METROPOLITAN COAL LONGWALLS 305-307

SUBSIDENCE MONITORING PROGRAM




Peabody

METROPOLITAN COAL

LONGWALLS 305-307

SUBSIDENCE MONITORING PROGRAM

ME-TSE-MNP-0083

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DPE Approval Date
All	SMP-R01-A	Original	DPIE, NSW Resources Regulator	-
Plan 7	SMP-R01-B	Plan 7 Updated	DPIE, NSW Resources Regulator	16 March 2020
All	SMP-R01-C	Updated to reflect 50 m extension to Longwall 307	DPIE	13 August 2021
All	SMP-R01-D	Changes to Longwall 307 monitoring for the Princes Highway and the Princes Motorway following consultation	DPE	

February 2022

TABLE OF CONTENTS

Section			Page
1	INTRODUCTION		1
	1.1	PURPOSE AND SCOPE	1
	1.2	STRUCTURE OF THE SMP	5
2	SMP REVIEW AND UPDATE		7
	2.1	DISTRIBUTION REGISTER	7
3	LONGWALLS 305-307 EXTRACTION LAYOUT		8
4	SURFACE FEATURES INCLUDED IN MONITORING PROGRAM		9
	4.1	THE STUDY AREA	9
		4.1.1 Streams	10
		4.1.2 Cliffs and Associated Overhangs	10
		4.1.3 Steep Slopes and Land in General	10
		4.1.4 Upland Swamps	10
		4.1.5 Other Natural Vegetation	10
	4.2	PUBLIC UTILITIES	11
		4.2.1 Railways	11
		4.2.2 Roads and Culverts	11
		4.2.3 Bridges	11
		4.2.4 Electrical Services	11
		4.2.5 Telecommunications Services	12
		4.2.6 Dams, Reservoirs and Associated Works	12
	4.3	MINE INFRASTRUCTURE	12
	4.4	GARRAWARRA CENTRE COMPLEX	13
	4.5	ITEMS OF ARCHAEOLOGICAL SIGNIFICANCE	13
		4.5.1 Aboriginal Heritage Sites	13
		4.5.2 Local Heritage Sites	13
	4.6	PERMANENT SURVEY CONTROL MARKS	13
5	REVISED SUBSIDENCE PARAMETERS AND SUBSIDENCE IMPACTS DUE TO LONGWALLS 305-307 EXTRACTION		14
	5.1	PREDICTED SUBSIDENCE PARAMETERS AND IMPACTS FOR THE NATURAL AND BUILT FEATURES WITHIN THE STUDY AREA	14
6	MONITORING		15
	6.1	INTRODUCTION	15
	6.2	SUBSIDENCE PARAMETER MONITORING COMPONENTS	25
		6.2.1 ‘300 XL Line’	25
		6.2.2 ‘Princes Highway Line’	25
		6.2.3 ‘Optic / Water Line’	26
		6.2.4 ‘M1 North Bound Line’	27
		6.2.5 ‘Transmission Towers Monitoring’	27
		6.2.6 ‘Telecommunication Towers Monitoring’	28
		6.2.7 ‘Bridge 2 Monitoring’	28
		6.2.8 ‘Cawley Road Overbridge Monitoring’	29
		6.2.9 Eastern Tributary Cross Lines	30

TABLE OF CONTENTS (continued)

6.2.10 Waratah Rivulet Cross Line 30
6.2.11 Ridge Top Survey Stations 30
6.2.12 Full Supply Level Valley Closure Stations 31
6.2.13 Parameters to be Measured 31
6.2.14 Monitoring Methods and Accuracy 31
6.3 LAND MANAGEMENT PLAN 33
6.3.1 Cliffs and Overhangs 34
6.3.2 Steep Slopes and Land in General 34
6.4 BIODIVERSITY MANAGEMENT PLAN 34
6.4.1 Upland Swamps - Vegetation 35
6.4.2 Upland Swamps - Groundwater 35
6.4.3 Riparian Vegetation 36
6.4.4 Aquatic Biota and Habitat 36
6.4.5 Terrestrial Fauna and their Habitats 37
6.5 WATER MANAGEMENT PLAN 37
6.5.1 Stream Features 38
6.5.2 Surface Water Flow 38
6.5.3 Eastern Tributary Gauging Station 39
6.5.4 Pool Water Levels and Drainage Behaviour 39
6.5.5 Surface Water Quality 40
6.5.6 Woronora, Nepean and Cataract Reservoir Water Quality 41
6.5.7 Shallow Groundwater Levels near Streams 41
6.5.8 Groundwater Levels/Pressures 41
6.5.9 Groundwater Quality 42
6.5.10 Mine Water Make 42
6.6 HERITAGE MANAGEMENT PLAN 43
6.7 BUILT FEATURES MANAGEMENT PLAN 44
6.7.1 Garrawarra Centre Complex (BFMP-GAR) 45
6.7.2 M1 Princes Motorway including Bridges (BFMP-TfNSW) 46
6.7.3 Old Princes Highway (BFMP-WCC) 48
6.7.4 Waterfall General [Garrawarra] Cemetery 49
6.7.5 Water Mains (BFMP-SYDWATER) 49
6.7.6 Transmission Lines and Towers (BFMP-TRA, BFMP-END) 49
6.7.7 Telecommunication Cables (BFMP-TELSTRA, BFMP-OPTUS) 52
6.7.8 Telecommunication Towers and Compounds (BFMP-TELSTRA, BFMP-AXICOM, BFMP-SYDTRAINS) 53
6.8 ACCESS ROADS/TRACKS 54
7 ANALYSIS OF SUBSIDENCE EFFECTS, SUBSIDENCE IMPACTS AND ENVIRONMENTAL CONSEQUENCES 54
8 REFERENCES 56

TABLE OF CONTENTS (continued)

LIST OF FIGURES

Figure 1 Longwalls 305-307 and Project Underground Mining Area

Figure 2 Longwalls 305-307 Layout

Figure 3 Longwalls 305-307 and Project Underground Mining Area – Aerial Photograph

Figure 4 Environmental Management Structure

Figure 5 Subsidence Monitoring Layout

LIST OF TABLES

Table 1 Summary of Longwall Dimensions for Longwalls 305-307

Table 2 Provisional Extraction Schedule

Table 3 Subsidence Parameter Monitoring Components

Table 4 Subsidence Impact and Environmental Consequences Monitoring Components

Table 5 Classification of Horizontal Control Survey

LIST OF ATTACHMENTS

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*

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).

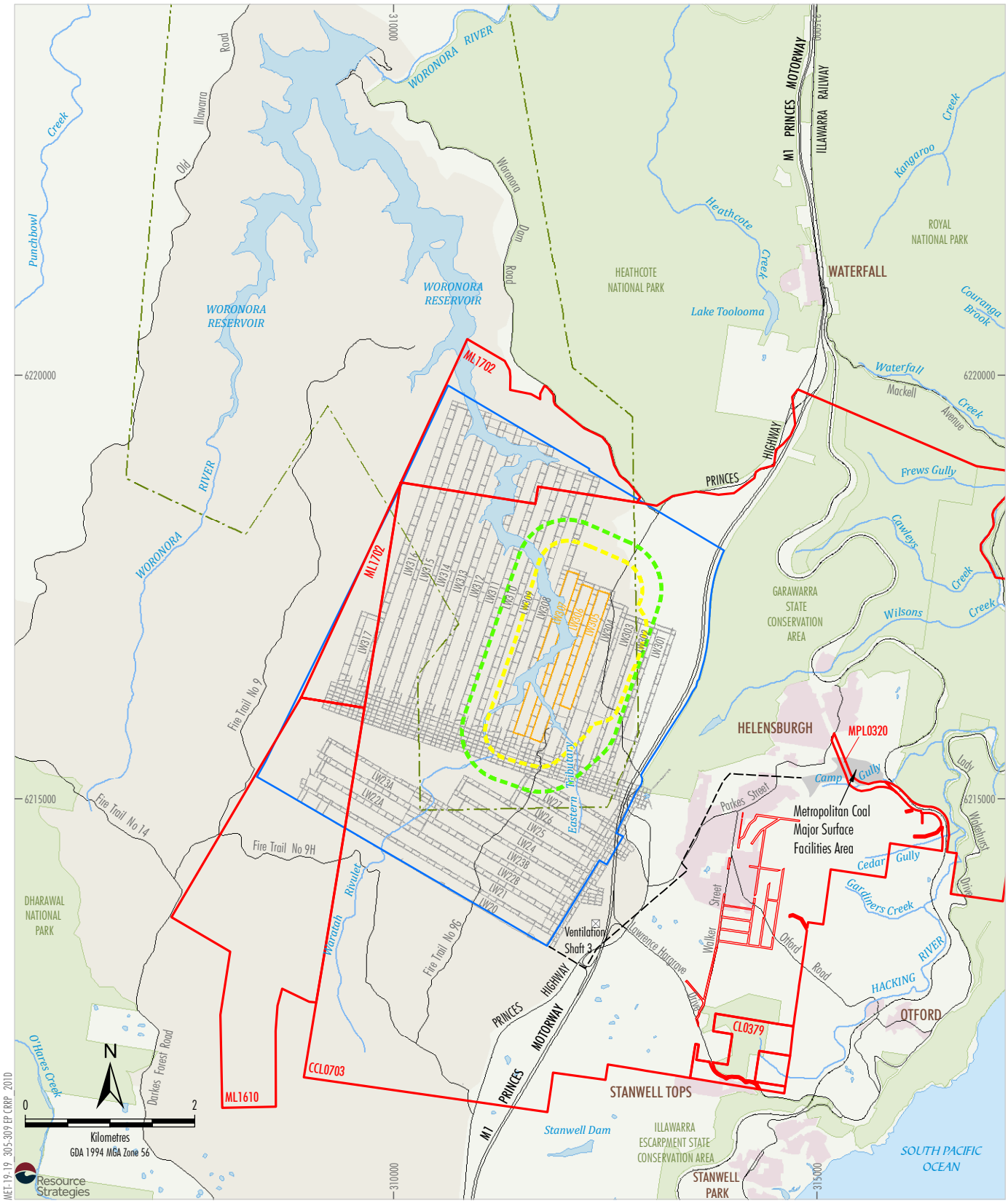
The Project comprises the continuation, upgrade and extension of underground coal mining operations (Longwalls 20-27 and Longwalls 301-317) and surface facilities at Metropolitan Coal (Figure 1). Longwalls 305-307 are situated to the west of Longwalls 301-304 and define the next mining sub-domain within the Project underground mining area (Figures 1 to 3). Longwalls 308 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 Longwalls 305-307. Where relevant, this SMP includes the post-mining requirements for Longwalls 20-22, Longwalls 23-27, Longwalls 301-303 and Longwall 304. The Longwall 304 Subsidence Monitoring Program will be superseded by this document following the completion of Longwall 304 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;*
>
> *…*



LEGEND

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

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

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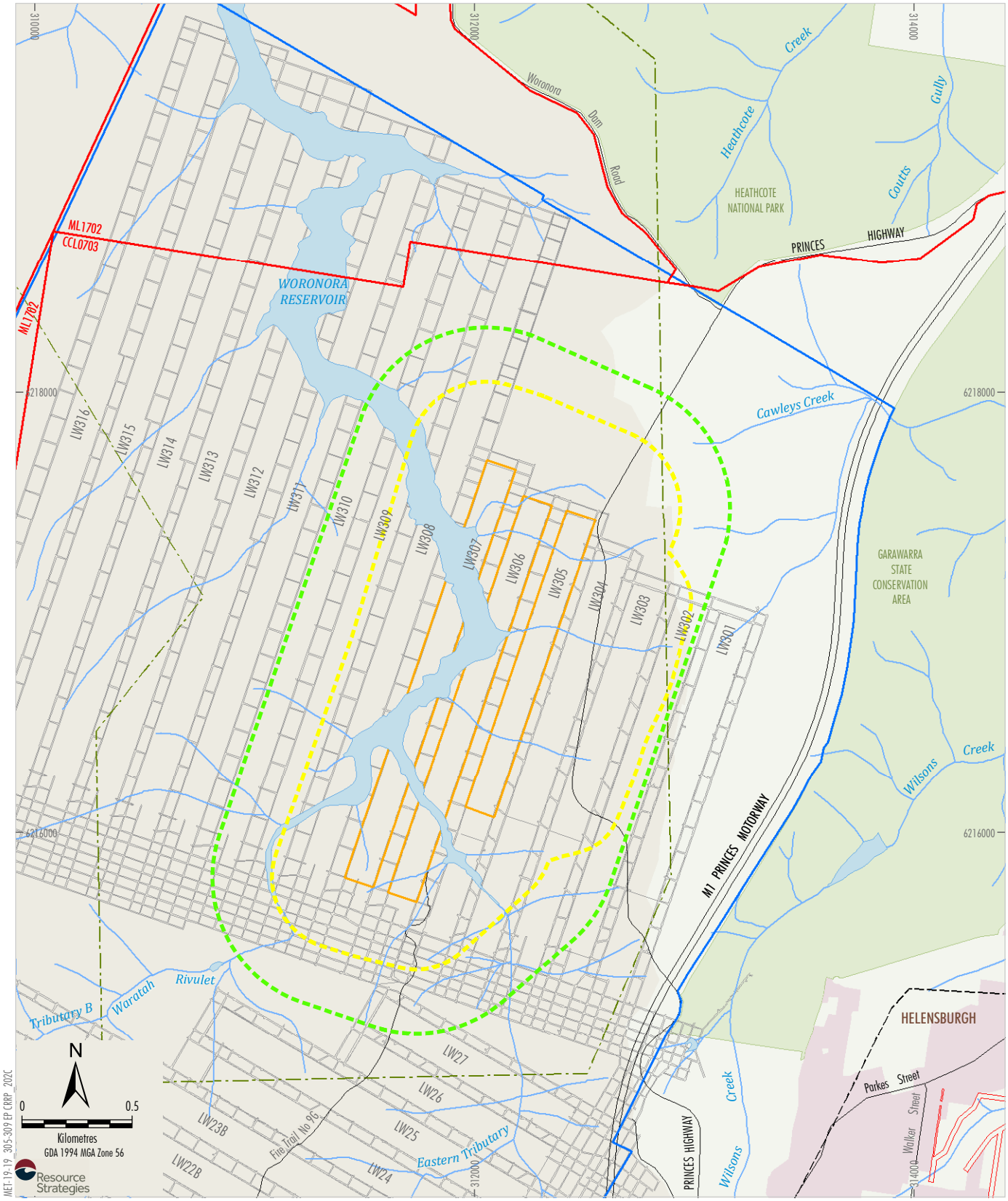
Longwalls 305-307 and Project Underground Mining Area

Figure 1



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

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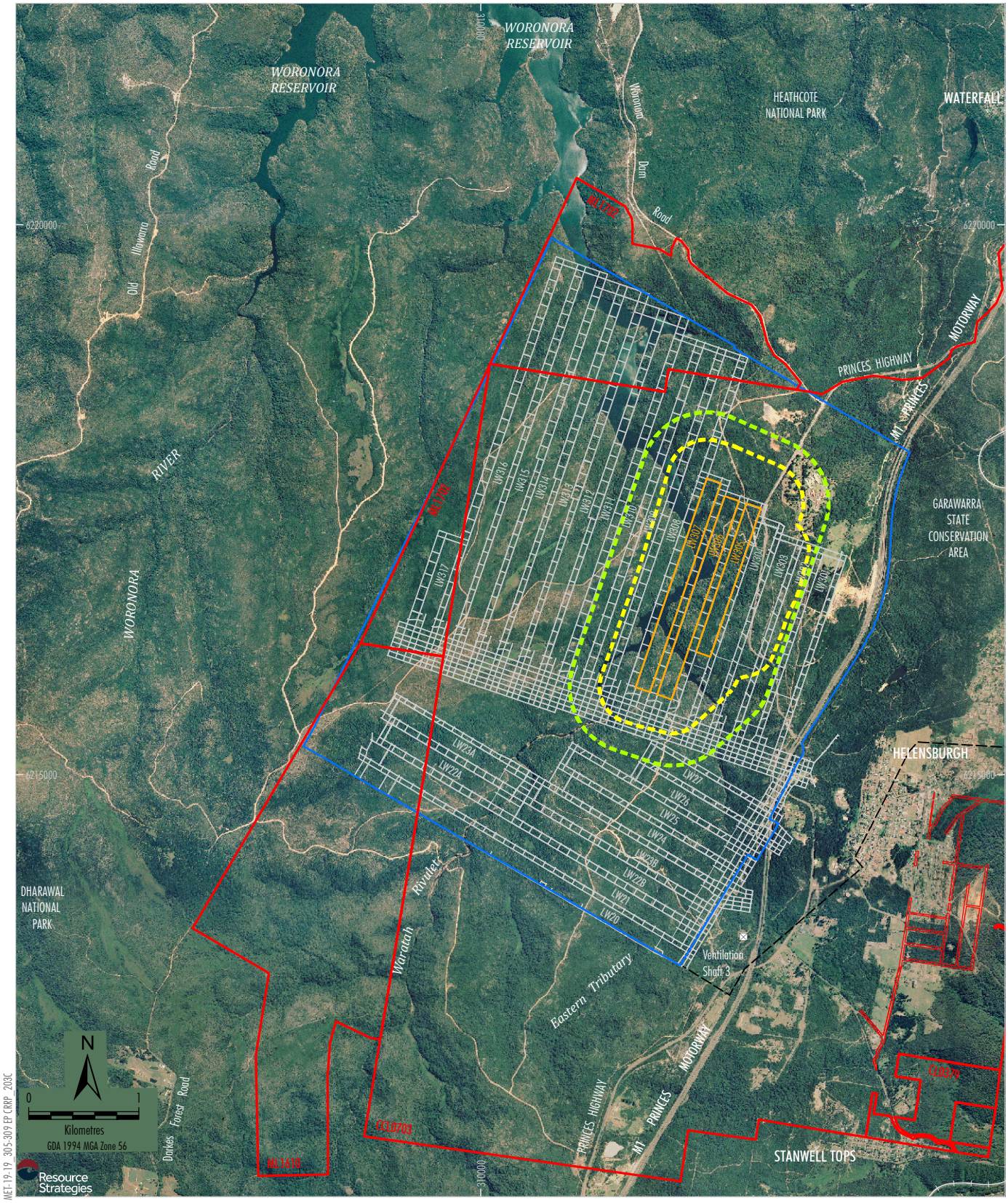
Longwalls 305-307 Layout

Figure 2



MET-19-19 305-309 EP CRRP 203C

LEGEND

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

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

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Longwalls 305-307 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 Longwalls 305-307 Coal Resource Recovery Plan (CRRP, Appendix H of the Longwalls 305-307 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 - Longwalls 305 to 307 Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan* prepared by Mine Subsidence Engineering Consultants (MSEC) (2019) (Appendix I of the Longwalls 305-307 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 Longwalls 305-307 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 Longwalls 305-307 extraction layout.

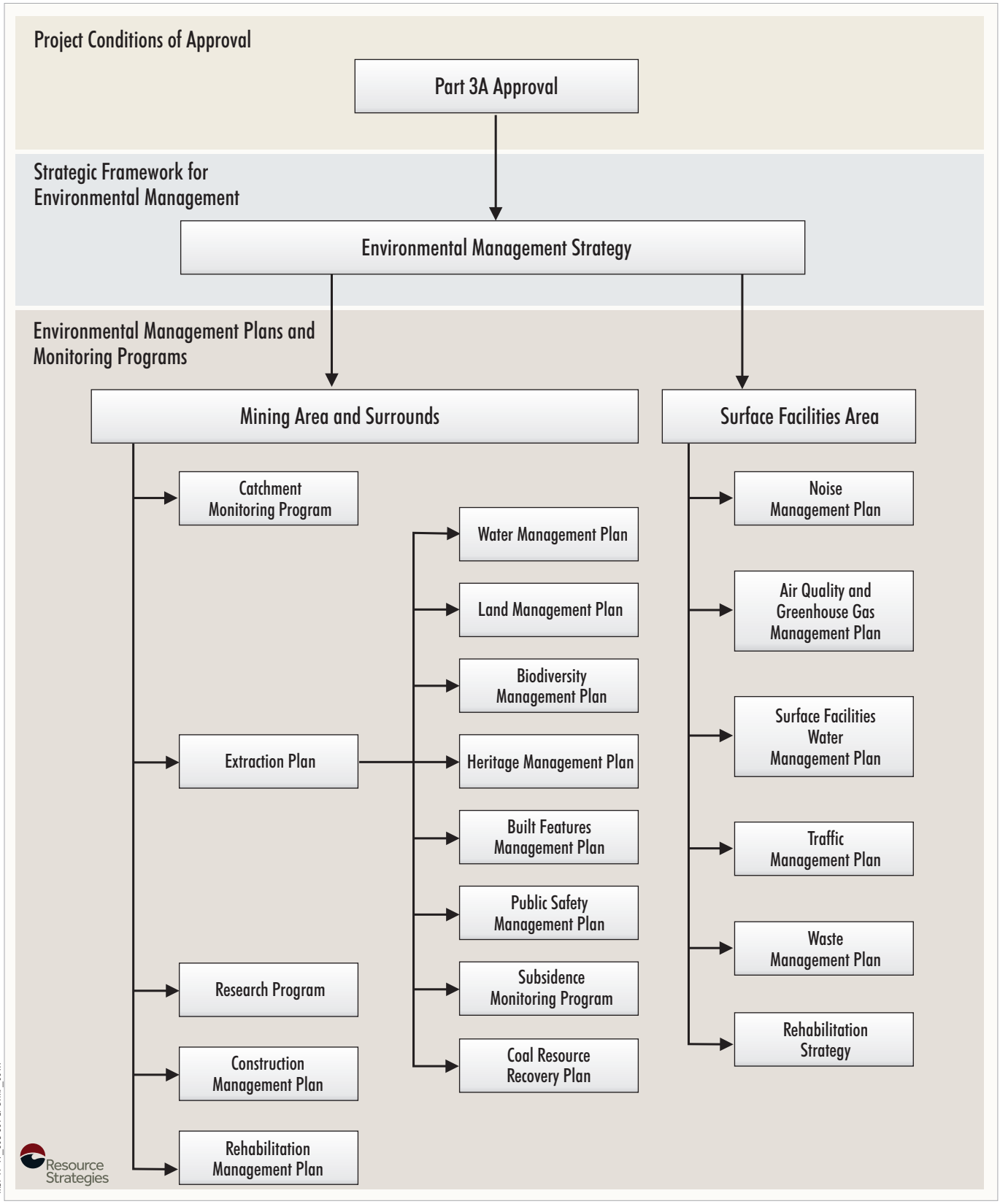
Section 4: Describes the natural and built features.

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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Environmental Management Structure

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 Department of Planning and Environment (DPE) [1], 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 DPE.

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 Secretary of the DPE.

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.

[1] The former Department of Planning, Industry and Environment (DPIE) was renamed to the Department of Planning and Environment (DPE) on 21 December 2021.

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.

3 LONGWALLS 305-307 EXTRACTION LAYOUT

Longwalls 305-307 and the area of land within 600 metres (m) of Longwalls 305-307 secondary extraction is shown on Figures 1, 2 and 3. A summary of the longwall dimensions for Longwalls 305-307 is provided in Table 1. The Longwall 305 layout includes a 138 m panel width (void), a 45 m tailgate pillar width and a 70 m maingate pillar width. The longwall layout of Longwalls 306 and 307 includes 138 m panel widths (void) and 70 m pillars (solid) consistent with the Preferred Project Layout (PPL).

Table 1
Summary of Longwall Dimensions for Longwalls 305-307

Longwall	Longwall Length (m)	Total Void Width (m)	Tailgate Chain Pillar Width (m)
Longwall 305	1,596	138	45
Longwall 306	1,956	138	70
Longwall 307	2,006	138	70

m = metres.

Longwall extraction will occur from north to south. The provisional extraction schedule for Longwalls 305-307 is provided in Table 2.

Table 2
Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
Longwall 305	April 2020	8 Months	November 2020
Longwall 306	June 2021	11 Months	April 2022
Longwall 307	May 2022	8 Months	December 2022

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 Longwalls 305-307 CRRP.

The depth of cover within the Longwalls 305-307 35 degree (°) angle of draw and/or predicted 20 millimetres (mm) subsidence contour varies between a minimum of 410 m and a maximum of 535 m.

The seam floor within the Longwalls 305-307 35° angle of draw and/or predicted 20 mm subsidence contour generally dips from the south-east to the north-west. The seam thickness within the Longwalls 305-307 goaf area varies between 2.6 m to 2.9 m. Longwalls 305-307 will extract the full height of the seam, with localised extraction up to 3.2 m around development headings and longwall install and take off points.

4 SURFACE FEATURES INCLUDED IN MONITORING PROGRAM

4.1 THE STUDY AREA

The Study Area in MSEC (2019) is defined as the surface area that is likely to be affected by the mining of Longwalls 305-307 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 Longwalls 305-307; and
- the predicted limit of vertical subsidence, taken as the predicted incremental 20 mm subsidence contour resulting from the extraction of Longwalls 305-307.

Natural features identified within the Study Area include:

- streams (including 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 Longwalls 305-307 Study Area. The full supply level of the Woronora Reservoir is also located within the Longwalls 305-307 Study Area.

Built features identified within the Longwalls 305-307 Study Area include:

- Old Princes Highway;
- communication towers and compounds;
- optical fibre cables;
- water pipelines and water storage tanks;
- Garrawarra Centre Complex buildings, structures and services (southern areas);
- 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 within 600 m 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; and
- 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 Longwalls 305-307 CRRP.

4.1.1 Streams

Streams within the Study Area for Longwalls 305-307 include first and second order streams. These streams consist of shallow drainage lines from the topographical high points, forming streams where valley heights increase and drain into the Woronora Reservoir.

The Eastern Tributary flows into the full supply level of the Woronora Reservoir to the south-east of the Longwalls 305-307 Study Area.

The Waratah Rivulet flows into the full supply level of the Woronora Reservoir to the south-west of the Longwalls 305-307 Study Area.

4.1.2 Cliffs and Associated Overhangs

Five cliff and overhang sites are located within the Longwalls 305-307 Study Area (namely COH11, COH12, COH13, COH16 & COH17). None of the cliffs are located directly above Longwalls 305-307. Detailed baseline recordings of these cliff and overhang sites have been completed and are included in the Longwalls 305-307 Land Management Plan (Appendix B).

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 18 swamps located within the Study Area. Detailed descriptions of the swamps within the Study Area are provided in the Metropolitan Coal Longwalls 305-307 BMP.

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 Longwalls 305-307 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 2.0 km from Longwall 305.

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 305-307 CRRP.

The M1 Princes Motorway is located more than 1.0 km from Longwall 305. A series of culverts of varying diameters from 375 mm to 1,800 mm cross the M1 Princes Motorway.

The Old Princes Highway passes close to the northern commencing end of Longwall 305 but does not cross directly above Longwalls 305-307.

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 1.02 km from the finishing end of Longwall 305.

The Cawley Road Overbridge is located approximately 1.67 km from the northern end of Longwall 305.

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 Longwalls 305-307 CRRP and on Drawing No. MSEC1057-08 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 and would not be undermined by Longwalls 305-307. 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 305. 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 Longwalls 305-307 CRRP and on Drawing No. MSEC1057-08 in MSEC (2019).

There are three main optical fibre cables outside the Study Area that cross the southern end of Longwall 301 owned by Telstra, Optus and Vocus. Situated on the eastern edge of the Study Area 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. No optical fibre cables are located directly above Longwalls 305-307.

Copper telecommunications cables owned by Telstra are located to the north-east of Longwalls 305-307 and these cables service the Garrawarra Centre Complex. No copper telecommunication cables are situated above Longwalls 305-307.

There are also a number of telecommunications towers and compounds that are located to the east of Longwall 305, nearby the commencing end of Longwall 303. These towers and compounds are owned by Telstra, Axicom and Sydney Trains. No communication towers are situated above Longwalls 305-307.

4.2.6 Dams, Reservoirs and Associated Works

The closest dam to Longwalls 305-307 is the Woronora Dam. The Woronora Dam wall is located approximately 6.5 km from the commencing end of Longwall 307. The distance from the labyrinth spillway (south of the dam wall) is approximately 6.0 km from the nearest point of Longwall 307. Monitoring of the Woronora Dam wall is not included in this SMP due to the large distance of the dam wall from the extraction of Longwalls 305-307.

The extraction of Longwalls 305-307 will occur within the Woronora Notification Area and Longwall 306 is the first of the 300 series longwalls to pass beneath the full supply level of the Woronora Reservoir. Longwall 305 does not extend beneath the Woronora Reservoir full supply level but approaches within the angle of draw. Longwalls 306 and 307 will extend beneath the full supply level.

The extraction geometries of Longwalls 305-307 have been revised in consideration of mining occurring proximal to the Woronora Reservoir full supply level. Longwalls 305, 306 and 307 have a reduction in extraction width to 138 m and Longwalls 306 and 307 have an increase in pillar width to 70 m as they will pass directly under the reservoir full supply level. The extraction geometries are in accordance with the Project Approval (08_0149).

Further considerations of the Woronora Reservoir is provided in the Metropolitan Coal Longwalls 305-307 Extraction Plan Main Text and the Longwalls 305-307 WMP (Appendix A).

4.3 MINE INFRASTRUCTURE

There are no exploration drill holes (boreholes) located within the Study Area. The nearest borehole (S225) is located to the east of the Study Area, the location of which is shown on Plan 2 in the Longwalls 305-307 CRRP and on Drawing No. MSEC1057-09.

4.4 GARRAWARRA CENTRE COMPLEX

The location of the Garrawarra Centre Complex and buildings, structures and other services are shown in Drawings No. MSEC1057-08, MSEC1057-09 and MSEC1057-10 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. MSEC1057-09 in MSEC (2019). Five Aboriginal heritage sites of high archaeological significance and/or particular cultural significance are located within the Longwalls 305-307 Study Area. Site FRC 185 is of high archaeological significance and particular cultural significance, Sites FRC 68 and FRC 191 are of high archaeological significance, and sites FRC 198 and FRC 316 are of particular cultural significance.

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 Longwalls 305-307 Heritage Management Plan (HMP).

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. The Garrawarra Centre Complex is located to the east of the Longwall 305 commencing end, a portion of which is within the Study Area.

The Waterfall General [Garrawarra] Cemetery, also referred to 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). The Waterfall Cemetery is located outside the Study Area to the east of Longwall 305.

4.6 PERMANENT SURVEY CONTROL MARKS

The locations of survey control marks are shown on Plan 2 in the Longwalls 305-307 CRRP and on Drawing No. MSEC1057-09 in MSEC (2019).

5 REVISED SUBSIDENCE PARAMETERS AND SUBSIDENCE IMPACTS DUE TO LONGWALLS 305-307 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 Longwalls 305-307. The report includes the maximum predicted conventional subsidence parameters for Longwalls 305-307 (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 Longwalls 305-307 is 525 mm, and the maximum predicted total conventional subsidence from the extraction of Longwalls 305-307 is 1,100 mm within the Study Area (after Longwall 305, and does not increase for Longwalls 306 and 307), which represents approximately 39% of the minimum extraction height of 2.8 m.

A comparison of the maximum predicted conventional total subsidence parameters, for the Extraction Plan Layout and the Preferred Project Layout for Longwalls 305-307, is provided in Table 4.3 of MSEC (2019). The Extraction Plan Layout maximum predicted total subsidence, tilt and curvature for the extraction of Longwalls 305-307 are similar to or less than the predicted values based on the Preferred Project Layout.

MSEC (2020) reviewed the potential changes to subsidence impacts and environmental consequences resulting from the 50 m extension of Longwall 307 (refer to Section 1.3.2 of the Longwalls 305-307 Extraction Plan Main Text), and found that the approved potential impacts for relevant natural and built features described in the approved Longwalls 305-307 Extraction Plan do not change, and therefore the management and monitoring strategies do not need to change.

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 Longwalls 305-307. 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.

In particular, the following surface features were assessed:

- Waratah Rivulet.
- Eastern Tributary.
- Other Streams.
- Woronora Reservoir and Woronora Dam (*the latter being located approximately 6.5 km away*).
- Cliffs and Associated Overhangs.
- Steep Slopes and Land in General.
- Upland Swamps and other Natural Vegetation.

- Illawarra Railway (*located more than 2.0 km away*).
- M1 Princes Motorway.
- Old Princes Highway.
- Fire Trails and Four Wheel Drive Tracks.
- Bridges (Bridge 2 [*located approximately 1.0 km 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 Longwalls 305-307 extraction and where relevant, previous Longwalls 301-304 and Longwalls 20-27.
- To summarise and consolidate the various environmental monitoring programs presented in each of the key component plans of the Longwalls 305-307 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 2 and subsidence impact/environmental consequence monitoring as summarised in Table 3.

Table 2
Subsidence Parameter Monitoring Components

Monitoring Component	Description	Frequency	Relevant Management Plan
300 XL Line	Monitoring line traversing approximately perpendicular across 300 series longwalls	• Prior to Longwall 305. • Within 3 months following completion of each longwall.	General – all plans
[Old] Princes Highway Line	Along the Old Princes Highway from Survey Mark PH116 (near M1 Princes Motorway) to Garrawarra Centre Complex entrance road.	• Prior to Longwall 305. • Weekly on commencement of LW305 & LW306 for first 400 m of extraction until subsidence reduces below level of survey accuracy. • Fortnightly for LW307 at PH30 & PH32 to confirm no sustained increase in incremental tensile strain. • Following the completion of each Longwall full survey Garrawarra to M1 Princes Motorway.	BFMP-WCC BFMP-Sydney Water
Optic/Water Line	Along an unsealed track and Garrawarra Centre Complex internal roads from Survey Mark O30 (near the Waterfall Cemetery) to beyond the 35º angle of draw line within Garrawarra Centre Complex.	• Prior to Longwall 305. • Weekly on commencement of LW305 for first 400m of extraction until subsidence reduces below level of survey accuracy. • Following completion of each longwall survey from O30 to O97.	BFMP-Optus 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.	• Prior to Longwall 305. • Following the completion of Longwall 305. • Midpoint of Longwall 306.	BFMP-TfNSW
Transmission Towers	Tower survey TL11-104 to TL11-108 and F9132B-T8 to F9132B-T12 including: • Each of the four tower legs. • Four ground points adjacent to each leg. Real time absolute 3D monitoring at TransGrid Towers, sites #4, #5 & #6.	• Prior to Longwall 305. • Specifically during Longwall 305 measurements at 2 monthly intervals to confirm no ongoing movements post mining. • Within 3 months following the completion of each longwall. • Real-time (continuous) absolute 3D monitoring on TransGrid towers.	BFMP-TransGrid BFMP-Endeavour Energy BFMP-TfNSW
Telecommunication Towers	Lattice (Truss) Towers including: • Each of the tower legs. • Ground points adjacent each tower leg Pole Tower including: • Ground points adjacent to tower.	• Prior to Longwall 305. • Weekly on commencement of Longwall 305 for first 400 m of extraction until subsidence effects are no longer detectable. • Within 3 months following the completion of each longwall.	BFMP-Telstra BFMP-Axicom BFMP-Sydney Trains BFMP-Garrawarra

Table 2 (Continued)
Subsidence Parameter Monitoring Components

Monitoring Component	Description	Frequency	Relevant Management Plan
Bridge 2 (Old Princes Highway Underpass)	• Relative 3D movements of bridge monitoring prisms • Fibre Optic monitoring system (FBG). • Real time absolute 3D monitoring site #3.	• Real-time (continuous) absolute 3D monitoring sampled daily, reported monthly. • Weekly Fibre Bragg Grating (FBG) sensor monitoring from the commencement of longwall 305, for the duration of longwall 305 and midway through extraction of Longwall 306 (3 August 2021). Reported quarterly.	BFMP- TfNSW
Cawley Road Overbridge	• Relative 3D movements of bridge monitoring points. • Absolute real time 3D monitoring site #9.	• Real-time (continuous) absolute 3D monitoring sampled daily, reported monthly. • Survey of bridge monitoring points following the completion of Longwall 305 and midway through extraction of Longwall 306.	BFMP- TfNSW
Eastern Tributary	Cross lines at ETAU, ETAT, ETAR and ETAQ. High Resolution Survey lines A and B at ETAU for valley closure. Realtime absolute 3D monitoring sites 21, 22, 23.	• Prior to Longwall 305. • For Longwall 305 at ETAU and high-resolution lines A and B, measurements are fortnightly on commencement of Longwall 305 until 1,181 m void, then weekly until 1,381 m void and beyond 1,381 m at no greater than 3 day intervals until completion. • For Longwall 306 at ETAU and high-resolution lines A and B measurements are monthly on commencement of Longwall 306 until 1,400 m void, then fortnightly until 1,650 m void and beyond 1,650 m at no greater than weekly intervals until completion. • For Longwall 307 at ETAU and high-resolution lines A and B measurements are monthly on commencement of Longwall 306 until 1,400 m void, then fortnightly until 1,650 m void and beyond 1,650 m at no greater than weekly intervals until completion. • Real-time (continuous) absolute 3D monitoring at GNSS sites ETAU. • Following the completion of each Longwall.	WMP (Pools/rock bars ETAU, ETAT, ETAR and ETAQ and functionality of gauging station)
Waratah Rivulet Cross Line	Cross Line Q (WaterNSW gauging station). Cross Line at rock bars R, S, T, U, V & W	• Prior to Longwall 305. • Monthly when active longwall face within 450 m of relevant rock bars. • Following the completion of each Longwall.	WMP Rock Bars Q, R, S, T, U, V, W
Ridge Top and Full Supply Level Valley Closure monitoring	Realtime absolute 3D monitoring sites as per subsidence monitoring figure (Figure 5).	• Prior to Longwall 305. • In accordance with NSW DSC conditions at 500 m longwall retreat intervals. • Real-time (continuous) absolute 3D monitoring. • Following the completion of each longwall.	General Dams Safety Committee approval

Table 3
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
LMP	Cliffs and overhangs	• Cliff sites COH11, COH12, COH13, COH16 & COH17.	• Visual inspection prior to Longwall 305 extraction. • Monthly when longwall extraction is within 400 m of each site. • Following the completion of each longwall.	• 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	• Steep slopes and other land within 600 m of Longwalls 20-27 and Longwalls 301-307 secondary extraction.	• Visual observations during catchment visits.	• 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	• 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 301-304). • Swamps 69, 70, 71a, 71b, 72 and 73 within the Longwalls 305-307 35° angle of draw and/or predicted 20 mm subsidence contour. • Control Swamps 101, 111a, 125, 135, 136, 137a, 137b, 138, Bee Creek Swamp, Woronora River 1, Woronora River south arm and Dahlia Swamp.	• Visual inspections bi-annually in spring and autumn.	• 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).
		• 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, 48, 50 51/52 and 53 (Longwalls 301-304). • Control Swamps 101, 111a, 125, 135, 136, 137a, 137b, 138, Bee Creek Swamp, Woronora River 1, Woronora River south arm and Dahlia Swamp.	• Transect and quadrat monitoring bi-annually in spring and autumn.	• 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.
		• Twenty tagged individuals (*Epacris obtusifolia*) in each of Swamps 18, 24 and 25 (Longwalls 20-22) and Control Swamps 101, 111a and 125. • Twenty tagged individuals (*Epacris obtusifolia*) 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 (*Epacris obtusifolia*) in each of Swamps 40 and 53 (Longwalls 301-303) and Control Swamps 101, 136 and 137a. • Twenty tagged individuals (*Sprengelia incarnata*) in each of Swamps 24 (Longwalls 20-22) and Control Swamps 101 and 125. • Twenty tagged individuals (*Sprengelia incarnata*) in each of Swamps 19, 33, 35 and 94 (Longwalls 23-27) and Control Swamps 135, 136, 137a and 138. • Twenty tagged individuals (*Sprengelia incarnata)* in each of Swamps 40 and 53 (Longwalls 301-303) and Control Swamps 101, 136 and 137b. • Twenty tagged individuals (*Pultenaea aristata*) in each of Swamps 18, 24 and 25 (Longwalls 20-22) and Control Swamps 101 and 111a. • Twenty tagged individuals (*Pultenaea aristata*) in each of Swamps 19, 30, 33, 35 and 94 (Longwalls 23-27) and Control Swamps 135, 136, 137a and 138. • Twenty tagged individuals (*Banksia robur, Callistemon citrinus* and *Leptospermum juniperinum*) in each of Swamps 20 (Longwalls 20-22) and Control Swamps Woronora River 1, Woronora River south arm and Dahlia Swamp. • Twenty tagged individuals (*Banksia robur* and *Callistemon citrinus*) in each of Swamps 28 (Longwalls 23-27) and Control Swamps Woronora River 1, Woronora River south arm and Dahlia Swamp.	• Indicator species monitoring bi-annually in spring and autumn.	• Population monitoring data including condition/health rating for each plant and reproductive rating

Table 3 (Continued)
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
BMP (Cont.)	Upland Swamps - Groundwater	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). • 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). • Swamps 71a and 72 (Longwalls 305-307). • Control Swamps 101, 137a, 137b, Bee Creek Swamp and Woronora River 1.	• Datalogger (continuous).	• Groundwater levels.
	Riparian Vegetation	• Sites MRIP01 to MRIP12.	• Visual inspections bi-annually in spring and autumn.	• Areas of new water ponding. • Any cracking or rock displacement. • Changes in vegetation condition, including areas of stressed vegetation that appear unusual.
		• Sites MRIP01 to MRIP08, MRIP11 and MRIP12.	• Permanent quadrat (20 m x 2 m) monitoring bi-annually in spring and autumn.	• 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.
		• Existing tagged individuals (*Prostanthera linearis*, *Schoenus melanostachys* and *Lomatia myricoides*) at sites MRIP01 to MRIP12.	• Indicator species monitoring bi-annually in spring and autumn.	• Population monitoring data including condition/health rating for each plant and reproductive rating.
	Aquatic Biota and their Habitats	• Surface water resources and watercourses in accordance with the WMP.	• In accordance with the WMP.	• Monitoring of aquatic habitats in accordance with the WMP.
		• Stream monitoring at following Locations (if sufficient aquatic habitat is available for sampling); – WT3, WT4, WT5, ET1, ET2, ET3 and ET4. – Control Locations: WR1 and OC.	• Biannually in spring (15 September to 15 December) and autumn (15 March to 15 June).	Impacts on aquatic ecology: • Habitat Characteristics. • Water Quality. • Aquatic Macroinvertebrates. • Aquatic Macrophytes.
		• 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.	• 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).	The response of aquatic ecosystems to the implementation of stream remediation works: • Habitat Characteristics. • Water Quality. • Aquatic Macroinvertebrates. • Aquatic Macrophytes.
	Amphibian Monitoring	• Sites 1-6 (Longwalls 20-22), 13-17 (Longwalls 23-27) and 23-28 (Longwalls 301-303). • Sites 29 and 30 (Longwalls 305-307). • Control Sites 7, 8, 9, 10, 11, 12, 18, 19, 20, 21 and 22.	• Survey annually in spring/summer (i.e. October to February) during suitable weather conditions.	Species assigned to relative abundance categories for tadpole and adult stages.

Table 3 (Continued)
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
WMP	Stream Features	• 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.	• 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 of Eastern Tributary and Waratah Rivulet within 3 months of the completion of each longwall. • Weekly monitoring at pools observed with gas releases until no gas releases have been observed at the pool for three consecutive weeks.	• 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	• 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).	• Continuous (downloaded monthly).	• Stream flow data.
	Pool Water Levels and Drainage Behaviour	• Eastern Tributary Pools ETG, ETJ, ETM, ETO, ETU, ETW, ETAF, ETAG, ETAH, ETAI/ETAJ/ETAK, ETAL, ETAM, ETAN, ETAO, ETAP, ETAQ, ETAR, ETAS/ETAT[3] and ETAU. • Waratah Rivulet Pools A, F, J, K, L, M, N, O, P, Q, R, S, T, U, V and W. • Pools SR1, SR2 and SP1 on tributaries of the Woronora Reservoir. • Woronora River Control Pools WRP1, WRP2, WRP3 and WRP4.	• Continuous water level sensor and logger (downloaded monthly at all sites). • Pool ETAU - continuous water level sensor and logger (downloaded weekly when Longwalls 305 & 306 extraction is within 450 m of the Eastern Tributary).	• Pool water levels.
		• Waratah Rivulet Pools B, C, E, G, G1, H and I.	• Manually monitored daily, until such time that continuous sensors are installed.	• Pool water levels.
		• Pools ETAS, ETAT and ETAU on the Eastern Tributary.	• Visual inspections conducted weekly when extraction is within 450 m of the stream.	• 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.
		• Pools on the Waratah Rivulet from Pool P to the full supply level of the Woronora Reservoir.	• Visual inspections conducted at the time of download (monthly).	
	Stream Water Quality	• 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.	• Monthly.	• Water quality parameters as described in the WMP (samples collected for metal analysis to be field filtered).
		• 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.	• Monthly.	• Unfiltered water quality samples analysed for total iron.

Table 3 (Continued)
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
WMP (Cont.)	Stream Water Quality (Cont.)	• Eastern Tributary sites ETWQ AQ and ETWQ AU. • Woronora River site WOWQ 2.	• Fortnightly from the commencement of Longwall 304 to the completion of Longwall 307.	• 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.
		• 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.	• 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).	• 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	• Woronora Reservoir (site DW01). • Nepean Reservoir. • Cataract Reservoir.	• As made available by Water NSW.	• Total iron, total manganese and total aluminium.
	Shallow Groundwater Levels Near Streams	• Eastern Tributary sites ETGW1 and ETGW2. • Site ETO1, ETO2, ETO3 and ETO4 (adjacent to Pool ETO). • Waratah Rivulet sites WRGW1, WRGW2 and WRGW7.	• Data downloaded monthly at all sites; analysis on a six-monthly basis. • Sites ETGW1 and ETGW2 downloaded weekly when Longwall extraction is within 450 m of the Eastern Tributary.	• Groundwater levels.
	Groundwater Levels/Pressures	• Transect sites T1, T2, T3, T5 and T6. • Groundwater standpipes TBS02-90 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 (redrill). • Site PM03. • Site PHGW1B. • Site PHGW2A. • Site F6GW3A. • Site F6GW4A. • Site TBS02-250R. • Site TBS03-230R.	• Data downloaded/reading monthly. • Analysis at the frequency described in the WMP.	• Groundwater levels.
	Groundwater Quality	• Eastern Tributary site ETGW2. • Waratah Rivulet sites WRGW1, WRGW2 and WRGW7.	• Monthly.	• Water quality parameters as described in the WMP.
	Mine Water Make	Underground	• Mine water balance inputs (as described in the WMP). • Weekly statutory inspections. • Data downloaded monthly/analysis monthly	• Groundwater inflow to the mine (20-day average).

Table 3 (Continued)
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
HMP	Aboriginal Heritage	• Sites FRC 76, FRC 77, FRC 78, FRC 86, FRC 90 and FRC 309	• Within three months of the completion of Longwall 304.	• 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.
		• All sites within the Longwall 305 35° angle of draw and/or predicted 20 mm subsidence contour, namely Sites FRC 67, FRC 68, FRC 70, FRC 71, FRC 76, FRC 77, FRC 78, FRC 85, FRC 86, FRC 87, FRC 90, FRC 91, FRC 93, FRC 117, FRC 309, FRC 310 and FRC 325.	• Within three months following the completion of Longwall 305.	
		• All sites within the Longwalls 305 35° angle of draw and/or predicted 20 mm subsidence contour above, in addition to all sites within the Longwall 306 35° angle of draw and/or predicted 20 mm subsidence contour, namely Sites FRC 97, FRC 101, FRC 180, FRC 254, FRC 311, FRC 316, FRC 320 and FRC 321.	• Within three months following the completion of Longwall 306.	
		• All sites within the Longwalls 305-306 35° angle of draw and/or predicted 20 mm subsidence contour above, in addition to all remaining sites within the Longwalls 305-307 35° angle of draw and/or predicted 20 mm subsidence contour, namely Sites FRC 94, FRC 95, FRC 184, FRC 185, FRC 186, FRC 187, FRC 191, FRC 198, FRC 313, FRC 323, FRC 324 FRC 344 and FRC 345.	• Within three months following the completion of Longwall 307.	
BFMP-TfNSW	M1 Princes Motorway - Pavement	Visual inspection for impacts on: • Asphaltic concrete surface. • Kerbs, gutters and pits. • Signs or other road infrastructure.	• Following the completion of Longwall 307, specifically at FW207.15 around the identified pre-mining pavement defect on road shoulder. • Greater frequency if determined in consultation with the TfNSW Technical Committee • Network Safety Inspection twice weekly during longwall extraction.	To identify development of, or changes in existing: • Asphaltic concrete surface including cracks, buckling and stepping. • Kerbs and gutters including cracking, buckling and joint movement.
	M1 Princes Motorway - Cuttings	Visual inspection for impacts on: • Cuttings along the M1 Princes Motorway as described in the BFMP-TfNSW.	• Following the completion of Longwall 307. • Greater frequency if determined in consultation with the TfNSW Technical Committee • Network Safety Inspection twice weekly during longwall extraction.	To identify: • Changes in cutting condition, including opening of cracks, spalling. • Changes in groundwater seepage or surface water flows. • Rockfalls. • Changes in TfNSW risk ranking.
	M1 Princes Motorway - Culverts	• Closed circuit television (CCTV) inspection for impacts on internal surfaces.	• Following the completion of Longwall 310 • Greater frequency if determined in consultation with the TfNSW Technical Committee	• 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: • 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.	• Following the completion of Longwall 307. • Greater frequency if determined in consultation with the TfNSW Technical Committee.	To identify development of, or changes in existing: • Surface cracks. • Closing or opening of joints. • Distortion or damage to elastomeric bearings.
	Cawley Road Overbridge	Visual inspection for impacts on: • Abutments. • Pier blade wall. • Tetron bearings. • Deck expansion joints. • Steel traffic barrier and safety screen joints.	• Following completion of Longwall 307. • Greater frequency if determined in consultation with the TfNSW Technical Committee.	To identify development of, or changes in existing: • 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.	• Progress monitoring (visual inspections) coinciding with ground survey extents to occur weekly on commencement of Longwalls 305 and 306 for first 400 m of extraction and then until subsidence reduces to less than survey accuracy. • Following completion of each longwall.	• 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.	• Progress monitoring (visual inspections) coinciding with ground survey extents to occur weekly on commencement of Longwalls 305 and 306 for first 400 m of extraction and then until subsidence reduces to less than survey accuracy. • Within 3 months following the completion of extraction of each longwall.	• Impacts to the visible surfaces of pipes/culverts including cracking, buckling, shearing, and collapse. • Visible impacts to furniture.

Table 3 (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	• Towers T8 to T12.	• Prior to the commencement of Longwall 305. • End of panel survey of tower legs at completion of extraction of each longwall. • Endeavour Energy inspections (annual ground inspection, six yearly climbing inspection). • At any time in case of fault or emergency.	• Degradation of tower structure. • Degradation of tower foundations/footings. • Movement of insulator strings.
	Local Powerlines – poles and wires	• Timber poles and wires within the Study Area.	• Prior to the commencement of Longwall 305 • Within 3 months following the completion of each Longwall. • Routinely as per Endeavour Energy inspections. • At any time in case of fault or emergency.	• Degradation of structure. • Movement of conductors. • Vegetation clearance. • Land clearance. • Road clearance. • Integrity and function of support clamps or other items.
	Access Roads/Tracks	• Within 600 m of Longwalls 305-307 extraction.	• Within 3 months following the completion of each longwall. • Routinely as per Endeavour Energy inspections.	• Surface cracks, buckling and general safety.
BFMP-TransGrid	330 kV Towers	• Towers TL11-104 to TL11-108.	• Prior to the commencement of Longwall 305 • Survey of tower legs at 2 month intervals during Longwall 305 • End of panel survey of tower legs at completion of extraction of each Longwall. • Routinely as per TransGrid inspections (annual ground inspection, six yearly climbing inspection). • At any time in case of fault or emergency.	• 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	• Conductor lines strung from Towers TL11-104 to TL11-108. • Ground survey. • Climbing inspection.	• Routinely as per TransGrid inspections (annual ground inspection, six yearly climbing inspection). • At any time in case of fault or emergency.	• Vegetation clearance. • Land clearance. • Road clearance. • Integrity and function of support clamps or other items.
	Access Roads/Tracks	• Within 600 m of Longwalls 305-307 extraction.	• Within 3 months following the completion of each longwall. • Routinely as per TransGrid inspections.	• Surface cracks, buckling and general safety.
BFMP-Telstra	Fibre Optic Cable line 2 and associated pits Telecommunications Tower (and compound)	• Fibre Optic Cable line 2 and associated pits • Tower and compound.	• Monitoring to occur when longwall face approaches within 400 m of the cables. • Weekly survey on commencement of mining Longwall 305 for first 400 m of extraction and then until subsidence no longer detectable. • Within 3 months following the completion of each longwall.	• Monitor fibre signal integrity (loss signal). • Structural integrity of the telecommunications tower and compound.
	Access Roads/Tracks	• Within 600 m of Longwalls 305-307 extraction.	• Following the completion of each Longwall. • Visual observations during catchment visits as per the LMP.	• Surface cracks, buckling and general safety.
BFMP-Axicom	Telecommunications Towers (and compounds)	• Towers and compounds.	• Weekly survey on commencement of mining Longwall 305 for first 400m of extraction and then until subsidence no longer detectable. • Within 3 months following the completion of each longwall.	• Structural integrity of the telecommunications tower and compound.
	Access Roads/Tracks	• Within 600 m of Longwalls 305-307 extraction.	• Following the completion of each Longwall. • Visual observations during catchment visits as per the LMP.	• Surface cracks, buckling and general safety.
BFMP-Sydney Trains	Telecommunications Tower (and compound)	• Tower and compound.	• Weekly survey on commencement of mining Longwall 305 for first 400m of extraction and then until subsidence no longer detectable. • Within 3 months following the completion of each longwall.	• Structural integrity of the telecommunications tower and compound.

Table 3 (Continued)
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
BFMP-Sydney Water	Water pipelines	• Water Main 1 • Water Main 2	• Routinely as per Sydney Water inspections. • Weekly for Watermain 1 on commencement of mining Longwalls 305 and 306 for first 400 m of extraction and then until subsidence no longer detectable. • Following the completion of each Longwall.	• Surface ground cracks. • Cracks or leaks in the pipelines.
BFMP-Optus	Fibre Optic Cables	• Within 600 m of Longwalls 305-307 extraction.	• Weekly on commencement of Longwall 305 for first 400 m of extraction Surveys will continue until movement stabilises. • Within 3 months following the completion of each longwall.	• Ground compression / tension.
	Cable lines and associated pits	• Within 600 m of Longwalls 305-307 extraction.	• If Optus detects a fault or loss of signal integrity	• Movement of conduit, degree of freedom of cable in conduit. (Optus to inspect)
	Access Roads/Tracks	• Within 600 m of Longwalls 305-307 extraction.	• Visual observations as part of routine works and inspections. • Following the completion of each longwall.	• Surface cracks, buckling and general safety.
BFMP-Garrawarra	Garrawarra Centre Complex - House Structures	• Palmer House (A09a).	• External inspection only due to degraded state of derelict buildings. • Following the completion of Longwall 307.	• Structural integrity changes. • Fresh cracking.
	Garrawarra Centre Complex – Aged Care Buildings	• Building structures (B01a-B01e). • Administration / Kitchen Group (Buildings B02a and B02b).	• Following the completion of Longwall 307.	• Structural integrity changes. • Cracking at pre-existing joints.
	Garrawarra Centre Complex – Water Storage Tanks	• Water storage tanks (B14t01, B14t02, B16t01-B16t03, B17t01 and B18t01) and trickle filter tank (B15t01).	• Following the completion of Longwall 307.	• Structural integrity changes. • 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	• Gas storage tank (B01t03).	• Following the completion of Longwall 307.	• Structural integrity. • Leaks.
	Garrawarra Centre Complex – Other Services (Powerlines and Poles)	• Timber poles and powerlines.	• Following the completion of Longwall 307. • At any time in case of fault or emergency.	• 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)	• Water pipelines within the Study Area.	• Following the completion of Longwall 307.	• Surface ground cracks. • Cracks or leaks in the pipelines. • Fittings can be accessed beneath surface fittings and are operable.
	Garrawarra Centre Complex – Private Roads and Access Roads/Tracks	• Within 600 m of Longwall 305-307 extraction.	• Following the completion of Longwall 307. • As per the LMP.	• Surface cracks, buckling and general safety.
Waterfall Cemetery	Waterfall General (Garrawarra) Cemetery site	• Waterfall General (Garrawarra) Cemetery site.	• A follow up audit be undertaken two years after Longwall 304 (in 2022) to review any longer-term effects.	• Structural integrity of headstones and fencing. • Surface cracks, buckling and general safety.
	Access Roads/Tracks	• Within 600 m of Longwall 305-307 extraction.	• Following the completion of Longwall 307. • As per the LMP.	• 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 307 extending from the M1 Princes Motorway to the Woronora Reservoir full supply level, and westward to fire trail 9E.

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 each longwall; 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.

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:

- weekly on commencement of Longwalls 305 and 306 for first 400 m of extraction and then until subsidence reduces to less than survey accuracy;
- fortnightly for Longwall 307 at PH30 and PH32 to confirm no sustained increase in incremental tensile strain and then until subsidence reduces to less than survey accuracy;
- within 3 months of the completion of each longwall; 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), 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 305 for first 400 m of extraction until subsidence reduces to less than 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-Axicom, BFMP-Sydney Trains and BFMP-Garrawarra.

6.2.4 'M1 North Bound Line'

The location of 'M1 North Bound Line' is shown in Attachment 1. The line extends from south[2] 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.

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 305;
- midway during extraction of Longwall 306; and
- more frequently if directed by the TfNSW Technical Committee or the Principal Subsidence Engineer NSW Resources Regulator.

The 'M1 North Bound Line' is a monitoring component of BFMP-TfNSW. The M1 Motorway ground monitoring points were discontinued during Longwall 306 after monthly monitoring reports for Longwalls 305 and 306 continually showed survey results within nominated triggers. It was considered reasonable by the TfNSW Technical Committee to discontinue with the terrestrial monitoring method following resheeting of M1 in this area during the extraction of Longwall 306 and replace with remote GNSS monitoring of higher accuracy at key locations along the corridor.

6.2.5 '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 Longwalls 305-307.

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;

The ground survey marks are comprised of either:

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

[2] A distance determined in consultation with the TfNSW Technical Committee.

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:

- Survey of tower legs at 2 month intervals during Longwall 305;
- following the completion of each longwall; 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-TfNSW; BFMP-Telstra and BFMP-Optus.

6.2.6 '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 305 for first 400 m of extraction and then until subsidence no longer detectable;
- within 3 months of the completion of each longwall; 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.

6.2.7 '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-TfNSW.

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 (FBG).

The Fibre Bragg Grating (FBG) system was decommissioned during the extraction of Longwall 306 after consideration of some 14 months of monitoring results by the TfNSW Technical Committee (TC2-21, 3 August 2021) that deemed it no longer required because of comparable results from the GNSS unit operating in tandem with the FBG system. Absolute monitoring continues at Bridge 2 with the GNSS 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:

- daily (continuous) absolute 3D monitoring;
- weekly FBG sensor monitoring from the commencement of Longwall 305 until the 3 August 2021 during the extraction of Longwall 306; and
- greater frequency or commencing earlier if determined in consultation with the TfNSW Technical Committee or the Principal Subsidence Engineer NSW Resources Regulator.

The ‘Bridge 2 Monitoring’ is a monitoring component of the BFMP-TfNSW.

6.2.8 ‘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 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:

- daily (continuous) absolute 3D monitoring; and
- survey marks following the completion of Longwall 305 and the midpoint of Longwall 306.

The ‘Cawley Road Overbridge Monitoring’ is a monitoring component of the BFMP-TfNSW.

6.2.9 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 and B are established at ETAU. Absolute valley closure monitoring at ETAU is comprised of 4 real time (continuous) absolute 3D monitors.

The frequency of monitoring of the cross lines will be:

- prior to Longwall 305;
- specifically, at ETAU and during extraction of Longwall 305 the high-resolution lines A and B, measurements are fortnightly on commencement of Longwall 305 until 1,181 m void, then weekly until 1,381 m void and beyond 1,381 m at no greater than 3 day intervals until completion;
- specifically, at ETAU and during extraction of Longwall 306 the high-resolution lines A and B, measurements are monthly on commencement of Longwall 306 until 1,400 m void, then fortnightly until 1,650 m void and beyond 1,650 m at weekly intervals until completion;
- specifically, at ETAU and during extraction of Longwall 307 the high-resolution lines A and B, measurements are monthly on commencement of Longwall 307 until 1,400 m void, then fortnightly until 1,650 m void and beyond 1,650 m at weekly intervals until completion;
- Daily (continuous) absolute 3D monitoring at GNSS sites around ETAU; and
- following the completion of extraction of each longwall.

6.2.10 Waratah Rivulet Cross Line

Cross lines established downstream of the maingate of Longwall 23 at Pool Q (WaterNSW Gauging Station) and pools R, S, T will be monitored for relative subsidence movement. New cross lines will be established at Pools U, V & W to monitor for relative subsidence movement during the extraction of Longwalls 305-307.

The frequency of monitoring of the cross lines will be:

- prior to Longwall 305; and
- following the completion of extraction of each Longwall.

6.2.11 Ridge Top Survey Stations

Real-time (continuous) absolute 3D monitoring sites 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 observe the subsidence related movements at the tops of valley sides and relative movements between the locations across the Waratah Rivulet and Eastern Tributary Valleys.

Reporting of the ridge top survey points will occur after the completion of each Longwall.

6.2.12 Full Supply Level Valley Closure Stations

Real-time (continuous) absolute 3D monitors along both sides of the Waratah Rivulet and Eastern Tributary valleys proximal to the Full Supply Level of Woronora Reservoir.

The purpose of the lower valley survey points is to measure valley closure in closer proximity to the base of the valley as cross lines cannot be installed in the base of the valleys. The observed data will be compared with predicted values to assist in providing a better understanding of the mechanism of valley closure and/or better inform the prediction methods.

Reporting of the lower valley survey points will occur after the completion of each longwall.

6.2.13 Parameters to be Measured

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

Real-time (continuous) absolute 3D monitors will measure subsidence movements in three dimensions using Global Navigation Satellite Survey (GNSS) survey methods.

6.2.14 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).

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 Longwalls 305-307 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 4.

Table 4
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 (1 σ) 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). A new geodetic datum is likely to be introduced during the period of this SMP, being the Geocentric Datum of Australia 2020 (GDA20), this will be adopted by the Company after it is formally gazetted for mine surveyors in NSW.

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.

Real-time (continuous) absolute 3D monitors will be used to achieve an absolute survey accuracy of ±5 mm horizontal ±20 mm vertical and relative to external survey reference

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. Total station survey instrument accuracy relative to external survey reference is influenced by available access to the sky through vegetation or terrain and may be greater than ±20 mm.

Subsidence impacts/Environmental Consequences Monitoring Components

The subsidence impact/environmental consequences monitoring components are summarised in Table 3. All subsidence impact/environmental consequence monitoring is included in a relevant management plan within the Longwalls 305-307 Extraction Plan as summarised in Table 3. 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 nay 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;
- 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.

6.3 LAND MANAGEMENT PLAN

The Longwalls 305-307 LMP has been prepared to manage the potential environmental consequences of the Longwalls 305-307 Extraction Plan on cliffs and overhangs, steep slopes and land in general.

6.3.1 Cliffs and Overhangs

As outlined in the LMP, detailed baseline recording of the cliff and overhang sites located within the Longwalls 305-307 35° angle of draw and/or predicted 20 mm subsidence contour (sites COH11, COH12, COH13, COH16, and COH17 has been undertaken.

Visual inspections for subsidence impacts on cliff sites will be conducted to record subsidence impacts prior to the commencement of Longwall 305, on a monthly basis when longwall extraction is within 400 m of each site, and following completion of Longwall 305, Longwall 306 and Longwall 307.

In the event subsidence impacts are identified on cliff and overhang sites, 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.

6.3.2 Steep Slopes and Land in General

Visual inspections for subsidence impacts on steep slopes and land in general within 600 m of Longwalls 305-307 extraction will be conducted by Metropolitan Coal and its contractors during catchment visits, sampling and routine works conducted in the catchment.

In the event subsidence impacts are identified within 600 m of Longwalls 305-307, 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.

6.4 BIODIVERSITY MANAGEMENT PLAN

The Longwalls 305-307 BMP has been prepared to manage the potential environmental consequences of the Longwalls 305-307 Extraction Plan on aquatic and terrestrial flora and fauna, with a specific focus on swamps.

6.4.1 Upland Swamps - Vegetation

Longwalls 305-307

Upland swamp vegetation monitoring for Longwalls 305-307 will include visual and quadrat/transect monitoring consistent with the methods used for the monitoring of Longwalls 20-22, Longwalls 23-27, Longwalls 301-303 and Longwall 304 upland swamp vegetation.

Visual inspections will be conducted of Swamps 69, 70, 71a, 71b, 72 and 73, located within the Longwalls 305-307 35° angle of draw and/or predicted 20 mm subsidence contour, Transect and quadrat monitoring will continue to be conducted in Swamp 50 overlying Longwall 304 and Swamp 48 overlying Longwall 305.

The data collected for each quadrat will be consistent with the data collected for the Longwalls 20-22, Longwalls 23-27, Longwalls 301-303 and Longwall 304 upland swamp monitoring programs described in the Longwalls 305-307 BMP. Surveys will be conducted biannually in autumn and spring.

Previous Longwalls 20-22, Longwalls 23-27, Longwalls 301-303 and Longwall 304

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 Longwalls 305-307. 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, 58, 69, 70, 71a, 71b, 72, 73, 84 and 86 are located within the 35° angle of draw and/or predicted 20 mm subsidence contour for Longwalls 305-307.

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, 48, 50, 51/52 and 53 overlying or adjacent Longwalls 301-304 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 Longwalls 305-307 as described in Table 3. Indicator species monitored include *Epacris obtusifolia, Sprengelia incarnata, Pultenaea aristata, Callistemon citrinus, Leptospermum juniperinum* and *Banksia robur.*

6.4.2 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.

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 Longwalls 305-307.

Paired piezometers have also been installed in Swamps 60, 62, 64, 133 and 134, which can also be used as potential reference sites during the mining of Longwalls 305-307.

6.4.3 Riparian Vegetation

No additional riparian vegetation monitoring sites have been established for Longwalls 305-307. 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 Longwalls 305-307.

Riparian vegetation monitoring will include visual and quadrat monitoring consistent with the methods detailed in the Longwalls 305-307 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 Longwalls 305-307 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.

6.4.4 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 Longwalls 305-307 WMP.

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).

6.4.5 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 Longwalls 305-307 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 were established for Longwall 304.

The Longwalls 305-307 amphibian monitoring program includes two test sites (sites 29 and 30) proximal to Longwalls 305-307. No additional control sites are required for Longwalls 305-307 to ensure a continually robust experimental design.

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.

6.5 WATER MANAGEMENT PLAN

The Longwalls 305-307 WMP has been prepared to manage the potential environmental consequences of the Longwalls 305-307 Extraction Plan on water resources (including the Woronora Reservoir) and watercourses.

6.5.1 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 longwall extraction is within 450 m of the stream and within three months of the completion of each longwall.

Visual inspections and photographic surveys of the Waratah Rivulet from the full supply level of the Woronora Reservoir to Pool P will be conducted within three months of the completion of Longwall 307.

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).

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 Longwalls 305-307 (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.

6.5.2 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 Planning, Industry and Environment – 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]).

6.5.3 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 Eastern Tributary during the mining of Longwalls 303 and 304) 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.

6.5.4 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;
- Pools SR1, SR2 and SP1 on tributaries of the Woronora Reservoir; and
- control Pools WRP1, WRP2, WRP3 and WRP4 on the Woronora River.

Data from these devices will be downloaded monthly.

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.

Pools ETAS, ETAT and ETAU on the Eastern Tributary will be visually inspected at the time of download of the pool water level data (i.e. monthly) to observe whether any changes to the natural drainage behaviour have occurred.

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

Higher frequency monitoring will specifically occur on pools with 450 m of the active longwall extraction, specifically:

- Data from Pool ETAU on the Eastern Tributary will be downloaded weekly when longwall extraction (Longwalls 305 and 306) is within 450 m.
- Pools ETAS, ETAT and ETAU on the Eastern Tributary will be visually inspected weekly when longwall extraction is within 450 m of these pools.

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.

6.5.5 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 (SO_4), bicarbonate (HCO_3), total nitrogen (Ntot), total phosphorous (Ptot), nitrate (NO_3), 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 305 to the completion of Longwall 307, 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 Longwalls 305-307 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 Longwalls 305-307 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 CONFLU1 can be accessed for sampling (i.e. when the Woronora Reservoir water levels are suitably low).

6.5.6 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.

6.5.7 Shallow Groundwater Levels near Streams

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

- sites ETGW1 and ETGW2 along the Eastern Tributary;
- sites ETO1, ETO2, ETO3 and ETO4 adjacent to Pool ETO on 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.

6.5.8 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 at the northern end of Longwalls 305-307. 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) and TBS02-190 (post-mining Longwall 302).

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 TBS03-230R.

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

6.5.9 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, SO_4, HCO_3, 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.

6.5.10 Mine Water Make

Monitoring of the mine water balance will comprise moisture flows into and out of the mine.

Moisture flows into the mine:

- Clean water reticulated into the mine (recorded continuously and downloaded monthly).
- Backfill water used to assist pumping into the mine (recorded continuously and downloaded monthly).
- Ventilation moisture content entering the mine at the intake points by manual measurement 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) 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.

Moisture flows out of the mine:

- Return water reticulated out of the mine (recorded continuously and downloaded monthly).
- Moisture content of the raw coal conveyed out of the mine at the drift portal using an automated moisture scanner. Recorded continuously and downloaded monthly.
- Moisture content of gas stream reticulated out of the mine to the gas drainage plant (recorded continuously and downloaded monthly).
- Ventilation moisture content exiting the mine at the upcast shaft by manual measurement 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) that prevent readings to be taken; and
  - once per week as a minimum.

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 NSW 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.

6.6 HERITAGE MANAGEMENT PLAN

The Longwalls 305-307 HMP has been prepared to manage the potential environmental consequences of the Longwalls 305-307 Extraction Plan on Aboriginal heritage sites or values.

Aboriginal heritage sites FRC 76, FRC 77, FRC 78, FRC 86, FRC 90 and FRC 309 will be monitored within three months of the completion of Longwall 304. Monitoring of these sites will also be undertaken for Longwalls 305-307.

All[3] Aboriginal heritage sites located within the Longwalls 305-307 35° angle of draw and/or predicted 20 mm subsidence contour will be monitored for Longwalls 305-307.

Round 1 monitoring will be undertaken within three months following the completion of Longwall 305 and will include all sites within the Longwall 305 35° angle of draw and/or predicted 20 mm subsidence contour (Table 3).

[3] Despite extensive searches, site FRC 180 (which is located within the Longwalls 305-307 35°angle of draw and/or predicted 20 mm subsidence contour) was unable to be relocated during baseline recording, and will not be monitored as part of the Longwalls 305-307 HMP.

Round 2 monitoring will be undertaken within three months following the completion of Longwall 306 and will include all sites within the Longwalls 305 and 306 35° angle of draw and/or predicted 20 mm subsidence contour (Table 3).

Round 3 monitoring will be undertaken within three months following the completion of Longwall 307 and will include all sites within the Longwalls 305-307 35° angle of draw and/or predicted 20 mm subsidence contour (Table 3).

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.

6.7 BUILT FEATURES MANAGEMENT PLAN

Several component plans have been prepared to manage the potential environmental consequences of the Longwalls 305-307 Extraction Plan on built features including:

- Garrawarra Centre Complex buildings and services (BFMP-Garrawarra [BFMP-GAR]).
- M1 Princes Motorway including bridges (BFMP-Transport for New South Wales [BFMP-TfNSW]).
- Old Princes Highway (BFMP-Wollongong City Council [BFMP-WCC]).
- Water mains (BFMP-Sydney Water [BFMP-SYDWATER]).
- Transmission lines and towers (BFMP-Endeavour Energy [BFMP-END] and BFMP-TransGrid [BFMP-TRA).
- Telecommunication cables (BFMP-Telstra [BFMP-TELSTRA], and BFMP-Optus [BFMP-OPTUS]).
- Telecommunication towers and compounds (BFMP-TELSTRA, BFMP-Axicom [BFMP-AXICOM] and BFMP-Sydney Trains [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.

6.7.1 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

Inspections of house structures will be conducted prior to the commencement of Longwall 305 extraction and within three months following the completion of extraction of Longwall 307 to identify any subsidence impacts to the structural integrity:

- Palmer House (A09a).

Aged Care Buildings

Inspections of aged care buildings will be conducted prior to the commencement of Longwall 305 extraction (as agreed with NSW Health) and within 3 months following the completion of Longwall 307 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).

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 305 extraction and within 3 months following the completion of extraction of Longwall 307 to identify any subsidence impacts to the structural integrity and leaks.

Gas Storage Tank

Inspections of the gas storage tank (B01t03) will be conducted prior to the commencement of Longwall 305 extraction (or as otherwise agreed with NSW Health) and within 3 months following the completion of extraction of Longwall 307 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 305 extraction (or as otherwise agreed with NSW Health) and within 3 months following the completion of extraction Longwall 307, 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 305 extraction (or as otherwise agreed with NSW Health) and within 3 months following the completion of extraction of Longwall 307 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.

6.7.2 M1 Princes Motorway including Bridges (BFMP-TfNSW)

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 TfNSW personnel. The frequency of monitoring will be in accordance with the TfNSW inspection program (generally twice/week).

Regular visual inspections will be conducted during mining by representatives of the TfNSW as part of the TfNSW 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 TfNSW Technical Committee.

Culverts

A closed circuit television (CCTV) inspection of the culverts by TfNSW will occur at the completion of Longwall 310, or more frequently if determined in consultation with the TfNSW 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 TfNSW.

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 TfNSW risk ranking.

A site inspection of the cuttings will be conducted following the completion of Longwall 307, or more frequently if determined in consultation with the TfNSW Technical Committee. The site inspection will be conducted by representative(s) from the TfNSW. A report will be prepared by the TfNSW following the 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 extraction by representatives of the TfNSW as part of the TfNSW 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 TfNSW 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 Longwalls 305-307 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 Longwalls 305 and Longwall 306 up until 3 August 2021. The FBG system was decommissioned during the extraction of Longwall 306 after consideration of some 14 months of monitoring results by the TfNSW Technical Committee (TC2-21, 3 August 2021) that deemed it no longer required because of comparable results from the GNSS unit operating in tandem with the FBG system. Absolute monitoring continues at Bridge 2 with the GNSS system.

The existing system established for relative 3D survey of Bridge 2 using conventional survey equipment will be retained for Longwalls 305-307. Survey of Bridge 2 targets will occur:

- prior to extraction of Longwall 305; and
- if triggered by absolute movement recorded at GNSS #3 greater more than 50 mm of horizontal movement.

Monitoring frequency of Bridge 2 will be reviewed if:

- absolute horizontal movement of Real Time (3D) continuous monitoring site #3 indicates more than 50 mm of horizontal movement;
- visual inspection indicates cracking; or
- if otherwise determined in consultation with the TfNSW Technical Committee.

It is envisaged by the TfNSW Technical Committee that the frequency of conventional survey monitoring, after 50 mm of absolute movement is measured at GNSS Site #3 will be weekly. The frequency may be reduced following review of data by the TfNSW Technical Committee.

Visual inspection of Bridge 2 will be conducted at the completion of Longwall 307 or otherwise if determined in consultation with the TfNSW Technical Committee.

Cawley Road Overbridge

A visual inspection of the Cawley Road Overbridge will be conducted prior to the extraction of Longwall 305. Visual inspections of Cawley Road Overbridge will be conducted at the completion of Longwall 307 or otherwise if determined in consultation with the TfNSW Technical Committee.

The existing system established for relative 3D survey of Cawley Road Overbridge using conventional survey equipment will be retained for Longwalls 305-307. Survey of Cawley Road Overbridge targets will occur:

- prior to extraction of Longwall 305; and
- if triggered by absolute movement recorded at GNSS #9 greater more than 30 mm of horizontal movement.

Monitoring frequency of Cawley Road Overbridge will be reviewed if:

- absolute horizontal movement of Real Time (3D) continuous monitoring, GNSS #9, indicate more than 30 mm of horizontal movement;
- visual inspection indicates cracking; or
- if otherwise determined in consultation with the TfNSW Technical Committee.

It is envisaged by the TfNSW Technical Committee that the frequency of conventional survey monitoring, after 30 mm of absolute movement is measured, site #9, will be weekly. The frequency may be reduced following review of data by the TfNSW Technical Committee.

6.7.3 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 305. Weekly visual inspections will occur on commencement of Longwalls 305 and 306 along the highway to a position of 400 m in front of the face.

The Old Princes Highway will be visually inspected within three months of the completion of each longwall.

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 Longwalls 305 and 306. 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. Fortnightly survey of the highway at PH30 and PH32 will be undertaken on commencement of Longwall 307 to confirm no sustained increase in incremental tensile strain. The Old Princes Highway will be surveyed within three months of the completion of each Longwall.

6.7.4 Waterfall General [Garrawarra] Cemetery

A follow up audit be undertaken 2 years after Longwall 304 completion (in 2022) to review any longer-term effects.

6.7.5 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 305 and following completion of Longwall 305 and 306 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 on commencement of Longwalls 305 and 306 for the first 400 m of extraction until subsidence reduces below the level of survey accuracy. 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;
- 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.

6.7.6 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 Longwalls 305-307 secondary extraction. Notwithstanding, subsidence monitoring will continue for Longwalls 305-307 given the significance of the infrastructure.

A pre-Longwall 305 survey will be completed to record the following survey of tower legs and associated ground points (TL11-104 to TL11-108).

Surveys at 2 month intervals during Longwall 305 and after each longwall will be conducted at each tower (relative) 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 Longwalls 305-307 extraction at towers TL11-104, 105 and 106. Absolute survey monitoring at the TransGrid towers forms part of the TransGrid BFMP and other associated BFMP including BFMP-TfNSW and BFMP-Endeavour.

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.

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 Longwalls 305-307 secondary extraction, located further east than TransGrid infrastructure. Subsidence monitoring will continue for Longwalls 305-307 given the significance of the infrastructure.

A pre-Longwall 305 survey will be completed to record the following survey of tower legs and associated ground points (F9132B-T8 to F9132B-T12).

Survey at 2 monthly survey intervals will be conducted at each tower (relative) during the extraction of Longwall 305 and after each longwall 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 Longwalls 305-307 extraction at adjacent TransGrid towers (TL11-104, 105 and 106). Absolute survey monitoring at the TransGrid towers forms part of the TransGrid BFMP and other associated BFMPs including BFMP-TfNSW, 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.

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 poles[4] and powerlines will be conducted prior to commencement of Longwalls 305-307.

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 Longwalls 305-307, 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.

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

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.

6.7.7 Telecommunication Cables (BFMP-TELSTRA, BFMP-OPTUS)

Fibre Optic Cables

Fibre cables operated by each of the communication companies are in separate conduits in the same trench. No optical fibre cables directly overlie Longwalls 305-307. 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 surveys will be conducted for the Optus fibre optic local cable upon commencement of Longwall 305 extraction for the first 400 m of extraction. Surveys will continue until movement stabilises.

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 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) at the start, middle and completion of Longwall 305, and at the completion of Longwall 307.

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.

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.

6.7.8 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 305;
- weekly during the commencing 400 m of extraction of Longwall 305 until subsidence is no longer detectable; and
- within 3 months following the completion of extraction of each longwall.

Axicom Telecommunication Towers and Compounds

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

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

- prior to extraction of Longwall 305;
- weekly during the commencing 400 m of extraction from Longwalls 305; and
- within 3 months following the completion of extraction of each of Longwalls 305, 306 and 307.

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 305;
- weekly during the commencing 400 m of extraction of Longwall 305 until the level of subsidence is no longer detectable; and
- within 3 months following the completion of extraction of each longwall.

6.8 ACCESS ROADS/TRACKS

Visual inspection of the access roads/tracks will be conducted prior to the commencement of Longwall 305, and following extraction of each longwall panel.

Visual observations of access roads/tracks would occur as part of routine works and inspections within 600 m of Longwalls 305-307 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 and HMP) in accordance with Condition 3, Schedule 7 of the Project Approval.

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).*

Mine Subsidence Engineering Consultants (2020) *Metropolitan Mine – Modified commencing end Longwall 307 Mine Subsidence Overview.*

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

METROPOLITAN MINE
Longwalls 305-307 Extraction Plan: Plan 7 - Subsidence Monitoring

DRAWING No M200131 P7

DATE	DRAWN	SHEET	OF	SCALE
31/01/2020	Survey Dept.	1	1	1:4000

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METROPOLITAN COAL PTY LTD
METROPOLITAN MINE
PO BOX 402
HELENSBURGH 2508

CLIENT/PROJECT | SURVD/DESGD | CHECKED | AUTHORISED

Peabody

Mining Engineering Manager Date | Registered Mine Surveyor Date

MGA

LEGEND

- Existing Workings
- Proposed Extraction Area - LW305-LW307 -Mining Height 2.6m - 3.2m
- Proposed MG305-MG307 First Workings
- Future Workings
- Existing Subsidence Monitoring
- Existing Subsidence Monitoring (xx)
- Proposed infrastructure Monitoring
- Woronora Reservoir
- Woronora Notification Area
- Princes Highway
- M1 Princes Motorway
- Vehicular Track
- Surface Contours
- Streams
- Optus Optic Fibre Line
- Telstra Optic Fibre Line
- Vocus Optic Fibre Line
- TransGrid 330kV Transmission Line
- 132kV Transmission Line
- Water Mains
- Survey Marks
- Swamps (S25)
- Aboriginal Heritage Sites (FRC 21)
- Cliffs and Overhangs (COH13)
- Crown Land (Road Reserves)
- 600m from LW's 305-307 Secondary Extraction
- Extraction Plan Study Area/35d Angle of Draw and/or Predicted 20mm Total Subsidence
- Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion Endangered Ecological Community
- Steep Slopes (Project Approval)
- Built Features
- CCL 703
- ML 1702

ML1702
CCL 703
WORONORA RESERVOIR
NORTHERN CLOSURE LINE
GNSS Site36
Woronora Notification Area
SEWER MAINS
Princes Highway
PRINCES HWY
CAWLEYS CREEK
GARRAWARRA LINE UPPER
GARRAWARRA LINE LOWER
GNSS Site37
GNSS Site28
GNSS Site29
GNSS Site34
Optic / Water Line
GARRAWARRA RESERVOIR WS0406
Tower Monitoring
GNSS Site10
FIRE RD 9E
OLD ILLAWARRA RD
GNSS Site25
300XL CLOSURE LINE UPPER 1
300 MAINS Line
GNSS Site26
300XL CLOSURE LINE UPPER 2
GNSS Site27
LONGWALL 307
LONGWALL 306
LONGWALL 305
LONGWALL 304
LONGWALL 303
LONGWALL 302
LONGWALL 301
Princes Highway Line
GNSS Site16
GNSS Site6
GNSS Site14
Princes Highway Line
Optic / Water Line
GNSS Site5
M1 North Bound Line
F27 LINEAMENT MONITORING
GNSS Site30
GNSS Site31
ETAU High Precision Survey site
EAU MONITORING
GNSS Site22
ETAU
GNSS Site32
GNSS Site23
ETAT
GNSS Site21
ETAR
ETAQ
GNSS Site24
EASTERN CLOSURE LINE UPPER 2
EASTERN CLOSURE LINE UPPER 1
GNSS Site4
GNSS Site3
WARATAH CLOSURE LINE
GNSS Site33
W Cross Line
V Cross Line
U Cross Line
T Cross Line
S Cross Line
R Cross Line
Q Cross Line
WARATAH RIVULET
300 MAINS
Freeway Bridge 2 FBG Monitoring
GNSS Site1
GNSS Site2
TL11 102
TL11 101
F9132B-T13
F9132B-T14
F9132B-T15
WILSONS CREEK
RAJANI RD
ALMA RD
SAWAN ST
WILTONA PL
FIRE RD 9G
FIRE RD 9J
LONGWALL 27
LONGWALL 26
LONGWALL 25
LONGWALL 24
Woronora Notification Area
MG307
MG306
MG305
MG304
MG302
MG301
MG27
MG26
MG25
EASTERN TRIBUTARY
NORTH TRIBUTARY
6218000
6217000
6216000
6215000
312000
313000
311000