



UG4 LONGWALLS 401 TO 408 SUBSIDENCE MONITORING PROGRAM

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Attachment 2	Plans 1 to 7 (in Accordance with the Department of Planning and Environment and Division of Resources and Energy [2015] draft <i>Guidelines for the Preparation of Extraction Plans</i>)

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1.0 INTRODUCTION

The Moolarben Coal Complex is an open cut and underground coal mining operation located approximately 40 kilometres north of Mudgee in the Western Coalfield of New South Wales (NSW) (**Figure 1**).

Moolarben Coal Operations Pty Ltd (MCO) is the operator of the Moolarben Coal Complex on behalf of the Moolarben Joint Venture (Moolarben Coal Mines Pty Ltd [MCM], Yancoal Moolarben [YM] Pty Ltd and a consortium of Korean power companies). MCO, MCM and YM are wholly owned subsidiaries of Yancoal Australia Limited.

The Moolarben Coal Complex comprises four approved open cut mining areas (OC1 to OC4), three approved underground mining areas (UG1, UG2 and UG4) and other mining related infrastructure (including coal processing and transport facilities) (**Figure 2**). Since the commencement of coal mining operations in 2010, mining activities have occurred within OC1, OC2, OC3, OC4, and UG1 (**Figure 2**).

The UG4 Underground Mine (UG4) is a component of the Moolarben Coal Project Stage 1 Approval (05_0117) (**Figure 2**). First workings for UG4 North Mains commenced in October 2020 (**Figure 3**). Secondary extraction in UG4 of the first Longwall LW401 is scheduled to commence in 2022.

Mining operations at the Moolarben Coal Complex are currently approved until 31 December 2038 in accordance with Project Approval (05_0117) (Moolarben Coal Project Stage 1) (as modified) and Project Approval (08_0135) (Moolarben Coal Project Stage 2) (as modified), granted under the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act).

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1.1 PURPOSE AND SCOPE

This UG4 Longwalls 401 to 408 Subsidence Monitoring Program (LW401-408 SMP) forms a part of the Extraction Plan for Longwalls 401 to 408 (herein referred to as Longwalls 401-408) of the approved UG4 Underground Mine. This LW401-408 SMP has been prepared by MCO, with input from Mine Subsidence Engineering Consultants [MSEC], to satisfy Schedule 3, Condition 77(m) of Project Approval (05_0117) and the NSW Department of Planning and Environment (DP&E) and NSW Division of Resources and Energy (DRE) (2015) draft *Guidelines for the Preparation of Extraction Plans*.

This LW401-408 SMP has been prepared by MCO with input from suitably qualified experts (WRM Water & Environment [WRM] [surface water], AGE [groundwater], Niche Environment and Heritage (Niche) and Mine Subsidence Engineering Consultants [MSEC]). The appointment of the team of suitably qualified and experienced persons was endorsed by the Secretary of the DPE on the 26 April 2021 (Attachment 2 of the Extraction Plan).

In summary:

Purpose: This LW401-408 SMP describes the subsidence monitoring program (subsidence impacts and subsidence effects) that forms part of the overall management of the consequential environmental impacts associated with the extraction of Longwalls 401-408.

Scope: This LW401-408 SMP covers areas within and proximal to the Longwalls 401-408 Study Area¹ (**Figure 3**).

Longwalls 401-408 form part of the approved UG4 Underground Mine at the Moolarben Coal Complex.

1.2 STRUCTURE OF THE LONGWALLS 401 TO 408 SUBSIDENCE MONITORING PROGRAM

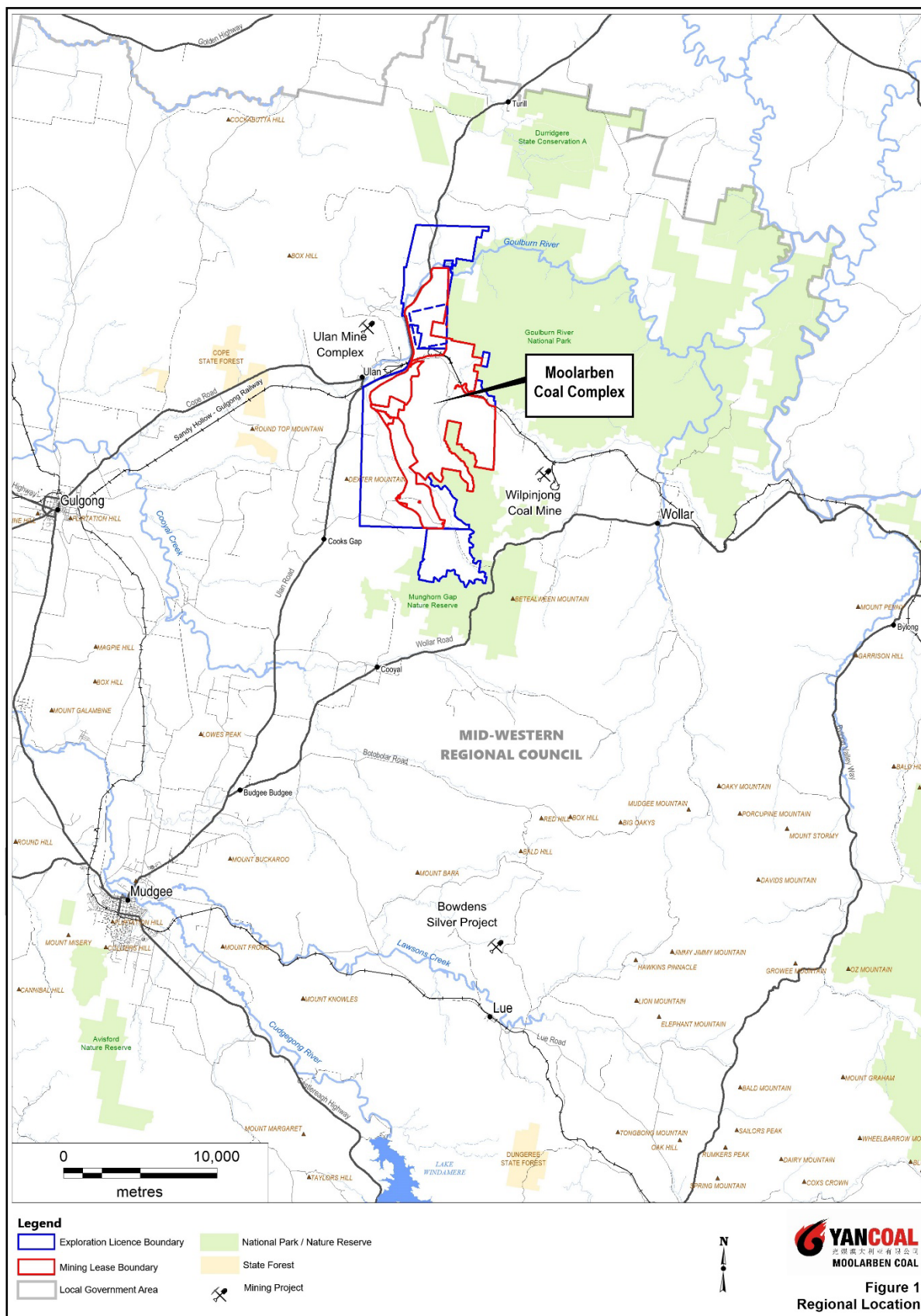
The remainder of the LW401-408 SMP is structured as follows:

- Section 2** Describes the LW401-408 SMP revision status.
- Section 3** Outlines the statutory requirements applicable to the LW401-408 SMP.
- Section 4** Describes the Longwalls 401-408 extraction layout and schedule.
- Section 5** Describes the natural and built features at the surface.
- Section 6** Summarises the predicted subsidence parameters and impacts for the longwalls.
- Section 7** Describes the monitoring program.
- Section 8** Describes the program to analyse subsidence effects, subsidence impacts, and environmental consequences.
- Section 9** Describes the roles and responsibilities for MCO personnel and key contacts.
- Section 10** Lists the references cited in this LW401-408 SMP.

¹ Longwalls 401-408 and the area of land within the furthest extent of the 26.5 degree (°) angle of draw and 20 millimetres (mm) predicted subsidence contour.

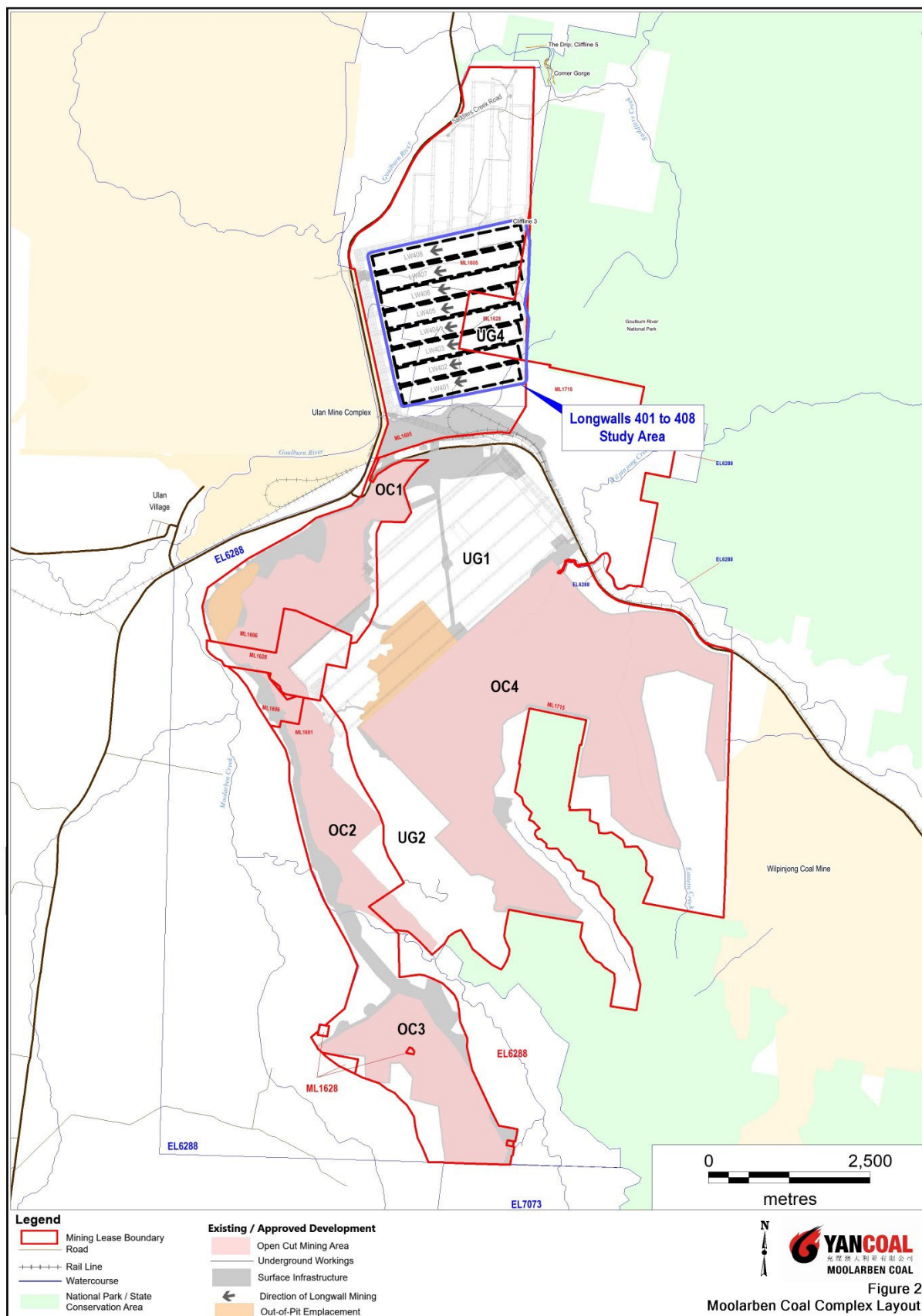
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Figure 1: Regional Location



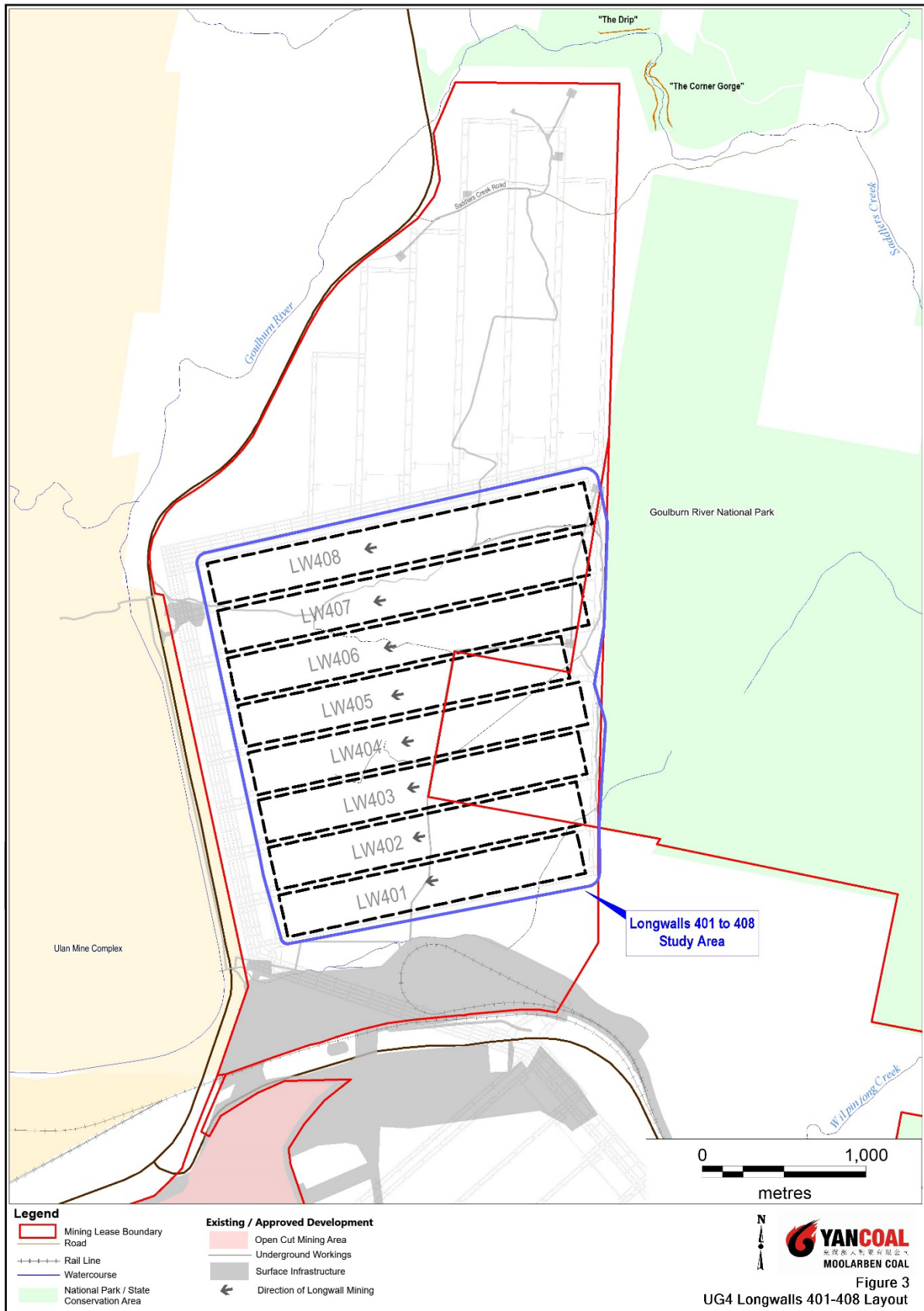
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Figure 2: Moolarben Coal Complex Layout



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Figure 3: Underground 4 Longwalls 401 to 408 Layout



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2.0 SUBSIDENCE MONITORING PROGRAM REVIEW AND UPDATE

In accordance with Condition 5, Schedule 5 of Project Approval (05_0117), this LW401-408 SMP will be reviewed as followed:

5. *Within 3 months of the submission of:*
 - (a) *the submission of annual review under condition 4 above;*
 - (b) *the submission of an incident report under condition 7 below;*
 - (c) *the submission of an audit under condition 9 below; or*
 - (d) *any modification of this approval,*

the Proponent shall review and, if necessary, revise the strategies, plans, and programs required under this approval to the satisfaction of the Secretary. Where this review leads to revisions in any such document, then within four weeks of the review the revised document must be submitted to the Secretary for approval.

2.1 ACCESS TO INFORMATION

In accordance with Condition 11, Schedule 5 of Project Approval (05_0117), MCO will make the approved LW401-408 SMP publicly available on the MCO website.

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3.0 STATUTORY REQUIREMENTS

MCO's statutory obligations are contained in:

- the conditions of the NSW Project Approval (05_0117) (as modified) and NSW Project Approval (08_0135) (as modified);
- the conditions of Commonwealth Approvals (EPBC 2007/3297, EPBC 2013/6926, EPBC 2008/4444 and EPBC 2017/7974);
- relevant licences and permits, including conditions attached to the Environment Protection Licence (EPL No. 12932) and MLs (i.e. ML 1605, ML 1606, ML 1628, ML 1691 and ML 1715); and
- other relevant legislation.

Obligations relevant to this LW401-408 SMP are described below.

3.1 EP&A ACT PROJECT APPROVAL

Condition 77(m), Schedule 3 of Project Approval (05_0117) requires the preparation of a Subsidence Monitoring Program (i.e. this LW401-408 SMP) as a component of the Extraction Plan. Condition 77(m), Schedule 3 of Project Approval (05_0117) states:

SUBSIDENCE

...

Extraction Plan

77. The Proponent shall prepare and implement an Extraction Plan for all second workings on site to the satisfaction of the Secretary. Each extraction plan must:

...

(m)include a Subsidence Monitoring Program, which has been prepared in consultation with Resources Regulator, to:

- *describe the on-going subsidence monitoring program;*
- *provide data to assist with the management of the risks associated with subsidence;*
- *validate the subsidence predictions;*
- *analyse the relationship between the predicted and resulting subsidence effects and predicted and resulting impacts under the plan and any ensuing environmental consequences; and*
- *inform the contingency plan and adaptive management process.*

The following graphical plans have been prepared in accordance with the DPE and RR (2015) draft *Guidelines for the Preparation of Extraction Plans* and are provided in **Attachment 1**:

- Plan 1: Extraction Plan Area and Mining Layout.
- Plan 2: Surface Features.
- Plan 3: Seam Geology.
- Plan 4: Seam Geology and Future Workings.
- Plan 5: Mining Titles and Land Ownership.
- Plan 6: Geological Sections.
- Plan 7: Subsidence Monitoring.

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The documents MSEC (2021) include predictions of the conventional and non-conventional subsidence impacts and subsidence effects of the Extraction Plan, incorporating any relevant information that has been obtained since Project Approval.

This LW401-408 SMP outlines the subsidence monitoring program prepared to satisfy that component of Condition 77(m), Schedule 3 of Project Approval (05_0117) relating to subsidence monitoring. The LW401-408 SMP is, among other things, designed to compare and validate the subsidence predictions outlined in MSEC (2021).

3.2 OTHER LEGISLATION

MCO will operate the Moolarben Coal Complex consistent with Project Approval (05_0117) and any other legislation that is applicable to an approved Part 3A Project under the *Environmental Planning and Assessment (EP&A) Act 1979*.

The Acts which may be applicable to the conduct of the Moolarben Coal Complex include, but are not limited to:

- *Crown Lands Act, 1989;*
- *Fisheries Management Act, 1994;*
- *Heritage Act, 1977;*
- *Coal Mine Subsidence Compensation Act, 2017;*
- *Mining Act, 1992;*
- *National Parks and Wildlife Act, 1974;*
- *Biodiversity Conservation Act, 2016;*
- *Protection of the Environment Operations Act, 1997;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Work Health and Safety Act, 2011;* and
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

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

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4.0 LONGWALLS 401-408 EXTRACTION LAYOUT AND SCHEDULE

Longwalls 401-408 and the area of land within the furthest extent of the 26.5° angle of draw and 20 mm predicted subsidence contour (i.e. the Longwalls 401-408 Study Area) are shown on **Figure 3**. Longwall extraction will occur from the east to the west. The longwall layout includes approximately 260 m panel widths (void) with 35 m width pillars (solid). The provisional extraction schedule for Longwalls 401-408 is provided in **Table 1**.

Table 1 Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration (months)	Estimated Completion Date
LW401	June 2022	4	October 2022
LW402	November 2022	4	March 2023
LW403	April 2023	4	August 2023
LW404	August 2023	5	January 2024
LW405	February 2024	4	June 2024
LW406	July 2024	5	December 2024
LW407	January 2025	4	May 2025
LW408	June 2025	4	November 2025

4.1 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

Revised predictions of the potential subsidence effects, subsidence impacts and environmental consequences of the proposed second workings, have been prepared by MSEC, incorporating any relevant information obtained since approval. Revised predictions have considered the results from nearby UG1 Longwall extraction.

Mine Subsidence Engineering Consultants (MSEC) were engaged by MCO to prepare a revised subsidence report to support the Extraction Plan for Longwalls 401 to 408 in June 2021. The predictions and impact assessments provided in this Extraction Plan are based on the Extraction Plan Layout (**Figure 3**) and the reduced extraction cut height of 3.0m, as presented in the *Subsidence Predictions and Impact Assessment for Longwalls 401 to 408* (MSEC, 2021) (**Technical Report 1**). A comparison of the maximum predicted subsidence parameters resulting from the extraction of Longwalls 401 to 408 (the Extraction Plan Layout), with those based on the Approved Layout is provided in Table 8 of the Extraction Plan and Technical Report 1. MSEC concluded that the maximum predicted total subsidence parameters based on the Approved Layout are the same as those for the Extraction Plan Layout for Longwalls 401 to 408 (MSEC, 2021). Further details related to predicted subsidence impacts are provided in **Section 6.0**.

Monitoring and management recommendations from MSEC and the endorsed suitably qualified experts have been incorporated throughout this LW401-408 SMP.

Further description of the geology, seam structure, seam thickness, and depth of cover is provided in MSEC (2021) and the Extraction Plan.

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5.0 SURFACE FEATURES INCLUDED IN THE MONITORING PROGRAM

5.1 THE LONGWALLS 401-408 STUDY AREA

Mine Subsidence Engineering Consultants (MSEC) has prepared a subsidence impact assessment report to support the Extraction Plan for Longwalls 401 to 408 (**Technical Report 1**).

The Study Area (**Figure 3**) for the Extraction Plan is defined as the surface area that is likely to be affected by the proposed mining of Longwalls 401 to 408 (Extraction Plan Layout) in the Ulan Seam. The extent of the Study Area has been calculated by MSEC combining the areas bounded by the following limits:

- The 26.5° angle of draw line;
- The predicted vertical limit of subsidence, taken as the 20 mm subsidence contour; and
- Features sensitive to far-field movements.

As the depth of cover above the longwalls varies between 83 and 205 m, the 26.5° angle of draw line has been conservatively determined by drawing a line around the outer edge of the longwall voids at a horizontal distance that varies between 42 and 103 m

There are features that lie outside the defined Longwalls 401-408 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 also been included in the assessments provided in MSEC (2021).

There are a number of natural and built features that have been identified within the Study Area including ephemeral drainage lines (Bora Creek, DL1 and DL2), native vegetation, MCO infrastructure (i.e. dewatering bores, pipelines, electrical cables, groundwater monitoring sites, exploration drill holes, unsealed tracks and farm dams), Aboriginal heritage sites and a privately owned quarry .

Natural features that have been identified outside the Study Area include the Goulburn River, The Drip and the Goulburn River Gorge, cliffs, native vegetation and Aboriginal heritage sites. There are no historic heritage sites within or in the vicinity of the Study Area.

There are a number of built features that have been identified outside the Study Area including assets owned by ARTC, MWRC, Telstra, Essential Energy, TransGrid, State Survey control marks, UCMPL, and MCO.

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5.2 NATURAL FEATURES

5.2.1 Drainage Lines

There are no perennial streams within the Study Area. The only named stream within the Study Area is Bora Creek, which is an ephemeral stream and is located above the commencing ends of Longwalls 401 and 402. A number of other small ephemeral drainage lines (DL1 and DL2) have been identified above the longwalls and within the Study Area. The drainage lines located across the study area are likely to be subjected to the full range of predicted systematic subsidence and valley related movements (MSEC, 2021).

5.2.2 Goulburn River

The Goulburn River Diversion is located on the western side of Longwalls 401 to 408 at distances of 425 m to 500 m from the longwall finishing ends. The distances to the Goulburn River Diversion represent about 5 to 6 times the depth of cover from Longwalls 401 to 408. At these distances conventional mine subsidence ground movements and valley related movements are expected to be less than limits of survey accuracy. However, the river may experience far-field horizontal movements (MSEC, 2021).

5.2.3 Groundwater

There is no 'highly productive' groundwater, as defined under the NSW Aquifer Interference Policy, mapped in the vicinity of the Moolarben Coal Complex. The nearest 'highly productive' groundwater is a portion of the alluvial aquifer associated with Wilpinjong Creek downstream of the Wilpinjong Coal Mine. The aquifers in the vicinity of LW401-408 are "less productive" as per the Aquifer Interference Policy (AIP) classification.

There are no high priority culturally significant sites listed in the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009. However, a spring known as The Drip is a groundwater dependent ecosystem (GDE) with local cultural significance located over 2km from LW401-408. The groundwater seepage is observed in a cliff on the northern side of the Goulburn River. The seepage is derived from the perching of groundwater in the Triassic Narrabeen Group sediments above less permeable horizons in the Triassic sequence to the north of the Goulburn River. The perched aquifer is effectively disconnected from the underling regional watertable and neither depressurisation of the lower hydrostratigraphic units, or a lowering of the regional water table caused by mining at LW401 to 408 will impact the water supply to The Drip.

5.2.4 Cliffs

The definitions of a cliffs provided in the NSW DP&E Standard and Model Conditions for Underground Mining (DP&E, 2012) are:

"Cliff Continuous rock face, including overhangs, having a minimum length of 20 metres, a minimum height of 10 metres and a minimum slope of 2 to 1 (>63.4°)"

A detailed assessment of cliffs and minor cliffs was carried out using 1 m surface level contours generated from a Light Detection and Ranging (LiDAR) survey and from site investigations (MSEC, 2021).

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There are no cliffs located within the Study Area, the nearest cliff is CL3. Cliff Line CL3 is located outside the Study Area and is 165 m to 440 m from Longwall 408. At this distance conventional mine subsidence ground movements and valley related movements are expected to be less than limits of survey accuracy (MSEC, 2021). Minor cliffs are located within the Goulburn River National Park to the east of LW401 to 408. An assessment of surface features carried out for the Goulburn River National Park identified no features considered to be sensitive to far-field movements (MSEC 2021).

5.2.5 The Drip & Goulburn River Gorge

The Drip and Corner Gorge (also called Goulburn River Gorge) are located over 2.7 km and 2.2 km respectively from Longwall 408. At over 2.2 km from Longwall 408, The Drip and Corner Gorge will not experience measurable conventional tilts, curvatures or strains from the extraction of Longwalls 401 to 408.

5.2.6 Land in General

Land in general includes other land features such as fire trails and vehicular tracks, however excludes surface features such as drains, diversions, and other MCO assets. Unsealed vehicular tracks and fire trails are located throughout the UG4 Study Area and above Longwalls 401- 408 and are predicted to experience the full range of predicted subsidence movements (MSEC, 2021).

5.2.7 Biodiversity

Plant community type (PCT) 281 located within the Study Area is consistent with the threatened ecological community (TEC), *White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions*.

No threatened flora species were detected within the study area during the Stage 1 EIS (Moolarben Biota 2006) or Moolarben Coal Complex UG4 Ancillary Works Modification Biodiversity Development Assessment Report (ELA 2019). A population of *Androcalva procumbens* (Vulnerable, BC Act and EPBC Act) were identified during the previous surveys undertaken by ELA and were confirmed by Niche during the baseline assessment and vegetation validation survey (Niche, 2021).

Ecological surveys undertaken for the Stage 1 EIS (Moolarben Biota 2006) and subsequent surveys identified the following threatened fauna species on or adjacent to the study area:

- Mammals
 - Corben's Long-eared Bat *Nyctophilus corbeni* (Vulnerable, EPBC Act and BC Act) formerly Greater Long-eared Bat *Nyctophilus timoriensis*
 - Eastern Cave Bat *Vespadelus troughtoni* (Vulnerable, BC Act)
 - Large Bent-winged Bat *Miniopterus orianae oceanensis* (Vulnerable, BC Act) formerly Eastern Bentwing-bat
 - Large-eared Pied Bat *Chalinolobus dwyeri* (Vulnerable, EPBC Act and BC Act)
 - Yellow-bellied Sheath-tail Bat *Saccolaimus flaviventris* (Vulnerable, BC Act)
- Birds
 - Black-chinned Honeyeater – eastern subspecies *Melithreptus gularis gularis* (Vulnerable, BC Act)

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- Brown Treecreeper – eastern subspecies *Climacteris picumnus victoriae* (Vulnerable, BC Act)
- Diamond Firetail *Stagonopleura guttata* (Vulnerable, BC Act)
- Dusky Woodswallow *Artamus cyanopterus cyanopterus* (Vulnerable, BC Act)
- Gilbert’s Whistler *Pachycephala inornata* (Vulnerable, BC Act)
- Glossy Black Cockatoo *Calyptorhynchus lathami* (Vulnerable, BC Act)
- Hooded Robin – south-eastern form *Melanodryas cucullata cucullata* (Vulnerable, BC Act)
- Painted Honeyeater *Grantiella picta* (Vulnerable, BC Act and EPBC Act)
- Powerful Owl *Ninox strenua* (Vulnerable, BC Act)
- Speckled Warbler *Cthonicola sagittata* (Vulnerable, BC Act)
- Square-tailed Kite *Lophoictinia isura* (Vulnerable, BC Act)
- Varied Sittella *Daphoenositta chrysoptera* (Vulnerable, BC Act).

5.3 PUBLIC UTILITIES

5.3.1 ARTC

The shortest distance from the Extraction Plan Layout to the Sandy Hollow – Gulgong Railway Line is 660 m. A rail loop owned and operated by MCO is located a minimum distance of 230 m from Longwall 401. The depth of cover along the southern side of Longwall 401 varies from approximately 83 m to 155 m. At 660 m from Longwall 401, the distance to the railway line equates to approximately 5 to 8 times the depths of cover from the Extraction Plan Layout (MSEC, 2021).

At distances of 660 m or greater between the longwalls and the ARTC railway track and based on the depths of cover, the ARTC rail track will not be subjected to measurable conventional mine subsidence ground movements (i.e. less than limits of survey accuracy) (MSEC, 2021); however, the railway line may experience far-field horizontal movements.

5.3.2 MWRC

MWRC infrastructure in the vicinity of Longwalls 401 to 408 includes Ulan Road, Ulan Road bridge (over the Sandy Hollow Gulgong Railway), Ulan-Wollar Road and Ulan Road bridge (over the Goulburn River).

Ulan Road is a sealed bitumen pavement with no kerb and gutter located to the west of Longwalls 401 to 408. The road is approximately parallel with the finishing ends of the longwalls and is approximately 360 m or more from the longwall voids. Features along the road include cuttings in sandstone bedrock, 3 m to 15 m high. Culverts beneath Ulan Road range from 400 mm to 1500 mm diameter concrete pipes with the largest pipes located at Bora Creek to the south west of Longwall 401. The depth of cover along the western side of Longwalls 401 to 408 varies from approximately 83 m to 130 m and the distances to the road from these longwalls equates to 2.9 to 4.5 times the depth of cover (MSEC, 2021).

The bridge over the Sandy Hollow – Gulgong Railway line is over 1 km from the finishing end of Longwall 401. The bridge over the Goulburn River is over 2.3 km from Longwall 408. Both bridges are not sensitive to far field movements due to their respective distances away from Longwalls 401 to 408 (MSEC, 2021)

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5.3.3 Essential Energy

The Essential Energy (EE) infrastructure in the vicinity of Longwalls 401 to 408 comprises of a 22kV powerline supply to a telecommunications tower, approximately 400 m from Longwall 401 at its nearest point. The depth of cover along the western end of Longwall 401 varies from approximately 83 m to 120 m which equates to 3.3 to 5 times the depths of cover from Longwall 401 (MSEC, 2021).

The 22kV powerline is fed from a dual circuit 66kV/22kV powerline supported on timber poles located further south along Ulan Road and Ulan Wollar Road, approximately 700m away from Longwall 401 at its nearest point (MSEC, 2021).

5.3.4 Telstra

Telstra infrastructure in the vicinity of the Study Area includes an optical fibre cable, a copper cable and a telecommunications tower.

Copper cables are located along Ulan road to the west of Longwall 401 to 408 and to the South along Ulan-Wollar Road. The nearest point of the copper cables along Ulan Road is approximately 310 m from the finishing ends of LW402 to 406. Optical fibre cables are located to the south west of the Longwall 401 to 408 along Ulan Road, and to the south along Ulan-Wollar Road. A telecommunications tower is located 410 m to the west of the finishing end of Longwall 401. The nearest point of the optical fibre cables is 390 m from Longwall 401 (MSEC, 2021).

At distances of 310 m or more to the copper cables along Ulan Road and 390 m or more to the optical fibre cables and tower, the cables and tower are not anticipated to experience measurable conventional mine subsidence ground movements (i.e. less than limits of survey accuracy) (MSEC, 2021); however, the cables may experience far-field horizontal.

5.3.5 Survey Control Marks

There are no survey control marks identified within the Study Area. The survey marks are predominantly located along road and railway easements. At these locations the survey marks will not be subjected to measurable conventional mine subsidence ground movements due to the Extraction Plan Layout; however, they may experience far-field horizontal movements. It will be necessary on the completion of the longwalls, i.e. when the ground has stabilised, to re-establish the exact location of the survey marks (MSEC, 2021).

5.3.6 TransGrid

A 330kV electricity transmission line owned by TransGrid is located to the south of the Study Area. The nearest tower of the 330kV powerline to the longwalls is 725 m from Longwall 401. At distances of 725 m or more between the longwalls and the transmission line towers, the towers will not be subjected to measurable conventional mine subsidence ground movements (i.e. less than limits of survey accuracy). The towers may experience minor far-field horizontal movements however, the movements are expected to be less than the limits of survey accuracy. Monitoring of transmission towers at similar distances from UG1 did not measure horizontal movements greater than the levels of survey accuracy (MSEC, 2021).

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5.4 PRIVATELY OWNED BUILT FEATURES

5.4.1 UCML

The Millers Dam Compound is located to the west of Longwalls 406 and 407, including three dams D8, D9 and D10 located 200m to 300m from the longwalls. Other features located 320 m to 350 m from the longwalls include a reverse osmosis plant, two above ground concrete storage tanks, telecommunications tower, cyclone fencing, and pipes and power lines. The overhead powerlines to the Millers Dam Compound are supported on timber poles and are located on the western side of Ulan Road at approximately 400 m from the longwalls. The nearest groundwater bore is located 430 m from Longwall 408. Monitoring piezometers PZ15 to PZ18 are located between the UCML East Pit to the west and the Goulburn River Diversion to the East. The bridge over the Goulburn River diversion is located 470 m from Longwall 408, (MSEC, 2021)

At distances of 200 m or more between the longwalls and the Millers Dam Compound, the site features will not be subjected to measurable conventional mine subsidence ground movements (i.e. less than limits of survey accuracy); however, the site features may experience far-field horizontal movements (MSEC, 2021).

5.4.2 DRONVISA QUARRY

The Dronvisa Quarry is located partially within the Study Area includes extraction pits, water management structures, and associated infrastructure. The Dronvisa Quarry is a gravel/clay quarry located to the west of the finishing ends of Longwalls 403 to 405 with part of one active pit located above Longwall 404 and 405.

The areas of the quarry located outside the Study Area boundary are not expected to be subjected to measurable conventional vertical subsidence, tilt, curvature or strain. However, the features may experience far-field horizontal movements.

The current and future areas of the quarry located above the longwalls will experience the full range of predicted conventional subsidence movements. Potential impacts to the quarry pits include cracking, stepping and rippling associated with ground surface deformation as the longwalls are extracted beneath. Batter stability may also be impacted if steep batters are present above the extracted longwalls. Increased surface ponding is also expected in areas with low surface grades (MSEC, 2021).

5.5 MCO BUILT FEATURES

MCO's Coal Handling and Preparation Plant (CHPP) is located 230 m to 650 m to the south of Longwall 401. the CHPP will not be subjected to measurable conventional mine subsidence ground movements (i.e. less than limits of survey accuracy); however, the site features may experience far-field horizontal movements (MSEC, 2021)

Dewatering infrastructure is located above the Extraction Plan Layout. The dewatering infrastructure includes dewatering bores, water pipelines and electrical cables. Potential impacts could occur as a result of irregular movements such as ground heave, stepping, large cracks, rock falls or tree falls (MSEC,2021).

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Exploration drill sites are located directly above and adjacent to the proposed longwalls and, therefore, could experience the full range of predicted subsidence movements. It is likely, therefore, that fracturing and shearing would occur in the drill holes as the result of mining (MSEC, 2021).

Fences are located within the Study Area and are constructed in a variety of ways, generally using either timber or metal materials. All fences are on MCO owned lands. The fences could experience the full range of predicted subsidence movements. There are five farm dams owned by MCO that have been identified within the Study Area (D6, D7, D11, D12 and D13). The dams are shallow but are no longer in use (MSEC, 2021).

There are a number of MCO owned four wheel drive tracks through the Study Area, These tracks are not publicly accessible. The tracks could experience the full range of predicted subsidence movements. Impacts are expected to include cracking, stepping and rippling of the track surfaces (MSEC, 2021).

5.6 ABORIGINAL HERITAGE

There is a total of 45 Aboriginal Heritage sites within the Study Area. Of these sites, 8 heritage sites comprising of isolated finds or open artefact scatters with/without PAD have been salvaged under existing approvals and are no longer *in situ*.

Aboriginal heritage sites 264, 282, 283, 286 and 287 are located to the north of the Study Area and are unlikely to experience impacts due to the extraction of Longwalls 401 to 408. Site 280 includes a rock shelter, artefacts, art, and grinding grooves and is located centrally above the chain pillar between Longwalls 402 and 403.

The risk of subsidence impacts to Site 280 is low to moderate consistent with the approved impacts, and includes tensile cracks and instabilities. Large scale failure of the rock shelter is not expected to occur and the likelihood of tensile cracks coinciding with the location of the grinding grooves is considered to be low.

Open sites containing artefact scatters and isolated finds can potentially be affected by cracking of the surface soils as a result of mine subsidence movements. It is unlikely that the scattered artefacts or isolated finds themselves would be impacted by surface cracking (MSEC, 2021).

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6.0 SUBSIDENCE PARAMETERS AND SUBSIDENCE IMPACTS DUE TO LONGWALLS 401-408 EXTRACTION

MSEC (2021) 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 the longwalls. The report includes the maximum predicted conventional subsidence parameters for the longwalls 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 401-408 is 1,800mm, with a maximum predicted total conventional subsidence of 1,900mm.

A comparison of the maximum predicted conventional total subsidence parameters, for the Extraction Plan Layout and the Approved Layout for Longwalls 401-408, is provided in MSEC (2021). MSEC (2021) concludes that the maximum predicted total subsidence parameters are the same (e.g. maximum predicted total conventional subsidence of 1,900 mm).

The predictions of conventional subsidence parameters do not include the valley related upsidence and closure movements, nor the effects of faults and other geological structures.

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

MSEC (2021) provides a comprehensive description of the 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 401-408.

Additionally, natural and built features that are located outside the Longwalls 401-408 Study Area, which may be subjected to far-field movements and may be sensitive to the predicted subsidence parameters, were also included in the assessments. Further descriptions are provided in MSEC (2021).

In particular, impact assessments were completed for the following surface features:

- Bora Creek and drainage lines (DL1 and DL2);
- Goulburn River, The Drip and the Goulburn River Gorge;
- cliffs (CL3);
- land in general;
- natural vegetation (including threatened, protected species or critical habitats and EECs);
- MWRC assets;
- ARTC assets;
- MWRC assets;
- Essential Energy assets;

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- Telstra assets;
- survey control marks;
- TransGrid assets;
- UCMPL assets;
- Dronvisa quarry;
- MCO assets; and
- Aboriginal heritage sites.

The monitoring program described in **Section 7** was developed in consideration of the predicted subsidence parameters and subsidence impacts outlined by MSEC (2021) with input from MCO's suitably qualified experts WRM, AGE, and Niche.

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7.0 MONITORING

7.1 OBJECTIVES

The objectives of the subsidence monitoring program are:

- To monitor the subsidence effects associated with Longwalls 401-408 extraction.
- To summarise and consolidate the various monitoring programs presented in each of the key component plans of the UG4 Longwalls 401-408 Extraction Plan. These include:
 - the UG4 Longwalls 401 to 408 Water Management Plan (LW104-408 WMP);
 - the UG4 Longwalls 401 to 408 Land Management Plan (LW104-408 LMP);
 - the UG4 Longwalls 401 to 408 Biodiversity Management Plan (LW401-408 BMP);
 - the UG4 Longwalls 401 to 408 Heritage Management Plan (LW101-408 HMP);
 - the UG4 Longwalls 401 to 408 Built Features Management Plans, including:
 - the UG4 Longwalls 401 to 408 Built Features Management Plan – Essential Energy (LW401-408 BFMP-EE);
 - the UG4 Longwalls 401 to 408 Built Features Management Plan – Australian Rail Track Corporation (LW401-408 BMFP-ARTC);
 - the UG4 Longwalls 401 to 408 Built Features Management Plan – Telstra (LW401-408 BFMP-Telstra);
 - the UG4 Longwalls 401 to 408 Built Features Management Plan – Mid-Western Regional Council (LW401-408 BFMP-MWRC);
 - the UG4 Longwalls 401 to 408 Built Features Management Plan – Ulan Coal Mines Pty Limited (LW401-408 BFMP-UCMPL);
 - the UG4 Longwalls 401 to 408 Built Features Management Plan – Dronvisa Quarry (LW401-408 BFMP-Dronvisa); and
 - the UG4 Longwalls 401 to 408 Public Safety Management Plan (LW401-408 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.

7.2 SUBSIDENCE MONITORING PROGRAM

7.2.1 Subsidence Parameters Monitoring

The subsidence parameters monitoring program for UG4 is summarised in **Table 2**. **Table 2** provides the description, subsidence parameters for monitoring, the frequency and relevant management plan.

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The subsidence parameters monitoring for UG4 includes establishing six ground transect lines (i.e. subsidence lines) and two aerial scan lines as displayed in Plan 7² **Attachment 1**.

The subsidence lines will be composed of survey marks comprised of either stations set in rock or star pickets.

Due to the practicalities of following existing tracks and steep terrain, bends in the survey line may have to be incorporated. Prior to installation of the survey marks, a Ground Disturbance Permit (GDP) must be completed and approved by MCO's Environment and Community Manager (E&C Manager) or delegate to consider the presence of Aboriginal heritage sites and other potentially sensitive features.

Prior to the commencement of LW401, the subsidence lines will be installed and surveyed in three dimensions to establish the distance and nature of ground movements. DV1 and DV2 surveys will be conducted via a combination of on ground subsidence measurements and drone based on the actual quarry progression at the time of subsidence occurring prior to the commencement LW403. UCML infrastructure surveys will be established prior to LW404 and CL3 monitoring will be established prior to LW406.

In addition to subsidence lines, Global Navigation Satellite System (GNSS) monitoring stations will be progressively established at 10 to 15 locations above and adjacent to the UG4 mining domain over the life the UG4. The units will generally be spaced at around 600m to allow for data collection over an appropriate range of distances.

The UG Technical Services Manager is responsible for ensuring the implementation of the subsidence parameters monitoring program as outlined in **Table 2**. The UG Registered Mine Survey is responsible for ensuring the surveys of the ground transects and aerial scans are completed as required by **Table 2** and the data is verified, processed and maintained.

7.2.2 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 Mining Surveyors 2020 (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 Mining Surveyors 2020 (NSW Mines)*. 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 central areas of Longwalls 401-408 to be surveyed to Class "D" using prescribed methods as described in ICSM SP1.

7.2.3 Subsidence Impact and Environmental Consequences Monitoring Components

A summary of the environmental, heritage, land management, built features and public safety monitoring programs implemented by MCO to evaluate the impacts from subsidence within the Study Area of UG4 Longwalls 401-408 is summarised in **Table 3**.

² Draft *Guidelines for the Preparation of Extraction Plans*

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The Environment and Community Manager is responsible for ensuring monitoring, visual inspections and recording data for groundwater, surface water, biodiversity, surface features, and Aboriginal heritage are carried out as outlined in **Table 4**. UG Technical Services Manager is responsible for ensuring monitoring, visual inspections and recording data for built features (MCO owned and non-MCO owned) are carried out as outlined in **Table 4**.

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Table 2 Subsidence Parameter Monitoring Components

Monitoring Component	Description	Frequency	Relevant Management Plan
K Line	Longitudinal monitoring line at Longwall 401 finishing end	- Prior to commencement of Longwall 401 extraction. - Within three months following completion of Longwall 401.	The Extraction Plan
L Line	Longitudinal monitoring line at Longwall 401 commencing end	- Prior to commencement of Longwall 401 extraction. - Within three months following completion of Longwall 401.	The Extraction Plan
M Line	Longitudinal monitoring line at Longwall 402 finishing end	- Prior to commencement of Longwall 401 extraction. - Within three months following completion of Longwall 402.	The Extraction Plan
N Line	Longitudinal monitoring line at Longwall 406 finishing end	- Prior to commencement of Longwall 401 extraction. - Within three months following completion of Longwall 406.	The Extraction Plan LW401-408 BFMP-UCMPL
R Line	Monitoring line along Ulan Road western end of Longwall 401-408 finishing ends	- Prior to commencement of Longwall 401 extraction. - Within three months following completion of each Longwall 401- 408. - At any time in case of fault or emergency and where requested by relevant asset owners.	The Extraction Plan LW401-408 BFMP-MWRC LW401-408 BFMP-TELSTRA LW401-408 BFMP-EE LW401-408 BFMP-UCMPL
S Line	Main monitoring line traversing Longwalls 401-408	- Prior to commencement of Longwall 401 extraction. - Within three months following completion of each Longwall 401-408	The Extraction Plan
DV1	Longitudinal monitoring line at Longwall 403 finishing end	- Prior to commencement of Longwall 403 extraction - Weekly while the active mining face of LW403, LW404 and LW405 is within 400m of the active Quarry area and until completion of major subsidence*. - Within three months following the completion of Longwall 403, 404 and 405.	LW401-408 BFMP-DRONVISA
DV2	Longitudinal monitoring line at Longwall 404 finishing end	- Prior to commencement of Longwall 403 extraction - Weekly while the active mining face of LW403, LW404 and LW405 is within 400m of the active Quarry area and until completion of major subsidence*. - Within three months following the completion of Longwall 403, 404 and 405.	LW401-408 BFMP-DRONVISA
UG4 GNSS Array	GNSS Monitoring Station array above and adjacent to the UG4 domain	- Prior to commencement of Longwall 402 – two southern stations installed. - Prior to commencement of LW405 – remainder of array including the Drip and Corner Gorge (subject to access and approvals). - Data recorded by local data logger at 12 hour intervals.	The Extraction Plan

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Monitoring Component	Description	Frequency	Relevant Management Plan
CL3	Cliff Line Monitoring	- Prior to commencement of Longwall 406 extraction - Within three months following the completion of Longwall 408.	LW401-408 LMP
ARTC Line	Monitoring line along ARTC Rail Line	- Prior to commencement of Longwall 401 extraction - Within three months following completion of Longwall 401 - At any time in case of fault or emergency and where requested by ARTC.	LW401-408 BFMP-ARTC

Notes: * Major subsidence is complete when less than 20mm Vertical Movement is detected between surveys

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Table 3 Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
LW401-408 LMP	Cliffs	Visual Inspection of CL3	- Prior to commencement of Longwall 401 extraction. - Opportunistic visual observations during mining. - Within 3 months of the completion of LW408.	Observations and description (e.g. baseline photography, existing rockfalls, cliff instabilities, surface cracking). Comparison to baseline photography.
	Minor cliffs in GRNP	Visual inspection of minor cliffs in GRNP within 400m of longwalls.	- Prior to commencement of Longwall 403 extraction. - Following completion of Longwall within 400m of minor cliff.	Observations and description (e.g. baseline photography, existing rockfalls, cliff instabilities, surface cracking). Comparison to baseline photography.
	Land in general	Access tracks and surface features within the Study Area.	Opportunistic visual observations during mining.	Evidence of subsidence impacts observations (e.g. photography, nature and extent of surface cracking, rockfalls, displacement of or dislodgement of boulders or slabs).
LW401-408 BMP	Biodiversity	Floristic monitoring plots	- During spring, prior to longwall extraction beneath the monitoring plot. - Annually during spring, for two years following longwall extraction beneath the monitoring plot.	Floristic survey at specific locations in the study area and reference sites consisting of a modified 50 x 20 m plot containing a nested 20 x 20 m plot along a fixed transect, recording the composition, structure and functional attributes of extant PCTs.
		Photo point monitoring	- During spring, prior to longwall extraction beneath the monitoring site. - Annually during spring, for two years following longwall extraction beneath the monitoring site.	Two photographs (portrait and landscape) to be taken at the established pickets at the start and end of each 50 metre transect of all floristic plots.
		Visual assessment	- During spring, prior to longwall extraction beneath the monitoring site. - Annually during spring until the completion of LW 408.	Visual inspection of threatened flora populations
		Acoustic monitoring (Microbats)	- During spring, prior to longwall extraction beneath the monitoring site. - Annually during spring, for two years following longwall extraction at each site.	Four acoustic devices targeting bats (three in the study area and one in the reference site) to be deployed for four nights.

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Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
LW401-408 WMP	Water features	Bora Creek DL1 DL2	- Prior to undermining Bora Creek over LW401. - Prior to commencement of LW406 for drainage line DL1 - Prior to the commencement of LW408 for DL2. - Within three months of undermining of Bora Creek and drainage lines DL1 & DL2. - An inspection every six months for one year after longwall undermines Bora Creek and drainage lines DL1 and DL2.	Undertake a baseline inspection along the upper reaches of Bora Creek over LW401 and LW402 and drainage lines DL1 and DL2 above LW407 and LW408 respectively. Note the condition of vegetation in the channel and any areas of active erosion, sediment deposition, water ponding or streambed cracking. Collect photographic record of channel condition along Bora Creek over LW401 and LW402 and drainage lines DL1 and DL2 above LW407 and LW408 respectively.
		Goulburn River	- Prior to commencement of Longwall 401 extraction 6 monthly until 1 year after completion of Longwall 408 extraction	Undertake a baseline inspection at access points along Goulburn River Diversion adjacent to LW401 – 408 and Goulburn River Downstream to Corner Gorge, noting the condition of vegetation in the channel and any areas of active erosion, sediment deposition, water ponding or streambed cracking. Collect photographic record of channel condition.
		Surface Water Quality SW01, SW02, SW22, SW23 and SW24	Monthly (if flowing)	Flow – Observation pH, EC, TSS, TDS, temperature, turbidity
			Six monthly (in addition to above)	Al, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr, Li, Ba, Sr, DO, Total P and Total N
			After rainfall event (>30mm in 24 hours)	Flow – Observation pH, EC, TSS, TDS, Zn, Fe
		Stream Flow SW22***	Data Logger	Stream flow and quality

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Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
		Groundwater PZ101B PZ101C PZ102A* PZ103A* PZ103C PZ105A PZ105C PZ128 PZ129 PZ191* PZ192 PZ193 PZ194 PZ195 PZ229 PZ232 (PZ-B) PZ235 (PZ-C) PZ236 (PZ-D) PZ-A, , PZ-E and PZ-F once established***.	In accordance with the approved complex-wide Groundwater Management Plan, whilst serviceable.	In accordance with the approved complex-wide Groundwater Management Plan.
LW401-408 HMP	Aboriginal heritage	Rock Shelters S1MC256, S1MC261, S1MC271, S1MC290, S1MC294, S1MC358b, S1MC466**, S1MC468, S1MC472, S1MC484, S1MC488	• Complete baseline recording prior to extraction of Longwall 401. • Where impacts are deemed likely to occur, undertake surface collection • Monitoring within three to six months of undermining (unless salvaged).	Monitoring of potential subsidence impacts will be undertaken for a number of rock shelter and open grinding groove sites (unless previously salvaged), in order to identify and document whether any subsidence impacts have arisen from mining.
		Rock Shelters S1MC474, S1MC491, S1MC494	• Complete baseline recording prior to extraction of Longwall 401. • Where impacts are deemed likely to occur, undertake surface collection, and if required, archaeological excavation prior to extraction • Monitoring within three to six months of undermining (unless salvaged).	

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Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
		Rock Shelter S1MC475	- Baseline recording prior to extraction. - Where impacts are deemed likely to occur, undertake surface collection and, if required, archaeological excavation prior to extraction. - Where impacts are likely to the grinding groove, archival recording through means such as photography, photogrammetry or 3D scanning should be undertaken prior to extraction. - Monitoring within three to six months of undermining (unless salvaged).	

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Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
		Rock Shelter S1MC280	- A baseline recording has been completed for the site. - Undertake detailed recording of art. It is recommended this included detailed photography and photogrammetry. Consideration should be given to the geochemical analysis of art pigments where supported by the RAPs. - Where impacts are deemed likely to occur, undertake surface collection and, if required, archaeological excavation prior to extraction. - Undertake a detailed archival recording of grinding grooves through means such as photography, photogrammetry, and 3D scanning prior to extraction. If supported by RAPs usewear and residue analysis of grinding surfaces should be undertaken during detailed archival recording phase. - Develop S1MC280 specific Subsidence Monitoring Program prior to commencement of LW402.	

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Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
LW401-405 BFMP-EE	Essential Energy assets	Timber poles. Condition of 22 kV circuit powerline – power poles to telecommunications tower	- Prior to commencement of Longwall 104 extraction. - Within three months following the completion of Longwall 401 and 402 - If/when ground surveys identify an exceedance of the predicted subsidence monitoring parameters measured along the UG4 R Line - At any time in case of fault or emergency and where requested by Essential Energy.	Visual inspection of the condition of existing 22 kV circuit powerline (e.g. pole foundations, integrity and function of support clamps or other items). Subsidence impact inspections, targeting the identification of: - surface cracking; - surface humps; - damage to poles, conductors and/or powerlines; - reduced ground clearance; - tilting of power poles; and - bent cross-arms or insulators. Photo points (including baseline photographic record).
		Structure survey – monitoring points at each timber pole.	- Prior to commencement of longwall 401 extraction. - If/when ground surveys identify an exceedance of the predicted subsidence monitoring parameters measured along the UG4 R Line - Within three months following completion of Longwall 401 and Longwall 402.	Evidence of subsidence impacts compared to design/baseline structure survey.

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Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
LW401-408 BFMP-MWRC	MWRC assets	Ulan Road pavements, culverts, cuttings, and other furniture within 400m of LW401 – LW408	- Prior to the secondary extraction of Longwall 401. - If/when ground surveys identify an exceedance of the predicted subsidence monitoring parameters measured along the UG4 R Line. - Opportunistic visual observations during routine works by MCO and its contractors. - At any time in case of an emergency and requested by MWRC.	Subsidence impact inspections will target the identification of: - impacts to the surface including cracks, buckling and stepping; - impacts to the visible surfaces of pipes/culverts including cracking, buckling, shearing, and collapse; - impacts to road cuttings including slope failure, rock falls and pavement impacts; and - visible impacts to furniture.
LW401-408 BFMP-TELSTRA	Telstra assets	Telecommunication tower.	- Prior to commencement of Longwall 401 extraction. - With 3 months following completion of Longwall 401 - If/when ground surveys identify an exceedance of the predicted subsidence monitoring parameters measured along the UG4 R Line. - At any time in case of fault or emergency and where requested by Telstra.	Survey and record condition of the telecommunication tower and compare to baseline condition
LW401-408 BFMP-UCMPL	UCMPL Infrastructure	Visual inspection of UCMPL Infrastructure within 400m of Longwalls 401-408	- Prior to the secondary extraction of Longwall 404. - If/when ground surveys identify an exceedance of the predicted subsidence monitoring parameters measured along the 'R Line' within 400m of UCMPL infrastructure - Opportunistic visual observations during routine works by MCO and its contractors or UCML.	Visual inspection of UCMPL Infrastructure within 400m of Longwalls 401-408 (bridge, pipelines, powerlines, dams, water treatment facility, concrete slabs and tanks, security fencing and telecommunications tower. The visual inspection will include: - recording of existing defects, cracking, tilting, surface condition of infrastructure using photography; and - survey power poles and telecommunications tower.

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Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
		Survey power poles, Goulburn River Diversion Bridge and telecommunications tower within 400m of Longwalls 401-408	- Prior to the secondary extraction for Longwall 404 - If/when ground surveys identify an exceedance of the predicted subsidence monitoring parameters measured along the 'R Line' within 400m of UCMPL infrastructure - At any time in case of fault or emergency and where requested by UCMPL.	Baseline survey – monitoring points at each timber pole and at the telecommunications tower
		Goulburn River (Diversion)	- Prior to the secondary extraction for Longwall 401 6 monthly until 1 year after completion of Longwall 408 extraction	Undertake a baseline inspection at access points along Goulburn River adjacent to LW401 - 408, noting the condition of vegetation in the channel and any areas of active erosion, sediment deposition, water ponding or streambed cracking. Collect photographic record of channel condition.
LW401-408 BFMP-ARTC	Sandy Hollow Gulgong Railway	Rail line and infrastructure (section between Ulan Road Rail Bridge and Rail Loop)	- Prior to commencement of Longwall 401 extraction. - At the completion of Longwall 401. - If/when ground surveys identify an exceedance of the predicted subsidence monitoring parameters measured along the UG4 ARTC Line. - Opportunistic observations of subsidence impacts will be conducted during routine works by MCO and its contractors. - At any time in case of fault or emergency and where requested by ARTC.	Visual inspection of alignment and condition of rail and associated infrastructure (including culverts) and compare to baseline condition.

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Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
LW401-408 BFMP-DRONVISA	Dronvisa Quarry	- Quarry Pits; - Access roads; - Water management structures; and Structures.	- Prior to commencement of Longwall 403 extraction. - Within one (1) month following the completion of Longwall 403, 404 and 405.	Visual inspections to record baseline condition of Quarry and Quarry Infrastructure: - Quarry Pits; - Access roads; - Water management structures; - Structures; and - Rehabilitation areas Inspect and record condition of Quarry and Quarry Infrastructure during mining and at post mining and compare to baseline condition. Quarry works completed since baseline inspections to be noted.
LW401-408 PSMP	Cliffs	CL3 and CL5	- Prior to commencement of Longwall 401 extraction. - Opportunistic visual observations during mining. - Within 3 months of the completion of LW408.	As outlined in the LW401-408 LMP Observations and description (e.g. baseline photography, existing rockfalls, cliff instabilities, surface cracking).
	Land in general	Access tracks and surface features within the Study Area.	Opportunistic visual observations during mining.	As outlined in the LW401-408 LMP Evidence of subsidence impacts observations (e.g. photography, nature and extent of surface cracking).

Notes:

* To be decommissioned prior to extraction for safety of underground operations. Will continue to be monitored until decommissioned.

** S1MC466 The shelter is located outside of the Study Area for Longwalls 401-408. The extent of the site is within the Study Area, however it is unlikely that the open artefact scatters and PAD themselves would be impacted by mine subsidence (MSEC 2021).

*** Monitoring Subject to confirmation of location and necessary access agreements and approvals.

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8.0 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 component management plan (e.g. LW401-408 LMP, LW401-408 WMP, LW401-408 BMP, LW401-408 HMP and LW401-408 BFMPs).

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9.0 ROLES AND RESPONSIBILITIES

Key responsibilities of MCO personnel in relation to this LW401-408 SMP are summarised in **Table 4**. Responsibilities may be delegated as required.

Table 4 Longwalls 401 to 408 Subsidence Monitoring Program Responsibility Summary

Responsibility	Task
General Manager	Ensure resources are available to MCO personnel to facilitate the completion of responsibilities under this LW401-408 SMP.
Underground Technical Manager	- Ensure the LW401-408 SMP is implemented. - Ensure monitoring required under this LW401-408 SMP is carried out within specified timeframes, adequately checked and processed and prepared to the required standard. - Undertake relevant monitoring summarised in Section 7.
Environment and Community Manager	- Ensure the LW401-408 SMP is implemented. - Liaise with relevant stakeholders regarding subsidence impact management and related environmental consequences.
Registered Mine Surveyor	Undertake all subsidence monitoring to the required standard within the specified timeframes and ensure data are adequately checked, processed and recorded.

9.1 KEY CONTACTS

The details of key contacts and phone numbers in relation to this LW401-408 SMP are summarised in **Table 5**.

Table 5 Longwalls 401 to 408 Subsidence Monitoring Program Key Personnel Contact Details

Organisation	Position	Contact Name	Phone Number
MCO	Underground Technical Manager	Mr Liam Mildon	02 6376 1614
	Environment and Community Manager	Mr Trent Cini	02 6376 1436
	Registered Mine Surveyor	-	02 6376 1613
	Moolarben Coal Hotline		1800 556 484
Resource Regulator	Principal Subsidence Engineer	Dr Gang Li	02 4931 6644

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10.0 REFERENCES

Australasian Groundwater and Environmental Consultants (2021) Groundwater Technical Report for Moolarben UG4 LW401 to LW408 Extraction Plan, report prepared for Moolarben Coal Operations Pty Ltd by Australasian Groundwater and Environmental Consultants.

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

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.

Mine Subsidence Engineering Consultants (2021) *Subsidence Predictions and Impact Assessment for Longwalls 401 to 408* (MSEC, 2021)

Moolarben Biota (2006) *Flora, Fauna and Aquatic Ecology Assessment*, Appendix 11 in Wells Environmental Services (2006) *Moolarben Coal Project Environmental Assessment Report*. Prepared for Moolarben Coal Mines Pty Limited.

Niche Environment and Heritage (2021) Moolarben Coal UG4 Longwalls 404-408 Extraction Plan Aboriginal Cultural Heritage Technical Report.

Niche Environment and Heritage Pty Ltd (2021) Moolarben UG4 – Longwall 401-408 Biodiversity Technical Report

WRM Water and Environment (2021) UG4 Longwalls 401 to 405 Extraction Plan Surface Water Technical Report

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ATTACHMENT 1

**UG4 LONGWALLS 401 TO 408 SUBSIDENCE PARAMETERS MONITORING
TRIGGER ACTION RESPONSE PLAN**

Condition	Normal		Level 1	Level 2
	Baseline Conditions	Predicted Impacts	Implement Management Measures	Restoration/Contingency Phase
Trigger	Subsidence monitoring program (i.e. subsidence impacts and subsidence effects) that forms part of the overall management of the consequential environmental impacts associated with the extraction of Longwalls 401-408.	Subsidence parameters (i.e. maximum predicted total conventional subsidence, tilt and curvature) as predicted (Section 1.6 of the Extraction Plan) within the Study Area.	One or more subsidence parameters (i.e. maximum predicted total conventional subsidence, tilt and curvature) has exceeded prediction (Section 1.6 of the Extraction Plan) within the Study Area. Assessment of the relevant Performance Indicators (Section 3 of the Extraction Plan) have not been triggered. Assessment of the relevant Performance Measure (Section 1.7 of the Extraction Plan) has not been exceeded and is not likely to be exceeded.	One or more subsidence parameters (i.e. maximum predicted total conventional subsidence, tilt and curvature) has exceeded prediction (Section 1.6 of the Extraction Plan) within the Study Area. Assessment of the relevant Performance Indicators (Section 3 of the Extraction Plan) have been triggered. Assessment of the relevant Performance Measure (Section 1.7 of the Extraction Plan) has been exceeded and/or is likely to be exceeded.
Action	Establish baseline data: Pre-extraction subsidence survey as per the UG4 Longwalls 401 to 408 Subsidence Monitoring Program (Section 7.2.1 to Sections 7.2.3 and Table 2 and 3).	Conduct monitoring, consistent with the UG4 Longwalls 401 to 408 Subsidence Monitoring Program (Section 7.2.1 to Sections 7.2.3 and Table 2 and 3).	Management measures implemented as described in Section 3 of the Extraction Plan (with regard to the specific circumstances of the subsidence impact [e.g. the nature and extent of the impact]). Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.	Implement Contingency Plan including notifications as described in Section 4 of the Extraction Plan.
Frequency	Prior to commencement of extraction of Longwall 401 or in accordance with Table 2 and 3 .	As required, by the UG4 Longwalls 401 to 408 Subsidence Monitoring Program (Section 7.2.1 to Sections 7.2.3 and Table 2 and 3).	As required, by the UG4 Longwalls 401 to 408 Subsidence Monitoring Program (Section 7.2.1 to Sections 7.2.3 and Table 2 and 3).	As required, in accordance with Section 4 of the Extraction Plan.
Position of Decision Making	Underground Technical Manager.	Underground Technical Manager.	Environment and Community Manager and Underground Technical Manager.	Environment and Community Manager and Underground Technical Manager.

ATTACHMENT 2

PLANS 1 TO 7

**(IN ACCORDANCE WITH THE DEPARTMENT OF PLANNING AND ENVIRONMENT AND DIVISION OF
RESOURCES AND ENERGY [2015] DRAFT *GUIDELINES FOR THE PREPARATION OF EXTRACTION
PLANS*)**