. The frequency of monitoring will be in accordance with the RMS inspection program (generally twice/week).

Regular visual inspections will be conducted during mining by representatives of the RMS as part of the RMS Network Safety Inspections. These inspections are carried out by a dedicated inspector twice weekly and any observed defects that represent a safety hazard will be reported to the RMS Technical Committee.

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Culverts

A closed circuit television (CCTV) inspection of the culverts will occur at the completion of Longwall 304, or more frequently if determined in consultation with the Technical Committee.

CCTV inspections will be used to identify changes to the visible surfaces of the culverts including cracking, buckling, shearing, and collapse and include:

- recording of existing cracks;
- recording of other defects and general condition;
- two-dimensional image records of the affected structures; and
- condition of the access roads with specific attention to surface cracks.

The site inspection will be conducted by representative(s) from the RMS.

Cuttings

Visual monitoring will be undertaken to assess potential movement and or impacts to the cuttings, including:

- changes in cutting condition, including opening of cracks or spalling;
- changes in groundwater seepage or surface water flows;
- rockfalls; and
- changes in RMS risk ranking.

A site inspection of the cuttings will be conducted following the completion of Longwall 304, or more frequently if determined in consultation with the Technical Committee. The site inspection will be conducted by representative(s) from the RMS. A report will be prepared by the RMS following each inspection noting the observed changes to the condition of the cuttings and any changes to the ARL ranking for the cuttings.

Twice weekly visual inspections will be conducted during Longwall 304 extraction by representatives of the RMS as part of the RMS Network Safety Inspections. These inspections are carried out by a dedicated inspector twice weekly and any observed defects that represent a safety hazard will be reported to the RMS Technical Committee.

Bridges

Bridge 2 (Old Princes Highway Underpass)

The existing system for high accuracy measurement of the Bridge 2 structure distortions using FBG sensors will be retained for Longwall 304 to allow early detection of small relative ground movements which could then be monitored more closely using all available methods. The FBG monitoring frequency will be weekly during extraction of Longwall 304.

The existing system established for relative 3D survey of Bridge 2 using conventional survey equipment will be retained for Longwall 304. Survey of Bridge 2 targets will occur:

- prior to extraction of Longwall 304; and
- within 3 months of the completion of Longwall 304.

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Monitoring frequency of Bridge 2 will be reviewed if:

- absolute horizontal movement of Real Time (3D) continuous monitoring indicate more than 30 mm of horizontal movement;
- FBG sensor monitoring detects significant distortion of the structure;
- visual inspection indicates cracking; or
- if otherwise determined in consultation with the RMS Technical Committee.

It is envisaged by the RMS Technical Committee that the frequency of conventional survey monitoring, after 30 mm of absolute movement is measured or significant structure distortion is detected by the FBG sensor system, will be weekly. The frequency may be reduced if the FBG sensor system readings indicate that relative ground movements are developing slowly.

Visual inspection of Bridge 2 will be conducted at the completion of Longwall 304 or otherwise if determined in consultation with the RMS Technical Committee.

Cawley Road Overbridge

A visual inspection of the Cawley Road Overbridge will be conducted prior to the extraction of Longwall 304. Visual inspections of Cawley Road Overbridge will be conducted at the completion of Longwall 304 or otherwise if determined in consultation with the RMS Technical Committee.

The existing system established for relative 3D survey of Cawley Road Overbridge using conventional survey equipment will be retained for Longwall 304. Survey of Cawley Road Overbridge targets will occur:

- prior to extraction of Longwall 304; and
- within 3 months of the completion of Longwall 304.

Monitoring frequency of Cawley Road Overbridge will be reviewed if:

- absolute horizontal movement of Real Time (3D) continuous monitoring indicate more than 30 mm of horizontal movement;
- visual inspection indicates cracking; or
- if otherwise determined in consultation with the RMS Technical Committee.

It is envisaged by the RMS Technical Committee that the frequency of conventional survey monitoring, after 30 mm of absolute movement is measured, will be weekly.

6.8.3 Old Princes Highway (BFMP-WCC)

Pavement

Subsidence impacts will be monitored extending from the Old Princes Highway Underpass (Bridge 2) to the entrance to the Garrawarra Centre Complex.

An inspection of the pavement will occur prior to commencement of Longwall 304. Weekly visual inspections will occur on commencement of Longwall 304 along the highway to a position of 400 m in front of the face.

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The Old Princes Highway will be visually inspected within three months of the completion of Longwall 304.

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.

Survey of the highway pavement at approximately 20 m centres will be undertaken at weekly frequency on commencement of Longwall 304. Survey extents will be around the active longwall face to 400 m in front of face. Weekly surveys will continue until subsidence reduces below level of survey accuracy. The Old Princes Highway will be surveyed within three months of the completion of Longwall 304.

6.8.4 Waterfall General [Garrawarra] Cemetery (BFMP-CEM)

A post mining audit will be conducted following the completion of Longwall 303 for comparison with the pre-mining audit records. A follow up audit be undertaken 2 years after Longwall 303 (in 2021) to review any longer-term effects.

6.8.5 Water Mains (BFMP-SYDWATER)

Routine visual inspections by Sydney Water will be conducted of the pipelines in accordance with the Sydney Water inspection program. For pipelines, this generally includes:

- assessment of the condition of water mains and associated fittings;
- inspection on fittings (valves and hydrants); and
- detection of leaks, breaks or water pressure drops in the pipeline reported by Sydney Water customers.

A visual inspection of the pipeline route will occur prior to commencement of Longwall 304 and following completion of Longwall 304 to identify surface ground cracks, cracks or leaks in the pipelines, and to confirm that fittings can be accessed beneath surface fittings and are operable.

Weekly observations of subsidence impacts along the pipeline route will be conducted when Longwall 304 is within 400 m of passing directly underneath the pipeline. 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);
- evidence of wet ground where the pipe is buried;
- assessment against the performance indicators and performance measure;

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- 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.

6.8.6 Transmission Lines and Towers (BFMP-TRA, BFMP-END)

TransGrid

330 kV Transmission Line and Towers

The TransGrid infrastructure is outside the 20 mm subsidence prediction line and beyond 600 m from Longwall 304 secondary extraction. Notwithstanding, subsidence monitoring will continue for Longwall 304 given the significance of the infrastructure.

A pre-Longwall 304 survey will be completed to record the following:

- survey of transmission monitoring line; and
- survey of tower legs and associated ground points (TL11-104 to TL11-108).

Monthly survey inspections will be conducted at each tower (relative) during the extraction of Longwall 304 and include the following:

- survey 4 x ground monitoring points outside each leg; and
- survey 4 x tower leg mounted prisms.

Continuous real-time (absolute) monitoring (3D) will be maintained for the duration of Longwall 304 extraction at each tower (TL11-104 to TL11-108). Absolute survey monitoring at the TransGrid towers forms part of the TransGrid BFMP and other associated BFMP including BFMP-RMS and BFMP-Endeavour and BFMP-Sydney Trains.

For each survey event the surveyors will record on their field notes any of the following:

- Any observable surface deformations or other subsidence related effects at the tower being surveyed.
- Any observable subsidence effects on the road accessing each tower.
- Any observable effects will be noted quantitatively in regards width, length, orientation.

Visual inspections by TransGrid will be conducted of the towers and transmission line between TransGrid Tower TL11-104 to TL11-108 inclusive in accordance with the TransGrid inspection program. This generally includes:

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

Additional observations of subsidence impacts will be conducted during routine works and recorded by surveyors during tower monitoring surveys.

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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.

Endeavour Energy

132 kV Transmission Line and Towers

The Endeavour Energy infrastructure is outside the 20 mm subsidence prediction line and beyond 600 m from Longwall 304 secondary extraction, located further east than TransGrid infrastructure. Subsidence monitoring will continue for Longwall 304 given the significance of the infrastructure.

A pre-Longwall 304 survey will be completed to record the following:

- survey of transmission monitoring line; and
- survey of tower legs and associated ground points (F9132B-T8 to F9132B-T12).

Monthly survey inspections will be conducted at each tower (relative) during the extraction of Longwall 304 and include the following:

- survey 4 x ground monitoring points outside each leg; and
- survey 4 x tower leg mounted prisms.

Continuous real-time (absolute) monitoring (3D) will be maintained for the duration of Longwall 304 extraction at adjacent TransGrid towers (TL11-104 to TL11-108). Absolute survey monitoring at the TransGrid towers forms part of the TransGrid BFMP and other associated BFMPs including BFMP-RMS, BFMP-Endeavour and BFMP-Sydney Trains.

Visual inspections will be conducted of the 132 kV transmission line and towers between Tower T8 and T12 inclusive in accordance with the Endeavour Energy inspection program. This generally includes:

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

Additional observations of subsidence impacts will be conducted during routine works and recorded by surveyors during tower monitoring survey.

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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.

Timber Poles and High Voltage Powerlines

A visual inspection of the timber poles² and powerlines will be conducted prior to commencement of Longwall 304.

Inspections to identify any degradation of the structure and movement of conductors as well as the high voltage power lines (e.g. vegetation clearance, land clearance, road clearance, and integrity and function of support clamps or other items) will occur within 3 months following the completion of Longwall 304, or at any time in case of a fault or emergency.

Additional observations of subsidence impacts will be conducted during routine works and sampling by Metropolitan Coal and its contractors.

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

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

6.8.7 Telecommunication Cables (BFMP-TELSTRA, BFMP-VOCUS, BFMP-OPTUS)

Fibre Optic Cables

Fibre cables operated by each of the three communication companies are in separate conduits in the same trench. No optical fibre cables directly overlie Longwall 304. The main trunk cables are located over Longwall 301 and east of Longwall 301. Separate local fibre cables connect to the communication towers at Garrawarra along the unsealed road to Garrawarra.

Weekly survey inspections will be conducted for the Optus fibre optic local cable upon commencement of Longwall 304 extraction to 400 m south of Garrawarra gate. Surveys will continue until movement stabilises. Survey monitoring of the optical / water line will be carried out.

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

For each survey event the surveyors will record on their field notes and provide in the weekly report the following:

- Any observable surface deformations or other subsidence related effects along the track being surveyed.
- Any observable effects will be noted quantitatively in regards width, length, orientation.

Telstra Fibre Optic Cable 1

Continuous RFMS monitoring using the 1,625 nanometres Optical Time Domain Reflectometer (OTDR) monitoring on a Telstra spare fibre will be used to measure the signal integrity (i.e. dB change) during mining of Longwall 304.

Monthly visual inspections will be conducted of the cable line and associated pits if triggered by a transmission fault (e.g. RFMS records loss event ± 0.3 dB; or exceeds ± 1.0 dB) detected by the Telstra monitoring system (BFMP-Telstra). The visual inspections would be used to identify any movement of conduit, degree of freedom of cable in conduit and ground compression / tension.

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.

Telstra Fibre Optic Cable 2

Continuous RFMS monitoring using the 1,625 nanometres OTDR monitoring a Telstra spare fibre will be used to measure the signal integrity (i.e. dB change) during the commencing 400 m of extraction from Longwall 304.

Monthly visual inspections will be conducted of the cable line and associated pits if triggered by a transmission fault (e.g. RFMS records loss event ± 0.3 dB; or exceeds ± 1.0 dB) detected by the Telstra monitoring system (BFMP-Telstra). The visual inspections would be used to identify any movement of conduit, degree of freedom of cable in conduit and ground compression / tension.

Vocus Fibre Optic Cable

The continuous RFMS monitoring on the Telstra spare fibre will also be used to measure the signal integrity (i.e. dB change) for the Vocus fibre optic cable during mining of Longwall 304.

Monthly visual inspections will be conducted on the cable line and joint house pit if triggered by a transmission fault (RFMS records loss event ± 0.3 dB; ± 0.5 dB; or exceeds ± 1.0 dB) detected by the Vocus monitoring system (utilising the continuous RFMS monitoring using the 1,625 nanometres OTDR monitoring the Telstra spare fibre). The visual inspections would be used to identify any movement of conduit, degree of freedom of cable in conduit and ground compression / tension.

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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.

Optus 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.

Copper Telecommunication Cables

Visual inspections of the aerial and buried copper telecommunication cables (at the Garrawarra Centre Complex) will be conducted as required in accordance with the Telstra Management Plan Agreement for the area.

6.8.8 Telecommunication Towers and Compounds (BFMP-TELSTRA, BFMP-AXICOM, BFMP-SYDTRAINS)

Monitoring of subsidence parameters at the telecommunication towers and compounds will be undertaken as described in the BFMPs. Survey monitoring for subsidence, tilt and ground strain at the towers has been established.

Telstra Telecommunication Tower and Compound

A pre and post-mining inspection of the Telstra hut and fencing at the compound will be undertaken. Visual inspections will be conducted as required in accordance with the Telstra Management Plan Agreement for the area included in the BFMP-Telstra.

During mining, monitoring of the structural integrity of the telecommunications tower and compound and the tower tilt (i.e. to determine if greater than 1 degree) will occur:

- prior to extraction of Longwall 304;
- weekly during the commencing 400 m of extraction of Longwall 304 until subsidence is no longer detectable; and
- within 3 months following the completion of extraction of Longwall 304.

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Axicom Telecommunication Towers and Compounds

A pre and post-mining inspection of the Axicom towers and huts (including fencing) at the compounds will be undertaken. Visual inspections will be conducted of the compounds. An audit and site inspection of the entries and cable lines to the hut and condition of the cable will also be conducted prior to extraction of Longwall 304.

During mining, monitoring of the tower structures as described in the BFMP will occur:

- within 3 months following the extraction of Longwall 301;
- weekly during the commencing 400 m of extraction from each of Longwalls 302, 303 and 304; and
- within 3 months following the completion of extraction of each of Longwalls 302, 303 and 304.

Sydney Trains Telecommunication Tower and Compound

Visual inspections of the telecommunications tower and compound will be conducted in consultation with the Sydney Trains.

Monitoring of the Sydney Trains tower and compound will be conducted by Metropolitan Coal as described in the BFMP:

- prior to the commencement of Longwall 304;
- weekly during the commencing 400 m of extraction of Longwall 304 until the level of subsidence is no longer detectable; and
- within 3 months following the completion of extraction of Longwall 304.

6.8.9 Illawarra Railway (BFMP-SYDTRAINS)

Sydney Trains Illawarra Railway is located more than 1.9 km from Longwall 304 and at that distance, no measurable conventional or non-conventional subsidence movements are anticipated. Notwithstanding the separation distance, survey monitoring is installed at the Wilsons Creek and Cawley Creek culverts to confirm negligible relative movement of these structures. In addition, for Longwall 304 real time (continuous) absolute 3D monitoring will monitor any far field valley closure mechanism that may be detectable at Wilsons Creek and Cawley Creek.

While not a component of the monitoring program, visual inspections of the Illawarra Railway are also conducted in accordance with the Sydney Trains inspection plans for the area. This generally includes:

- track condition;
- structures condition;
- drainage changes; and
- culvert condition.

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6.9 ACCESS ROADS/TRACKS

Visual inspection of the access roads/tracks will be conducted prior to the commencement of Longwall 304, and following extraction of the longwall panel.

Visual observations of access roads/tracks would occur as part of routine works and inspections within 600 m of Longwall 304 secondary extraction as described in the Metropolitan Coal LMP.

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

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

7 ANALYSIS OF SUBSIDENCE EFFECTS, SUBSIDENCE IMPACTS AND ENVIRONMENTAL CONSEQUENCES

Analysis of the relationship between subsidence effects, subsidence impacts and environmental consequences will be reported annually in the Annual Review. The analysis will include:

- comparison of predicted subsidence effects and measured parameters;
- comparison of predicted subsidence impacts and measured impacts;
- analysis of any variations between predicted and measured conventional subsidence effects and impacts (e.g. consideration of underlying parameters such as distance functions, etc. used to determine the predicted subsidence profile);
- analysis of variations between predicted and measured far-field movements and non-conventional subsidence effects (e.g. effects of geological structures and valley closure) and impacts; and
- analysis of the 3D movement about longwall extraction with particular reference to the transverse and longitudinal movements versus distance in advance of the longwall panel.

The analyses will be used to assess the validity of the subsidence predictions and to refine the predictive methods where appropriate.

The relationship between subsidence effects, impacts and environmental consequences will be determined through review and reporting of each environmental management plan (e.g. LMP, WMP, BMP) in accordance with Condition 3, Schedule 7 of the Project Approval.

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8 REFERENCES

Department of Planning and Environment and NSW Trade & Investment – Division of Resources and Energy (2015) *Guidelines for the Preparation of Extraction Plans Required under Conditions of Development Consents, Project Approvals and Mining Lease Conditions for Underground Coal Mining*. Version 5. Draft.

Eco Logical Australia (2016) *Longwalls 301-303 Upland Swamp Vegetation Mapping and Proposed Monitoring Program*. Report prepared for Metropolitan Coal. August 2016.

Eco Logical Australia (2018) *Revised Longwalls 304-310 Upland Swamp Vegetation Mapping*. Report prepared for Metropolitan Coal Pty Ltd.

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

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

Mine Subsidence Engineering Consultants (2019) *Metropolitan Mine – Longwall 304 Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan (MSEC Report MSEC1009)*.

ATTACHMENT 1

PLAN 7 (SUBSIDENCE MONITORING LOCATIONS)
IN ACCORDANCE WITH THE
DEPARTMENT OF PLANNING AND ENVIRONMENT AND
DIVISION OF RESOURCES AND ENERGY (2015)
GUIDELINES FOR THE PREPARATION OF EXTRACTION PLANS

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