



# UG1 LONGWALLS 101 TO 105 LAND MANAGEMENT PLAN

Version	Issue Date	Section Revised	Description	Review Team
1	September 2017	All	Approved	MCO
2	March 2019	Sections 1, 4, 13 and Figures	Amended 103 Layout	MCO
3	June 2020	All	Inclusion of LWs 104 - 105	MCO

Approved: *S. Archinal* Date: 11/06/2020

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

**TABLE OF CONTENTS**

**1.0 INTRODUCTION .....1**

1.1 PURPOSE AND SCOPE .....5

1.2 STRUCTURE OF THE LONGWALLS 101-105 LAND MANAGEMENT PLAN.....8

**2.0 LAND MANAGEMENT PLAN REVIEW AND UPDATE.....9**

2.1 ACCESS TO INFORMATION.....9

**3.0 STATUTORY REQUIREMENTS .....10**

3.1 EP&A ACT PROJECT APPROVAL..... 10

3.2 OTHER LEGISLATION ..... 12

**4.0 PREDICTED SUBSIDENCE IMPACTS AND ENVIRONMENTAL CONSEQUENCES .....13**

4.1 LONGWALLS 101-105 EXTRACTION SCHEDULE ..... 13

4.2 ENVIRONMENTAL RISK ASSESSMENT ..... 14

4.3 CLIFFS ..... 14

4.3.1 Baseline Data ..... 14

4.3.2 Predicted Subsidence Impacts and Environmental Consequences..... 17

4.4 MINOR CLIFFS AND ROCK FACE FEATURES..... 18

4.4.1 Baseline Data ..... 18

4.4.2 Predicted Subsidence Impacts and Environmental Consequences..... 19

4.5 STEEP SLOPES AND LAND IN GENERAL ..... 20

4.5.1 Baseline Data ..... 20

4.5.2 Predicted Subsidence Impacts and Environmental Consequences..... 21

**5.0 PERFORMANCE MEASURES AND PERFORMANCE INDICATORS.....23**

**6.0 MONITORING .....25**

6.1 SUBSIDENCE PARAMETERS..... 26

6.2 SUBSIDENCE IMPACTS ..... 26

6.3 ENVIRONMENTAL CONSEQUENCES..... 28

**7.0 MANAGEMENT MEASURES.....29**

**8.0 CONTINGENCY PLAN.....31**

8.1 TRIGGER ACTION RESPONSE PLAN ..... 32

**9.0 REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE .....33**

9.1 ANNUAL REVIEW..... 33

9.2 AUDITS ..... 34

9.3 FUTURE EXTRACTION PLANS ..... 34

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

**10.0 INCIDENTS .....35**  
**11.0 COMPLAINTS .....36**  
**12.0 NON-COMPLIANCE WITH STATUTORY REQUIREMENTS .....37**  
**13.0 REFERENCES .....38**

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

### LIST OF TABLES

Table 1	Land Management Plan Requirements
Table 2	Provisional Extraction Schedule
Table 3	Mapped Dimensions of Cliffs Relevant to the Extraction of Longwalls 101-105
Table 4	Maximum Predicted Total Conventional Subsidence Parameters for Cliffs
Table 5	Predicted Strains for the Cliffs based on Conventional and Non-Conventional Anomalous Movements
Table 6	Comparison of Maximum Predicted Conventional Subsidence Parameters for Cliffs
Table 7	Maximum Predicted Incremental Conventional Subsidence Parameters Resulting from the Extraction of Longwalls 101-105
Table 8	Maximum Predicted Total Conventional Subsidence Parameters Resulting from the Extraction of Longwalls 101-105
Table 9	Comparison of Maximum Predicted Conventional Subsidence Parameters Based on the Extraction Plan Layout and the Approved Layout for Longwalls 101-105
Table 10	Land Subsidence Impact Performance Measures
Table 11	Land Monitoring Program Overview
Table 12	Potential Management Measures

### LIST OF FIGURES

Figure 1	Regional Location
Figure 2	Moolarben Coal Complex Layout
Figure 3	Underground Mine 1 Longwalls 101 to 105 Layout
Figure 4	Cliffs and Steep Slopes in the Vicinity of Longwalls 101 to 105
Figure 5	Land Ownership in the Vicinity of Longwalls 101 to 105

### LIST OF ATTACHMENTS

Attachment 1	Subsidence Impact Register
Attachment 2	Land Management Plan Trigger Action Response Plan

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

## 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], Sojitz Moolarben Resources Pty Ltd and a consortium of Korean power companies). MCO and MCM are wholly owned subsidiaries of Yancoal Australia Limited.

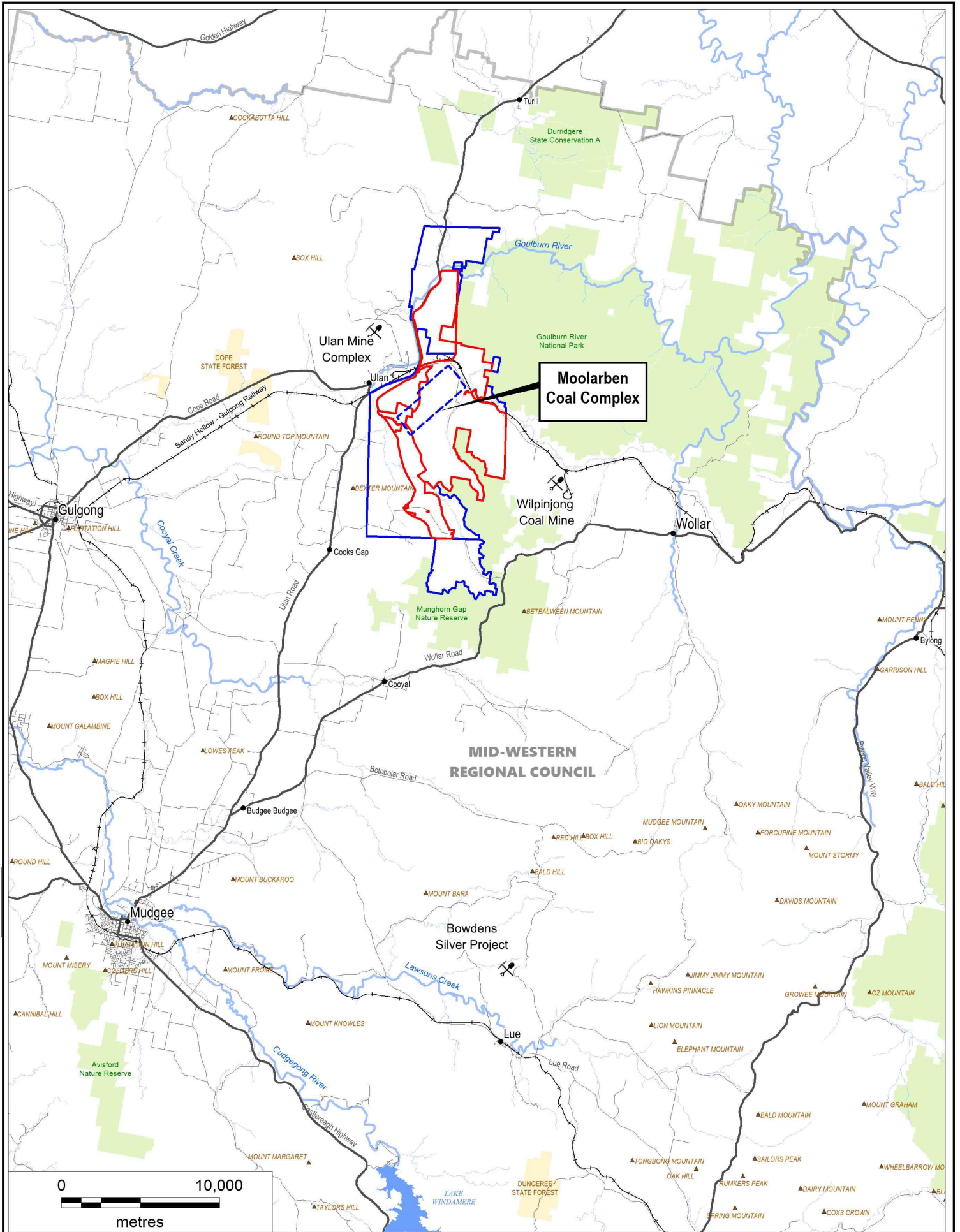
The Moolarben Coal Complex comprises four approved open cut mining areas (OC1 to OC4), three approved underground mining areas (UG, UG2 and UG4) and other mining related infrastructure (including coal processing and transport facilities) (Figure 2).

Since the commencement of coal mining operations in 2010, mining activities have occurred within OC1, OC2, OC4 and UG1 (Figure 2).

The UG1 Underground Mine is a component of the approved Moolarben Coal Complex (Figure 2). The UG1 Underground Mine commenced first workings in April 2016 and commenced secondary workings (longwall extraction) in October 2017 by longwall mining methods from the Ulan Seam within Mining Lease (ML) 1605, ML 1606, ML 1628, ML 1691 and ML 1715 (Figure 3).

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) (as modified) and Project Approval (08\_0135) (Moolarben Coal Project Stage 2) (as modified).

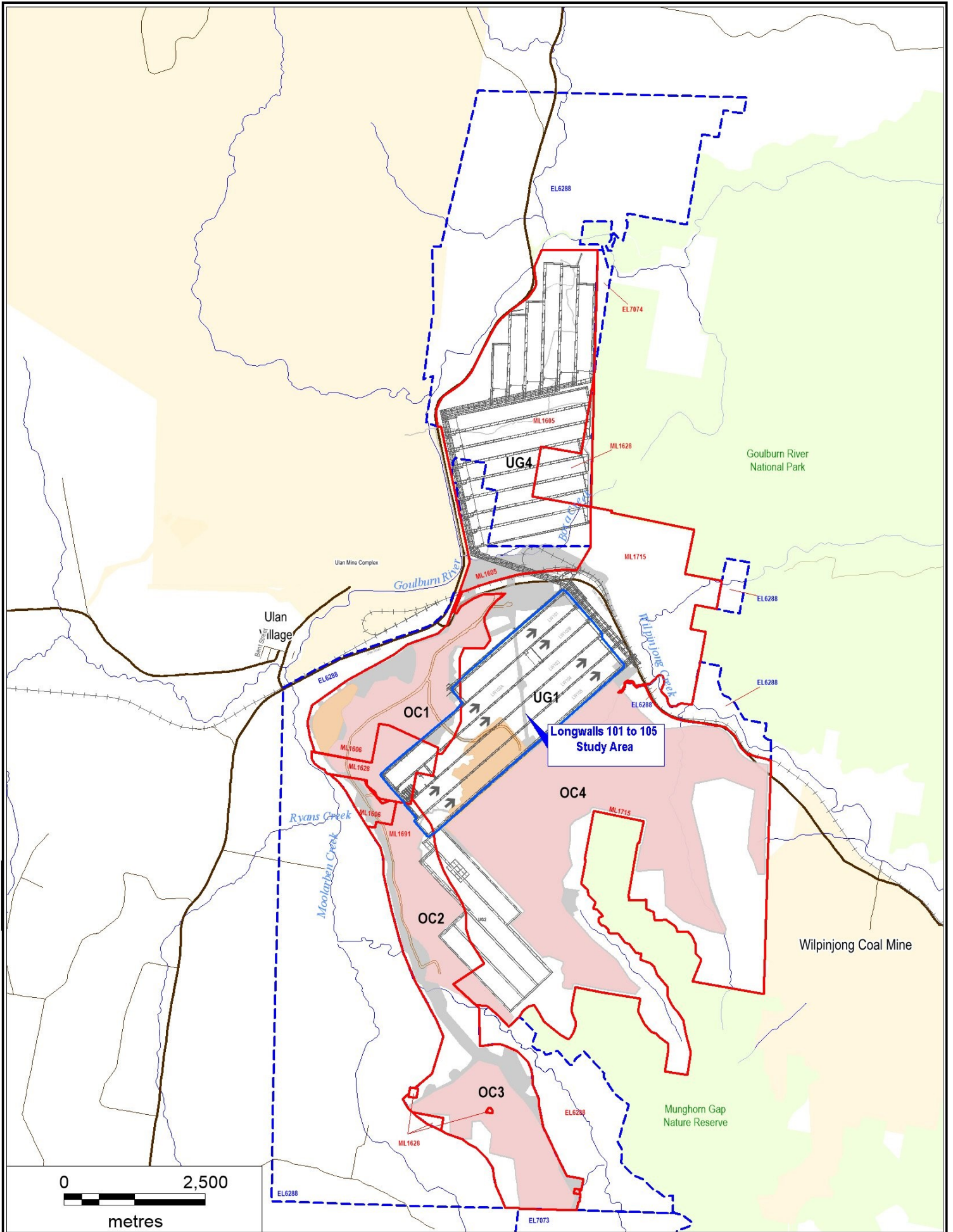
Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal



- Legend**
- Exploration Licence Boundary
  - Mining Lease Boundary
  - Local Government Area
  - National Park / Nature Reserve
  - State Forest
  - Mining Project



**Figure 1**  
**Regional Location**



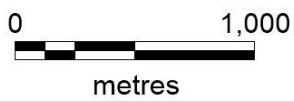
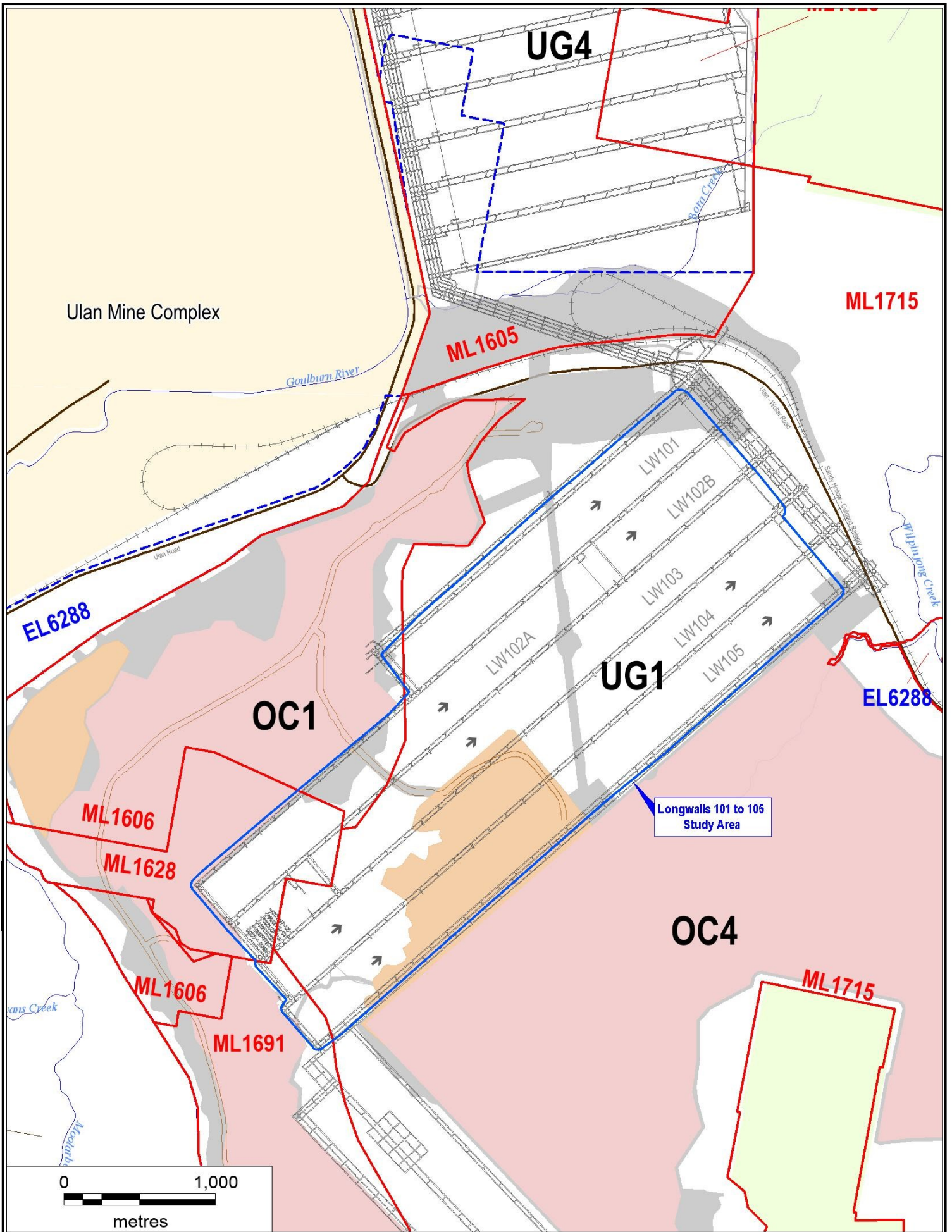
- Legend**
- Exploration Licence Boundary
  - Mining Lease Boundary
  - Haul Road
  - Rail Line
  - Watercourse

- Existing / Approved Development**
- Open Cut Mining Area
  - Underground Workings
  - Out-of-Pit Emplacement
  - Surface Infrastructure

- Longwalls 101 to 105 Study Area
- Direction of Longwall Mining



Figure 2  
Moolarben Coal Complex Layout



**Legend**

- Exploration Licence Boundary
- Mining Lease Boundary
- Haul Road
- Rail Line
- Watercourse

**Existing / Approved Development**

- Open Cut Mining Area
- Underground Workings
- Out-of-Pit Emplacement
- Surface Infrastructure

- Longwalls 101 to 105 Study Area
- Direction of Longwall Mining



Figure 3  
UG1 Longwalls 101-105 Layout



## 1.1 PURPOSE AND SCOPE

This UG1 Longwalls 101 to 105 Land Management Plan (LW101-105 LMP) has been prepared by MCO with input from suitably qualified experts (i.e. Resource Strategies and Mine Subsidence Engineering Consultants [MSEC]) to satisfy the requirements of Project Approval (08\_0135) as modified and the NSW Department of Planning, Industry and Environment (DPIE) and NSW Division of Resources and Energy (DRE) (2015) *Guidelines for the Preparation of Extraction Plans*. The appointment of the team of suitably qualified and experienced persons (which includes representatives of MCO, Resource Strategies and MSEC) has been endorsed by the Secretary of the DPIE.

**Purpose:** This LW101-105 LMP outlines the management of potential environmental consequences on cliffs, minor cliffs, rock face features, steep slopes and land in general resulting from the extraction of Longwalls 101-105.

**Scope:** This LW101-105 LMP covers cliffs, minor cliffs, rock face features, steep slopes and land in general within the Longwalls 101-105 Study Area<sup>1</sup> (Figure 4).

Longwalls 101-105 form the UG1 Underground Mine at the Moolarben Coal Complex.

This amendment has been prepared to incorporate the final two longwalls panels 104 and 05 of the UG1 mining area into the Extraction Plan. The only mine plan alteration from that approved under the Stage 2 Project Approval (08\_0135) is the shortening of the commencing end of LW104 by 70m, which was conducted to facilitate the installation of a rear panel ventilation shaft and associated roadway.

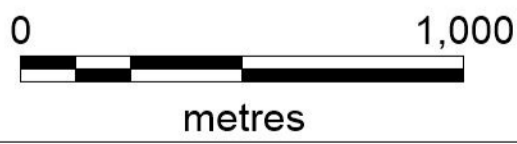
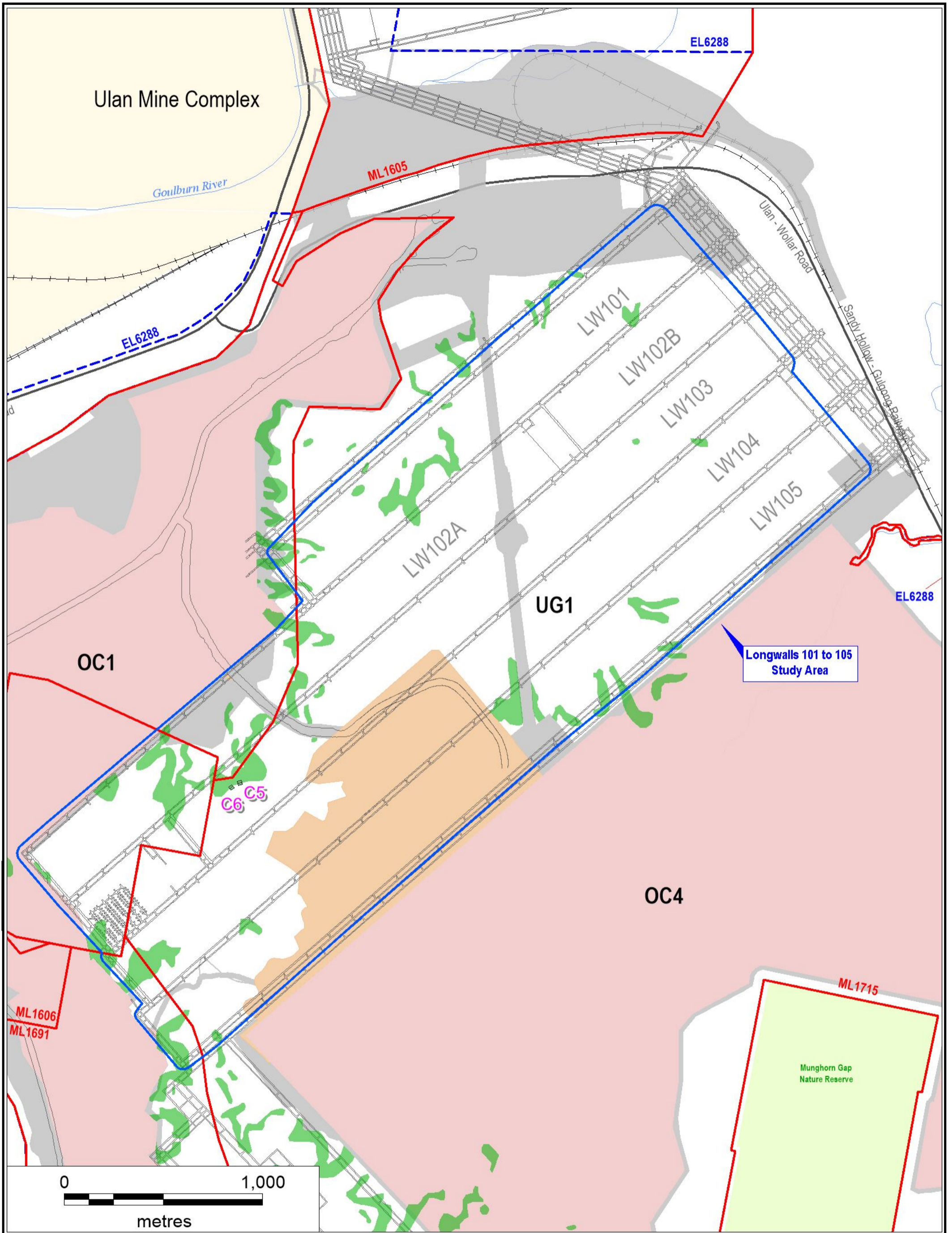
The State of NSW (Crown Land) owns a portion of land (Lot 7010, DP1025345) and the Mid-Western Regional Council and Crown Lands own a number of road reserves (and associated easements) within the Longwalls 101-105 (Figure 5). As such, MCO has consulted with NSW Crown Land and the Mid-Western Regional Council as potentially affected public authorities. All other land within the Longwalls 101-105 is owned by MCO.

Owners of public infrastructure on land within the Longwalls 101-105 Study Area and surrounds have also been consulted with separately as part of the Built Features Management Plans for Longwalls 101-105, including Essential Energy, TransGrid, Mid-Western Regional Council, Telstra and Australian Rail Track Corporation.

Built features owned by MCO (including the OC1 highwall and the out-of-pit emplacement) are addressed separately in the Extraction Plan. Drains and diversions for the management of surface water on the land within the Longwalls 101-105 Study Area are also addressed separately in the UG1 Longwalls 101-105 Water Management Plan.

<sup>1</sup> Longwalls 101-105 and the area of land within the furthest extent of the 26.5 degree (°) angle of draw and 20 millimetre (mm) predicted subsidence contour.

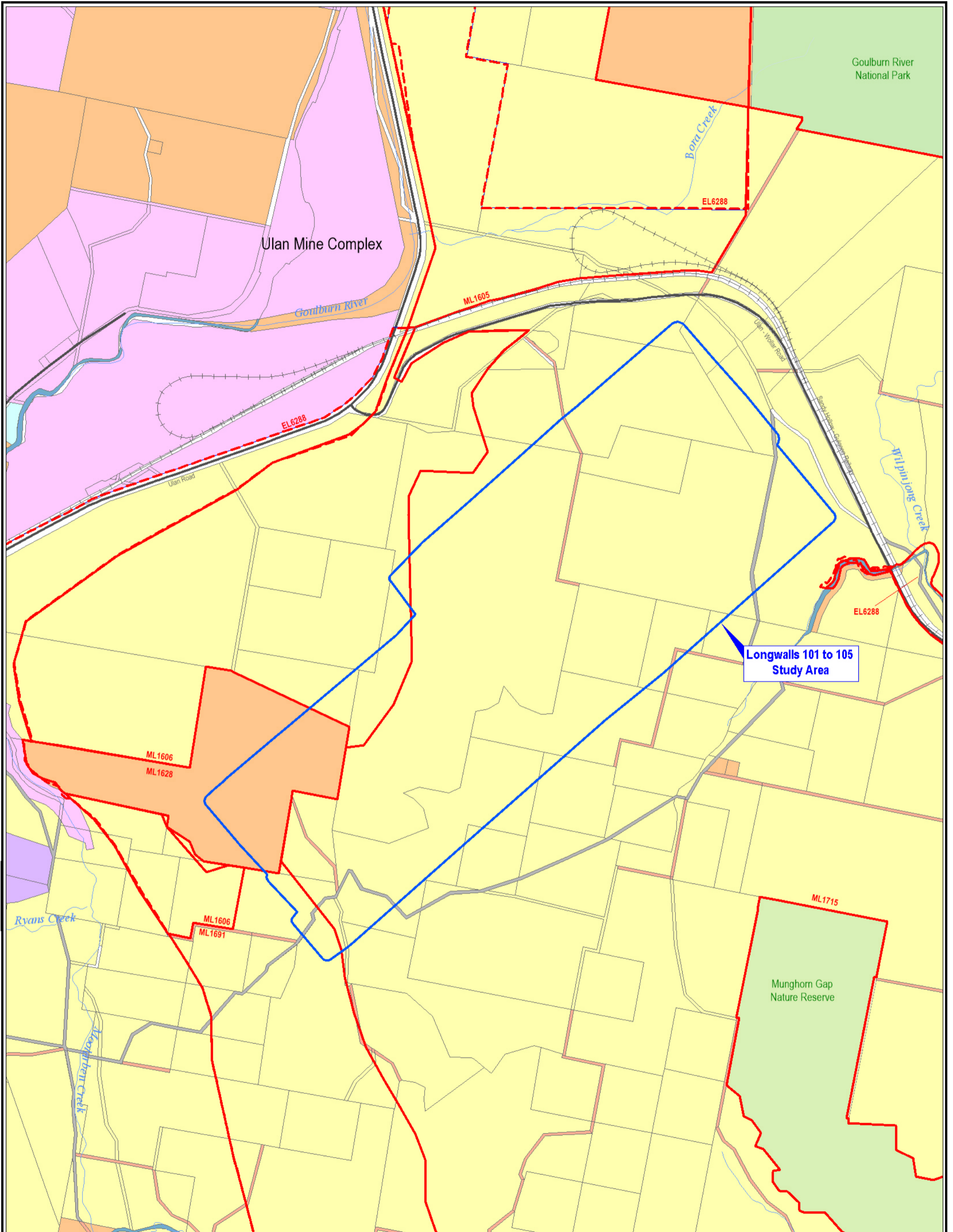
Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal



<b>Legend</b>		<b>Existing / Approved Development</b>		<b>Longwalls 101 to 105 Study Area</b>	
	Exploration Licence Boundary		Open Cut Mining Area		Longwalls 101 to 105 Study Area
	Mining Lease Boundary		Underground Workings		Cliffines and Steep Slopes
	Haul Road		Out-of-Pit Emplacement		Cliffs
	Rail Line		Surface Infrastructure		
	Watercourse				



**Figure 4**  
**Cliffs and Steep Slopes**



- Legend**
- Exploration Licence Boundary
  - Mining Lease Boundary
  - Rail Line
  - Watercourse
  - Longwalls 101 to 105 Study Area

- Crown
- Moolarben Coal Operations Pty Ltd
- Privately Owned

- Ulan Coal Mines Limited
- National Park / Nature Reserve
- Commercial



**Figure 5**  
**Land Ownership**  
**in the Vicinity of Longwalls 101 to 105**

## 1.2 STRUCTURE OF THE LONGWALLS 101-105 LAND MANAGEMENT PLAN

The remainder of the LW101-105 LMP is structured as follows:

- Section 2** Describes the review and update of the LW101-105 LMP.
- Section 3** Outlines the statutory requirements applicable to the LW101-105 LMP.
- Section 4** Summarises the predicted subsidence impacts and environmental consequences resulting from the secondary extraction of Longwalls 101-105.
- Section 5** Details the performance measures and indicators that will be used to assess environmental performance in relation to land in general over time.
- Section 6** Describes the monitoring program.
- Section 7** Describes the potential management measures that could be implemented to remediate any identified impacts to land features.
- Section 8** Provides a Contingency Plan to manage any unpredicted impacts and their consequences and describes the Trigger Action Response Plan (TARP) management tool.
- Section 9** Describes the Annual Review requirements, audits, improvement of environmental performance and preparation for future Extraction Plans.
- Section 10** Outlines the management and reporting of incidents.
- Section 11** Outlines the management and reporting of complaints.
- Section 12** Outlines the management and reporting of any non-compliance with statutory requirements.
- Section 13** Lists the documents referred to in Sections 1 to 12 of this LW101-105 LMP.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

## 2.0 LAND MANAGEMENT PLAN REVIEW AND UPDATE

In accordance with Condition 5, Schedule 6 of Project Approval (08\_0135), this LW101-105 LMP 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 to the conditions of this approval or MP 05\_0117 (unless the conditions require otherwise),*

*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 4 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 6 of Project Approval (08\_0135), MCO will make the approved LW101-105 LMP publicly available on the MCO website.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

### 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 LW101-105 LMP are described below.

#### 3.1 EP&A ACT PROJECT APPROVAL

Condition 5(j), Schedule 4 of Project Approval (08\_0135) requires the preparation of a Land Management Plan (i.e. this LW101-105 LMP) as a component of the Extraction Plan. In addition, Conditions 5(n), 5(p) and 6, Schedule 4 and Condition 3, Schedule 6 of Project Approval (08\_0135) outline general management plan requirements that are applicable to the preparation of the LW101-105 LMP.

Table 1 presents these requirements and indicates where they are addressed within this LW101-105 LMP.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

**Table 1: Land Management Plan Requirements**

Project Approval (08_0135) Condition	LW101-105 LMP Section
<p><b>Condition 5, Schedule 4</b></p> <p>5. 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:</p> <p>...</p> <p>(j) include a Land Management Plan, which has been prepared in consultation with any affected public authorities, to manage the potential impacts and/or environmental consequences of the proposed second workings on land in general;</p> <p>...</p> <p>(n) include a contingency plan that expressly provides for adaptive management where monitoring indicates that there has been an exceedance of any performance measure in Tables 18 and 19, or where such exceedance appears likely;</p> <p>...</p> <p>(p) include a program to collect sufficient baseline data for future Extraction Plans.</p>	<p>This document</p> <p>Section 8</p> <p>Section 9.3</p>
<p><b>Condition 6, Schedule 4</b></p> <p>6. The Proponent shall ensure that the management plans required under conditions 5(g)-(l) above include:</p> <p>(a) an assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval; and</p> <p>(b) a detailed description of the measures that would be implemented to remediate predicted impacts.</p>	<p>Section 4 &amp; 6.3</p> <p>Section 7</p>
<p><b>Condition 3, Schedule 6</b></p> <p>3. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:</p> <p>(a) detailed baseline data;</p> <p>(b) a description of:</p> <ul style="list-style-type: none"> <li>• the relevant statutory requirements (including any relevant approval, licence or lease conditions);</li> <li>• any relevant limits or performance measures/criteria;</li> <li>• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;</li> </ul> <p>(c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;</p> <p>(d) a program to monitor and report on the:</p> <ul style="list-style-type: none"> <li>• impacts and environmental performance of the project;</li> <li>• effectiveness of any management measures (see c above);</li> </ul> <p>(e) a contingency plan to manage any unpredicted impacts and their consequences;</p> <p>(f) a program to investigate and implement ways to improve the environmental performance of the project over time;</p> <p>(g) a protocol for managing and reporting any:</p> <ul style="list-style-type: none"> <li>• incidents;</li> <li>• complaints;</li> <li>• non-compliances with statutory requirements; and</li> <li>• exceedances of the impact assessment criteria and/or performance criteria; and</li> </ul> <p>(h) a protocol for periodic review of the plan.</p>	<p>Sections 4.3.1, 4.4.1 &amp; 4.5.1</p> <p>Section 3</p> <p>Section 5</p> <p>Section 5</p> <p>Section 7 &amp; 8</p> <p>Sections 6 &amp; 9</p> <p>Section 8</p> <p>Sections 6 &amp; 9</p> <p>Section 10</p> <p>Section 11</p> <p>Section 12</p> <p>Section 8</p> <p>Section 2</p>

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

### 3.2 OTHER LEGISLATION

MCO will operate the Moolarben Coal Complex consistent with Project Approval (05\_0117) (as modified) and Project Approval (08\_0135) (as modified) and any other legislation that is applicable to an approved Part 3A Project under the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act).

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

- *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.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal



## 4.0 PREDICTED SUBSIDENCE IMPACTS AND ENVIRONMENTAL CONSEQUENCES

### 4.1 LONGWALLS 101-105 EXTRACTION SCHEDULE

Longwalls 101-105, 103 Plunge Panel 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 101-105 Study Area) are shown on Figures 3 and 4. Longwall extraction will occur from the west to the east. The longwall layout includes approximately 311 metre (m) panel widths (void) with 20 m pillars (solid).

The provisional extraction schedule for Longwalls 101-105 is provided in Table 2.

**Table 2: Provisional Extraction Schedule**

Panel	Estimated Start Date	Estimated Duration	Estimated Completion Date
LW101	-	-	Complete
LW102 (A+B)	-	-	Complete
LW103	-	9 months	June 2020
103 Plunge	-	-	Complete
LW104	July 2020	12 months	July 2021
LW105	July 2021	12 months	July 2022

Following approval of the UG1 Optimisation Modification in April 2016, MCO delineated a geological feature in Longwall 102 that prevented economic mining of this section, and subsequently revised the longwall layout to incorporate a barrier pillar around this feature. The barrier pillar separating Longwalls 102A and 102B is approximately 140m in length. In addition, following further detailed design, Longwalls 101-103 have been shortened by approximately 70 m to provide safe operational conveyor distance between the end of the longwalls and main headings.

A second geological intrusion has been located at the commencing end of LW103 preventing viable extraction by longwall mining methods in this area. As a consequence, the LW103 commencing position has been moved outbye of the influence of the structure, and a first workings plunge panel has been established to partially extract the remanent coal that would otherwise become sterilised.

LW104 commencing end has also been shortened by 70m to facilitate the installation of a rear panel ventilation shaft and associated roadway.

With the exception of these changes, the longwall geometry is the same as that for the approved UG1 Optimisation Modification, and MSEC (2017; 2019 and 2020) conclude that the overall impact assessments for the natural and built features are unchanged or reduced.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

## 4.2 ENVIRONMENTAL RISK ASSESSMENT

Environmental Risk Assessments (ERA) have been conducted for four of the key component plans of the UG1 Longwalls 101-105 Extraction Plan<sup>2</sup> viz. Water Management Plan, Biodiversity Management Plan, Heritage Management Plan and Land Management Plan, to provide appropriate consideration to risk assessment and risk management in accordance with the Draft DPIE and DRE (2015) *Guidelines for the Preparation of Extraction Plans*.

An ERA workshop for LW panels 101-103 was held on 8 December 2016 and reviewed in March 2019 to support the Longwalls 101-103 Extraction Plan Amendment and in consideration of the Revised Extraction Plan Layout. An ERA for Longwall panels 104-105 was held on 30 January 2020, facilitated by independent specialist, Risk Mentoring.

The suitably qualified and experienced experts endorsed by the Secretary of the DPIE for the preparation of the UG1 Longwalls 101-105 Extraction Plan participated in the ERA.

The ERA indicated that risks relevant to land in the Longwalls 101-103 and 104-105 panels were in the “Low” or “Medium” category, and it was expected that the risks could be managed with implementation of the appropriate mitigation, management and/or control measures.

## 4.3 CLIFFS

### 4.3.1 Baseline Data

Project Approval (08\_0135) includes the following definition:

*Cliff:*

*A continuous rock face, including overhangs, having a minimum length of 20 metres, a minimum height of 10 metres and a minimum slope of 2 in 1 (>63.4°).*

Consistent with this definition, for the purposes of subsidence assessments, MSEC (2015; 2017 and 2020) assessed cliffs as a continuous rock face having a minimum length of 20 m, height of 10 m and a minimum slope of 2 to 1 (i.e. having a minimum angle to the horizontal of 63.4°).

Six cliffs (cliffs C1 to C6) were identified by MSEC (2015) within the UG1 Study Area (i.e. associated with Longwalls 101-105) as part of the Subsidence Assessment for the *UG1 Optimisation Modification*

<sup>2</sup> Separate risk assessments have also been conducted for the built features in the vicinity of the UG1 Longwalls 101-105 Study Area and for public safety.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

*Environmental Assessment* (UG1 Optimisation Modification). The locations of the cliffs were determined from site inspections and 2 m surface contours and are shown on Figure 4.

Of the cliffs identified within the UG1 Study Area, cliffs C5 and C6 lie within the Longwalls 101-105. Cliffs C1, C2, C3 and C4 are located within the approved out-of-pit emplacement or surface infrastructure and no longer exist. Photographs of cliffs C5 and C6 taken in 2008 are provided in Plates 1 to 3.



**Plate 1: Cliff C5, looking north-east (2008)**

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal



**Plate 2: Cliff C5, looking south-west (2008)**



**Plate 3: Cliff C6, looking south-west (2008)**

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

The mapped dimensions of cliffs relevant to the extraction of Longwalls 101-105 (i.e. cliffs C5 and C6) are provided in Table 3.

**Table 3: Mapped Dimensions of Cliffs Relevant to the Extraction of Longwalls 101-105**

Cliff ID	Approximate Overall Length (m)	Approximate Maximum Height (m)	Approximate Maximum Overhang (m)
C5	20	15	0
C6	20	10	0

Source: MSEC (2017).

#### 4.3.2 Predicted Subsidence Impacts and Environmental Consequences

Subsidence impact predictions for cliffs in the Longwalls 101-105 Study Area were conducted in 2015 for the UG1 Optimisation Modification (the Approved Layout) and have been revised to reflect the latest longwall layout (the Extraction Plan Layout) (MSEC, 2017) and reviewed by MSEC (2019). MSEC (2020) recognised no other cliffs within Longwall panels 101-105. The maximum predicted total conventional subsidence, tilt and curvature for cliffs C5 and C6, based on the Extraction Plan Layout are provided in Table 4, with the maximum predicted strains provided in Table 5.

**Table 4: Maximum Predicted Total Conventional Subsidence Parameters for Cliffs**

Cliff ID	Subsidence <sup>1</sup> (mm)	Tilt <sup>2</sup> (mm/m)	Hogging Curvature <sup>3</sup> (km <sup>-1</sup> )	Sagging Curvature <sup>3</sup> (km <sup>-1</sup> )
C5	2100	19	>3	>3
C6	2000	28	>3	>3

Source: MSEC (2017).

mm/m = millimetres per metre, km<sup>-1</sup> = 1/kilometres

<sup>1</sup> Subsidence refers to vertical displacements of the ground.

<sup>2</sup> Tilt is the change in the slope of the ground as a result of differential subsidence, and is calculated as the change in subsidence between two points divided by the distance between those two points.

<sup>3</sup> Curvature is the second derivative of subsidence, the rate of change of tilt, and is calculated as the change in tilt between two adjacent sections of the tilt profile divided by the average length of those sections.

**Table 5: Predicted Strains for the Cliffs based on Conventional and Non-Conventional Anomalous Movements**

Type	Conventional Strain Based on 10 times Curvature	Non-Conventional based on the 95% Confidence Level	Non-Conventional based on the 99% Confidence Level
Tension	>30	10	22
Compression	>30	13	31

Source: MSEC (2017).

% = percent

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

MSEC (2017) compared the maximum predicted subsidence impacts on cliffs C5 and C6 due to the extraction of Longwalls 101-103 based on the Extraction Plan Layout with the maximum predictions due to the extraction of Longwalls 101-103 based on the Approved Layout. This comparison is provided in Table 6.

**Table 6: Comparison of Maximum Predicted Total Conventional Subsidence Parameters for Cliffs**

Layout	Subsidence (mm)	Tilt (mm/m)	Hogging Curvature (km <sup>-1</sup> )	Sagging Curvature (km <sup>-1</sup> )
Approved Layout (LW101-103)	2100	28	>3	>3
Extraction Plan Layout	2100	28	>3	>3

Source: MSEC (2017).

This comparison shows the maximum predicted total conventional subsidence, tilt and curvature for the cliffs, based on the Extraction Plan Layout, are the same as the predicted maxima for the Approved Layout. MSEC (2017) concluded that the potential impacts on the cliff would be the same as those assessed based on the Approved Layout. MSEC (2017) considers that minor impacts are expected to cliffs C5 and C6, including the following potential impacts:

- rockfalls can be expected at these cliff lines; and
- cliff instabilities could occur on up to approximately 15% of the length of the exposed cliffs.

It is extremely difficult to assess the likelihood of mining induced cliff instabilities based upon the predicted ground movements alone. The likelihood of a particular cliff becoming unstable naturally (i.e. without the effects of mining induced ground movements) is dependent on many factors, including the existing vertical and horizontal jointing, inclusions or weaknesses within the rock mass, the height, extent of undercutting, the length and orientation of the particular cliff with respect to the valley and the water pressure and seepage flow behind the rock face (MSEC, 2015 and 2017).

#### 4.4 MINOR CLIFFS AND ROCK FACE FEATURES

##### 4.4.1 Baseline Data

Project Approval (08\_0135) includes the following definitions:

*Minor cliff:*

*A continuous rock face, including overhangs, which has a:*

- *minimum length of 20 metres and a height between 5 metres and 10 metres, or maximum length of 20 metres and a minimum height of 10 metres; and*

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

- minimum slope of 2 to 1 (>63.4°).

Rock face feature:

A continuous rock face, including overhangs, which has a:

- minimum length of 20 metres and a height between 3 metres and 5 metres, or maximum length of 20 metres and a minimum height of 5 metres; and
- minimum slope of 2 to 1 (>63.4°).

MSEC (2015; 2020) also identified a number of overhangs and smaller cliffs (i.e. minor cliffs and rock face features) within the UG1 Study Area, which are referred to as rock ledges.

#### 4.4.2 Predicted Subsidence Impacts and Environmental Consequences

As rock ledges are distributed over the UG1 Study Area, they are likely to experience the full range of predicted subsidence movements (MSEC, 2017 and 2020). Tables 7 and 8 present the maximum predicted conventional subsidence parameters after the extraction of each longwall within the Longwalls 101-105 Study Area (incremental and total predictions, respectively).

**Table 7: Maximum Predicted Incremental Conventional Subsidence Parameters Resulting from the Extraction of Each of Longwalls 101, 102, 103, 104 and 105**

Longwall	Subsidence (mm)	Tilt (mm/m)	Hogging Curvature (km <sup>-1</sup> )	Sagging Curvature (km <sup>-1</sup> )
LW101	2250	65	>3	>3
LW102A	2200	>100	>3	>3
LW102B	2150	45	2.1	1.5
LW103	2250	75	>3	>3
LW104	2250	90	>3	>3
LW105	2150	85	>3	>3

Source: MSEC (2020).

**Table 8: Maximum Predicted Total Conventional Subsidence Parameters Resulting from the Extraction of Each of Longwalls 101, 102, 103, 104 and 105**

Longwall	Subsidence (mm)	Tilt (mm/m)	Hogging Curvature (km <sup>-1</sup> )	Sagging Curvature (km <sup>-1</sup> )
After LW101	2250	65	>3	>3
After LW102	2400	>100	>3	>3
After LW103	2400	>100	>3	>3
After LW104	2400	>100	>3	>3
After LW105	2400	>100	>3	>3

Source: MSEC (2020).

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

The maximum predicted total conventional subsidence parameters for Longwalls 101-105, based on the Extraction Plan Layout, were compared to the maximum predicted total conventional subsidence parameters based on the Approved Layout (Table 9).

**Table 9: Comparison of Maximum Predicted Total Conventional Subsidence Parameters Based on the Extraction Plan Layout and the Approved Layout for Longwalls 101-105**

Layout	Subsidence (mm)	Tilt (mm/m)	Hogging Curvature (km <sup>-1</sup> )	Sagging Curvature (km <sup>-1</sup> )
Approved Layout (LW101-105)	2400	>100	>3	>3
Extraction Plan Layout (LW101-105)	2400	>100	>3	>3

Source: MSEC (2020).

This comparison indicates that the maximum predicted total conventional subsidence, tilt and curvature based on the Extraction Plan Layout are the same as the predicted maxima for the Approved Layout.

Therefore, the potential impacts on the rock ledges, based on the Extraction Plan Layout, are the same as those assessed based on the Approved Layout, specifically, the potential for fracturing of sandstone and subsequent rockfalls, particularly where the rock ledges are marginally stable (MSEC, 2017; 2019 and 2020). It is expected that occasional rockfalls or fracturing would not impact more than 5% of the total face area of rock ledges in the Longwalls 101-105 Study Area.

## 4.5 STEEP SLOPES AND LAND IN GENERAL

### 4.5.1 Baseline Data

Project Approval (08\_0135) includes the following definition:

*Steep slope:*

*An area of land having a gradient between 1 in 3 (33% or 18.3°) and 2 in 1 (200% or 63.4°).*

MSEC (2015) identified a number of steep slopes within the UG1 Study Area. Steep slopes were identified by MSEC as having a gradient of between 2 to 1 (i.e. having an angle to the horizontal of 18°) and 3 to 1 (i.e. having an angle to the horizontal of 63°) and were determined using 2 m contours of the UG1 Study Area.

Steep slopes have been identified to highlight areas where the existing ground slopes may be marginally stable. However, no significant slope failures have been observed in the Western or

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal



Southern Coalfields as a result of longwall mining (MSEC, 2017). Steep slopes overlying Longwalls 101-105 and in the vicinity of the UG1 Study Area are shown on Figure 4. Vertical subsidence associated with steep slopes located within Longwall 103 Plunge panel are predicted to be less than 20mm (Mine Advice, 2019).

Land in general refers to the general landscape other than cliffs, minor cliffs, rock face features and steep slopes. 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 including the conveyor trace, open cut highwalls and out-of-pit emplacements which are addressed elsewhere in the Extraction Plan. Unsealed vehicular tracks and fire trails are located throughout the UG1 Study Area and above Longwalls 101-105.

The surface soils above Longwalls 101-105 generally consist of soils derived from sandstone, in varying stages of weathering and fracturing. The stability of these natural slopes varies depending on their soil or rock types, and in many cases, natural slopes can be stable at much higher gradients than 1 to 3. The majority of these existing natural steep slopes have been stabilised, to some extent, by trees and other natural vegetation. Some steep slopes are located within the footprint of the approved out-of-pit emplacement area and were covered prior to the extraction of Longwall 103.

#### 4.5.2 Predicted Subsidence Impacts and Environmental Consequences

As steep slopes are distributed over the UG1 Study Area, they are likely to experience the full range of predicted subsidence movements (MSEC, 2017 and 2020). Similarly, land in general could experience the full range of predicted subsidence movements. Tables 7 and 8 present the maximum predicted conventional subsidence parameters after the extraction of each longwall within the Longwalls 101-105 Study Area (incremental and total predictions, respectively).

As discussed in Section 4.4.2, the maximum predicted total conventional subsidence parameters for Longwalls 101-105, based on the Extraction Plan Layout, were compared to the maximum predicted total conventional subsidence parameters, based on the Approved Layout. This comparison is provided in Table 9 and indicates that the maximum predicted total conventional subsidence, tilt and curvature based on the Extraction Plan Layout are the same as the predicted maxima for the Approved Layout.

MSEC (2017;2019 and 2020) assessed that steep slopes could experience the full range of predicted subsidence movements. Therefore, the potential impacts on steep slopes, based on the Extraction Plan Layout, are the same as those assessed based on the Approved Layout, specifically, the potential for down slope movements and ground surface cracking.

It has been observed that down slope movements occur on slopes that are located over or near extracted longwalls. Sometimes these movements are observed to be directed down the hill slope

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

rather than towards the extracted goaf area. Where such movements occur on steep slopes, there is a higher likelihood that surface tension cracking can occur near the tops of the slopes. It is unlikely that mine subsidence would result in any large-scale slope failure, since such failures have not been observed elsewhere as the result of longwall mining (MSEC, 2017 and 2020).

Longwall mining can result in surface cracking, heaving, buckling, humping and stepping at the surface. The extent and severity of these mining induced ground deformations are dependent on a number of factors, including the mine geometry, depth of cover, overburden geology, locations of natural joints in the bedrock, the presence of near surface geological structures and mining conditions (MSEC, 2017).

The depths of cover over Longwalls 101-105 vary from 47 m to 165 m. Where the depths of cover are less than 100 m, surface cracking is expected to be typically in the order of 150 to 200 mm wide, but could be as large as 500 mm wide where the depths of cover are the shallowest. The surface crack widths are likely to be smaller where the depths of cover are greater, or where the surface cracks result from the travelling wave. Where the depths of cover above Longwalls 101 to 105 are 100 to 150 m, the surface crack widths are expected to be typically in the order of 100 to 150 mm wide (MSEC, 2017 and 2020).

The surface cracking and deformation could result in safety issues (i.e. trip hazards), affect vehicle access (i.e. large deformations in access tracks), or result in increased erosion (especially along the drainage lines and the steeper slopes) (MSEC, 2017 and 2020).

Fire trails and vehicular tracks could experience surface cracking during the mining period, particularly where the trails/tracks are located near the tops of existing slopes or at the bottom of valleys.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

## 5.0 PERFORMANCE MEASURES AND PERFORMANCE INDICATORS

This LW101-105 LMP has been developed to manage the potential environmental consequences of the secondary extraction of Longwalls 101-105 on cliffs, minor cliffs, rock face features and steep slopes in accordance with Condition 5(j), Schedule 4 of Project Approval (08\_0135). In accordance with Condition 1, Schedule 4 of Project Approval (08\_0135), MCO must ensure that there is no exceedance of the subsidence impact performance measures listed in Table 18 of Condition 1, Schedule 4 and Table 19 of Condition 3, Schedule 4 of Project Approval (08\_0135). Subsidence impact performance measures relevant to land in the UG1 Study Area are listed in Table 10.

**Table 10: Land Subsidence Impact Performance Measures**

Feature	Subsidence Impact Performance Measure
Other cliffs	No greater subsidence impacts or environmental consequences than predicted in the EA
Minor cliffs Rock face features Steep slopes	Minor environmental consequences (that is, occasional rockfalls, displacement of or dislodgment of boulders or slabs, or fracturing, that in total do not impact more than 5% of the total face area of each such type of feature within any longwall mining domain)

Source: Table 18 of Condition 1, Schedule 4 of Project Approval (08\_0135).

Notes:

- MCO is required to define more detailed performance indicators (including impact assessment criteria) for each of these performance measures in the various management plans that are required under this approval.
- Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Secretary will be the final arbiter.

Rockfalls occur naturally at locations where there is no mining and this is a reminder that cliffs and rock overhangs are landforms that are part of a naturally occurring erosion/weathering cycle and hence they can be marginally stable (MSEC, 2015). This highlights that caution is required when inspecting surface areas near these natural features and when proposing any surface management plans near or around cliffs and overhangs before, during and immediately after mining (MSEC, 2015).

The performance measure '*No greater subsidence impacts or environmental consequences than predicted in the EA*' for other cliffs is considered to reflect the prediction by MSEC (2015) that cliff instabilities could occur on up to approximately 15% of the lengths of the exposed cliffs in the UG1 Study Area.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

Table 3 shows the mapped dimensions of cliffs relevant to the extraction of Longwalls 101-105. Figure 4 shows the location of the identified cliffs in the Longwalls 101-105 Study Area. Table 3 indicates the total length of these cliffs is approximately 40 m. Therefore, to ensure that no greater subsidence impacts or environmental consequences than predicted in the EA occur, the total length of cliffs within the Longwalls 101-105 panels that experience cliff instabilities (i.e. the exposure of a fresh face of rock and debris scattered around the base of the cliff) is to be less than 6 m.

The performance measure *‘Minor environmental consequences (that is, occasional rockfalls, displacement of or dislodgment of boulders or slabs, or fracturing, that in total do not impact more than 5% of the total face area of each such type of feature within any longwall mining domain)’* for minor cliffs, rock face features and steep slopes relates to features that are present across the Longwalls 101-105 Study Area. In each instance of an identified impact (that is, occasional rockfalls, displacement of boulders or slabs, or fracturing) to a minor cliff, rock face feature or steep slope, the affected percentage of the total face area of the feature affected will be determined. It is expected that occasional rockfalls or fracturing would not impact more than 5% of the total face area of rock ledges and overhangs in the Longwalls 101-105 Study Area (MSEC, 2017 and 2020).

Section 6 describes the monitoring that will be conducted to assess the UG1 Underground Mine against the relevant subsidence impact performance measures.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

## 6.0 MONITORING

A monitoring program will be implemented to monitor the impacts of the secondary extraction of Longwalls 101-105 on land features (including cliffs, minor cliffs, rock face features, steep slopes and land in general). Key components of the monitoring program are summarised in Table 11.

**Table 11: Land Monitoring Program Overview**

Monitoring Component	Parameter	Timing/Frequency	Responsibility
<b>Pre-mining</b>			
Visual inspection of cliffs C5 and C6.	Location, physical description (e.g. length and height of cliffs, angle to horizontal) and general condition of cliffs.	Prior to commencement of Longwall 101 extraction.	Underground Technical Manager
Visual inspection of representative minor cliffs, rock face features, steep slopes and land in general in the 101-105 Study Area.	Observations (e.g. baseline photography, existing rockfalls, cliff instabilities, surface cracking).	Prior to commencement of LW extraction beneath the area	Underground Technical Manager
UG1 subsidence monitoring lines, as described in the UG1 Longwalls Subsidence Monitoring Program (LW101-105 SMP).	Ground survey – baseline, as described in the SMP.	Prior to commencement of Longwall extraction beneath the monitoring location.	Underground Technical Manager / Registered Mine Surveyor
<b>During Mining</b>			
UG1 subsidence monitoring lines, as described in the SMP.	Ground survey of LW101-103, as described in the SMP.	Following completion of extraction of the relevant Longwall	Underground Technical Manager / Registered Mine Surveyor
Visual inspection of cliffs C5 and C6.	Location, physical description (e.g. length and height of cliffs, angle to horizontal) and general condition of cliffs.	Prior to commencing Longwall 103 extraction.	Underground Technical Manager
Subsidence impacts and environmental consequences on representative minor cliffs, rock face features, steep slopes and land in general	Surface cracking and rockfalls (nature and extent of surface tension cracks and rock ledge collapse). Condition of minor cliffs, rock face features, steep slopes and land in general.	Opportunistic visual observations during routine works.	Underground Technical Manager

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

**Table 11 (Continued): Land Monitoring Program Overview**

Monitoring Component	Parameter	Timing/Frequency	Responsibility
<b>Post-mining</b>			
UG1 subsidence monitoring lines, as described in the LW101-105 SMP.	Ground survey, as described in the SMP.	Within three month of the completion of relevant Longwalls.	Underground Technical Manager / Registered Mine Surveyor
Visual inspection of cliffs C5 and C6.	Location, physical description (e.g. length and height of cliffs, angle to horizontal) and general condition of cliffs.	Within one month of the completion of Longwall 103 extraction.	Underground Technical Manager
Subsidence impacts and environmental consequences on representative minor cliffs, rock face features, steep slopes and land in general.	Surface cracking and rockfalls (nature and extent of surface tension cracks and rock ledge collapse). Condition of minor cliffs, rock face features, steep slopes and land in general.	Within one month of the completion of Longwall 105 extraction (for previous Longwalls).	Underground Technical Manager

## 6.1 SUBSIDENCE PARAMETERS

Subsidence parameters will be measured in accordance with the LW101-105 SMP.

In summary, surveys will be conducted to measure subsidence movements in three dimensions using a total station survey instrument. Subsidence movements will be measured along subsidence lines that have been positioned across the general landscape.

## 6.2 SUBSIDENCE IMPACTS

Visual inspections of cliffs C5 and C6 will be conducted prior to commencement of secondary extraction of Longwalls 101 and 103, and following the completion of Longwall 103.

A visual inspection of other representative land features (i.e. minor cliffs, rock face features, steep slopes and land in general) will also be conducted to establish a baseline record.

Opportunistic observations of subsidence impacts to land features (i.e. cliffs, minor cliffs, rock face features and steep slopes) will be conducted during routine works by MCO and its contractors. Where relevant, inspections of subsidence impacts will include detailed measurement and photographic record of the impact for comparison with baseline records.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

If additional subsidence impact(s) (i.e. cliff instabilities) are observed during the inspection, 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 (e.g. implementation of management measures, initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety etc.); and
- any other relevant information.

The Subsidence Impact Register (Attachment 1) will also record the total face area of any minor cliffs, rock face features and steep slopes that experience minor environmental consequences (i.e. rockfalls, displacement of or dislodgement of boulders or slabs, or fracturing). Recording of the monitoring results in the Subsidence Impact Register will assist MCO in monitoring compliance with the subsidence impact performance measures.

The information will be recorded in the Subsidence Impact Register and reported in accordance with Project Approval (08\_0135).

The monitoring results will be used to assess the potential environmental consequences of the subsidence impact (as described in Section 6.3) and to identify management measures, where appropriate.

The monitoring results will also be assessed against the land subsidence impact performance measures:

*No greater subsidence impacts or environmental consequences than predicted in the EA.*

*Minor environmental consequences (that is, occasional rockfalls, displacement of or dislodgment of boulders or slabs, or fracturing, that in total do not impact more than 5% of the total face area of each such type of feature within any longwall mining domain).*

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

Section 8 provides a Contingency Plan in the event a subsidence impact performance measure relevant to land is exceeded.

### 6.3 ENVIRONMENTAL CONSEQUENCES

MCO will compare the results of the subsidence impact monitoring against the land performance measures and indicators (Section 5). In the event the observed subsidence impacts exceed the performance measure or indicators, MCO will assess the consequences of the exceedance in accordance with the Contingency Plan described in Section 8.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal



## 7.0 MANAGEMENT MEASURES

A number of potential management measures are available to mitigate/remediate subsidence impacts to land features (i.e. cliffs, minor cliffs, rock face features, steep slopes and land in general) resulting from the extraction of Longwalls 101-105. The requirement and methodology for any subsidence remediation techniques will be determined in consideration of:

- Potential impacts of the unmitigated impact, including potential risks to public safety and the potential for self-healing or long-term degradation.
- Potential impacts of the remediation technique, including site accessibility.

The implementation of management measures will be considered with regard to the specific circumstances of the subsidence impact (e.g. the location, nature and extent of the impact) and the assessment of environmental consequences. The implementation of management measures will be related to the scale of impact and the ability to, and value in, undertaking mitigation measures on a case by case basis.

Potential management measures that will be considered to mitigate/remediate environmental consequences, if safe to do so, are provided in Table 12.

**Table 12: Potential Management Measures**

Potential Management Measures	
Measure	Description
Stabilisation techniques	<ul style="list-style-type: none"> <li>• Scaling/dislodgement/removal of remaining loose rock.</li> </ul>
Erosion and sediment control techniques	<ul style="list-style-type: none"> <li>• Implementation of erosion and sediment control measures, such as:                             <ul style="list-style-type: none"> <li>– Installation of sediment fences downslope of erosion areas.</li> <li>– Stabilisation of erosion areas using rock or other appropriate materials.</li> </ul> </li> </ul>
Stabilisation techniques, salvage of artefacts	<ul style="list-style-type: none"> <li>• Aboriginal heritage management measures will be implemented in accordance with the UG1 Longwalls 101 to 105 Heritage Management Plan.</li> </ul>
Site access control, signage, stabilisation techniques	<ul style="list-style-type: none"> <li>• Measures to address safety hazards will be implemented in accordance with the UG1 Longwalls 101 to 105 Public Safety Management Plan, such as:                             <ul style="list-style-type: none"> <li>– Signage to warn persons accessing the area of safety hazards.</li> <li>– Construction or placement of barriers to restrict access to unsafe areas.</li> <li>– Road works to maintain road safety.</li> </ul> </li> </ul>
Remediation of surface tension crack	<ul style="list-style-type: none"> <li>• Permanent filling of the surface tension cracks. Methods of in-filling may include manual application or use of small machinery (e.g. bob cat) where practicable (e.g. where use of this equipment would not result in greater impact than the cracking itself).</li> </ul>

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

MCO will assess the potential environmental consequences of the recorded subsidence impact on known Aboriginal heritage sites and, where appropriate, implement measures in accordance with the UG1 Longwalls 101 to 105 Heritage Management Plan.

In the event the subsidence impacts are deemed to present a safety hazard (i.e. regardless of the nature or extent of the subsidence impact), actions will be implemented in accordance with the UG1 Longwalls 101 to 105 Public Safety Management Plan.

Where significant subsidence impacts on fire trails or vehicular tracks are detected (e.g. those that affect the serviceability of the fire trails or vehicular tracks), or at any time MCO or the landholder (e.g. Crown Land or the Mid-Western Regional Council) considers that the integrity of the fire trails or vehicular tracks may be compromised, appropriate management measures will be implemented (Table 12).

Where significant cracks are detected, the cracks will be repaired as soon as practicable in consultation with the landholders. This may include the use of earthmoving equipment if considered the most appropriate means of repair. Appropriate sedimentation controls will be implemented during repair works.

The implementation of any stabilisation techniques or measures to improve the aesthetic value of the feature, other than those listed in Table 12, will be conducted in consultation with the landholder. Appropriate erosion and sediment control techniques will be implemented as required. The landholder (e.g. Crown Land or the Mid-Western Regional Council) will be consulted in the event MCO propose to in-fill any surface tension cracks.

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

Management measures will be reported in the Annual Review (Section 9.1).

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

## 8.0 CONTINGENCY PLAN

In the event a subsidence impact performance measure relevant to land (Table 10) is considered to have been exceeded or is likely to be exceeded, MCO will implement the following Contingency Plan:

- The observation will be reported to the Underground Technical Manager and/or the Environmental and Community Manager within 24 hours.
- The observation will be recorded in the Subsidence Impact Register (Attachment 1) consistent with the monitoring program described in Section 6.
- Any exceedance of a subsidence impact performance measure relevant to land will be reported to the DPIE as soon as practicable after MCO becomes aware of the exceedance.
- MCO will assess public safety and where appropriate implement safety measures in accordance with the UG1 Longwalls 101-105 Public Safety Management Plan.
- MCO will assess the impacts on the aesthetic values of the land feature.
- MCO will conduct an investigation to evaluate the potential contributing factors. The investigation will:
  - include the re-survey of relevant subsidence monitoring lines;
  - compare and critically analyse measured versus predicted subsidence parameters;
  - review measured subsidence parameters against the observed impact; and
  - review the LW101-105 SMP and update the program where appropriate.
- MCO will identify an appropriate course of action with respect to the identified impact(s), in consultation with specialists and relevant agencies, as necessary. For example:
  - proposed contingency measures;
  - a program to review the effectiveness of the contingency measures; and
  - consideration of adaptive management.

Contingency measures will be developed in consideration of the specific circumstances of the impact (e.g. location, nature and extent) and the assessment of environmental consequences. Potential contingency measures would include management measures similar to those described in Table 12.

The proposed course of action will consider the nature and extent/scale of all recorded impacts. It may, for example, be more appropriate to remediate previously impacted areas as opposed to the specific impact that initiated the implementation of the Contingency Plan.

- MCO will submit the proposed course of action to the DPIE for approval.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

- MCO will implement the approved course of action to the satisfaction of the DPIE.
- In accordance with Condition 2, Schedule 4 of Project Approval (08\_0135), MCO will provide a suitable offset to compensate for the impact or environmental consequence to the satisfaction of the Secretary of the DPIE if either the remediation measures implemented by MCO have failed to remediate the impact or environmental consequence or the Secretary of the DPIE determines that it is not reasonable or feasible to remediate the impact or environmental consequence.

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

### 8.1 TRIGGER ACTION RESPONSE PLAN

The framework for the various components of this LW101-105 LMP are summarised in the TARP shown in Attachment 2. The TARP illustrates how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

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

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

## 9.0 REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

### 9.1 ANNUAL REVIEW

In accordance with Condition 4, Schedule 6 of Project Approval (08\_0135), MCO will conduct an annual review of operations conducted at the Moolarben Coal Complex (including the performance of this LW101-105 LMP) prior to 31 March for the preceding calendar year.

The Annual Review will:

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

In accordance with Condition 11, Schedule 6 of Project Approval (08\_0135), the Annual Review will be made available on the MCO website.

As described in Section 2, this LW101-105 LMP will be reviewed within three months of the submission of an Annual Review, and, if necessary, revised to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

## 9.2 AUDITS

In accordance with Condition 9, Schedule 6 of Project Approval (08\_0135), an independent environmental audit was conducted by the end of December 2015 and 2018, and will be undertaken every three years thereafter. A copy of the independent environmental audit report will be submitted to the Secretary of the DPIE and made publicly available on the MCO website.

The independent environmental audit will be conducted by suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Secretary of the DPIE.

The independent environmental audit will assess the environmental performance of the Project and assess whether it is complying with the requirements of Project Approval (08\_0135), and any other relevant approvals, and recommend measures or actions to improve the environmental performance of the Project.

As described in Section 2, this LW101-105 LMP will be reviewed within three months of the submission of an independent environmental audit, and, if necessary, revised to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

## 9.3 FUTURE EXTRACTION PLANS

In accordance with Condition 5(p), Schedule 4 of Project Approval (08\_0135), MCO will collect baseline data for future Extraction Plans (e.g. for the next Underground Mine).

Consideration of environmental performance and management measures, in accordance with the review(s) conducted as part of this LW101-105 LMP, will inform the appropriate type and frequency of monitoring and management/mitigation for future Extraction Plans.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

## 10.0 INCIDENTS

An incident is defined in Project Approval (08\_0135) as a set of circumstances that:

- causes or threatens to cause material harm to the environment; and/or
- breaches or exceeds the limits or performance measures/criteria in Project Approval (08\_0135).

In the event that an incident which causes or threatens to cause material harm to the environment occurs, the incident will be managed in accordance with the Pollution Incident Response Management Plan.

The reporting of incidents will be conducted in accordance with Condition 7, Schedule 6 of Project Approval (08\_0135).

MCO will notify the Secretary of DPIE and any other relevant agencies of any incident associated with the UG1 Underground Mine which causes or threatens to cause material harm to the environment immediately after MCO confirms that an incident has occurred. For any other incident associated with the UG1, MCO will notify the Secretary and any other relevant agencies as soon as practicable after becoming aware of the incident.. Within seven days of the date of the incident, MCO will provide the Secretary of the DPIE and any relevant agencies with a detailed report on the incident. The report will:

- describe the date, time and nature of the exceedance/incident;
- identify the cause (or likely cause) of the exceedance/incident;
- describe what action has been taken to date; and
- describe the proposed measures to address the exceedance/incident.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

## 11.0 COMPLAINTS

MCO maintains a Community Complaints Line (Phone Number: 1800 556 484) that is dedicated to the receipt of community complaints. The Community Complaints Line is publicly advertised and operates 24 hours per day, seven days a week, to receive any complaints from neighbouring residents or other stakeholders.

MCO has developed a Community Complaints Procedure which details the process to be followed when receiving, responding to and recording community complaints. The Community Complaints Procedure is supported by a Complaints Database.

The Community Complaints Procedure is a component of the MCO Environmental Management Strategy which requires the recording of relevant information including:

- the nature of complaint;
- method of the complaint;
- relevant monitoring results and meteorological data at the time of the complaint;
- site investigation outcomes;
- any necessary site activity and activity changes;
- any necessary actions assigned; and
- communication of the investigation outcome(s) to the complainant.

In accordance with Condition 11, Schedule 6 of Project Approval (08\_0135), the complaints register will be updated monthly and made available on the MCO website.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal



## 12.0 NON-COMPLIANCE WITH STATUTORY REQUIREMENTS

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

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with the Moolarben Coal Complex.

The Environmental and Community Manager (or delegate) will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in Section 10, MCO will notify the Secretary of the DPIE, and any other relevant agencies, of any incident associated with MCO immediately after MCO becomes aware of the incident. Within seven days of the date of the incident, MCO will provide the Secretary of the DPIE, and any relevant agencies, with a detailed report on the incident.

A review of MCO's compliance with all conditions of Project Approval (08\_0135), mining leases and all other approvals and licenses will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the MCO website.

As described in Section 9.2, an independent environmental audit was conducted by the end of December 2015 and 2018, and will be undertaken every three years thereafter. A copy of the independent environmental audit report will be submitted to the Secretary of the DPIE and made publicly available on the MCO website.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

## 13.0 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.

Mine Advice (2019), *Geotechnical Evaluation of Proposed Taking of Unsupported Plunges in LW103A Block*

Mine Subsidence Engineering Consultants (2015) *Subsidence Assessment (MSEC Report MSEC731 Revision A, June 2015)*, Appendix A in Moolarben Coal Operations Pty Ltd (2015) *Moolarben Coal Complex UG1 Optimisation Modification Environmental Assessment*.

Mine Subsidence Engineering Consultants (2017) *Moolarben Coal Complex: Moolarben Project Stage 2 – Longwalls 101 to 103 – Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan*. Report number MSEC867.

Mine Subsidence Engineering Consultants (2019) *Modified Commencing End of LW103 and Proposed 103A Workings* Report number MSEC103. Moolarben Coal Operations Pty Ltd (2009) *Moolarben Coal Project – Stage 2 Environmental Assessment*.

Mine Subsidence Engineering Consultants (2020) *Moolarben Coal Complex: Moolarben Project Stage 2 – Longwalls 104 to 105 – Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan*. Report Number MSEC1084

Moolarben Coal Operations Pty Ltd (2009) *Moolarben Coal Project – Stage 2 Environmental Assessment*.

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

**ATTACHMENT 1**

**UG1 LONGWALLS 101 TO 105 LAND MANAGEMENT PLAN  
SUBSIDENCE IMPACT REGISTER**

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal



**ATTACHMENT 2**

**UG1 LONGWALLS 101 TO 105 LAND MANAGEMENT PLAN  
TRIGGER ACTION RESPONSE PLAN**

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

Condition	Normal		Level 1	Level 2
	Baseline Conditions	Predicted Impacts	Implement Management Measures	Restoration/Contingency Phase
Trigger	<ul style="list-style-type: none"> <li>Photographic record of cliffs (C5 &amp; C6).</li> <li>Record of minor cliffs.</li> <li>Record of rock face features (rock ledges).</li> <li>Record of any observed surface tension cracks in the Longwalls 101-105 Study Area.</li> </ul>	<ul style="list-style-type: none"> <li>Cliff instabilities could occur on up to approximately 15% of the length of the exposed cliffs. Rockfalls expected.</li> <li>Occasional rockfalls or fracturing would not impact more than 5% of the total face area of minor cliffs, rock face features (rock ledges) or steep slopes for each such type of feature within the UG1 mining domain.</li> <li>Surface cracking (steep slopes and land in general) is expected to be typically in the order of 150 to 200 millimetres (mm) wide, but could be as large as 500 mm wide.</li> </ul>	<ul style="list-style-type: none"> <li>Management measures implemented (with regard to the specific circumstances of the subsidence impact [e.g. the nature and extent of the impact] in accordance with <b>Section 7</b>).</li> </ul>	<ul style="list-style-type: none"> <li>If the Subsidence Impact Performance Measure relevant to the cliffs, has been exceeded, or is likely to be exceeded (e.g. more than 15% of total length of cliffs [&gt;6 metres]).</li> <li>If the Subsidence Impact Performance Measure relevant to minor cliffs, rock face features and steep slopes has been exceeded, or is likely to be exceeded (e.g. more than 5% of the total face area of each such type of feature within the UG1 mining domain).</li> <li>Surface cracking greater than 500 mm wide.</li> </ul>
Action	Establish baseline data. Includes: <ul style="list-style-type: none"> <li>Visual inspection (baseline photography).</li> <li>Observations of existing rockfalls / instabilities / surface cracking.</li> </ul>	<ul style="list-style-type: none"> <li>Conduct monitoring, consistent with <b>Section 6</b> and the UG1 Longwalls 101 to 105 Subsidence Monitoring Program.</li> <li>Implement management measures, as required, in accordance with <b>Section 7</b>.</li> </ul>	<ul style="list-style-type: none"> <li>Implement management measures, as required, in accordance with <b>Section 7</b>.</li> </ul>	<ul style="list-style-type: none"> <li>Implement Contingency Plan including notifications as described in <b>Section 8</b>.</li> </ul>
Frequency	<ul style="list-style-type: none"> <li>Prior to commencement of extraction of Longwall LW101 and LW 104.</li> </ul>	<ul style="list-style-type: none"> <li>Monitoring frequency consistent with <b>Section 6</b>.</li> </ul>	<ul style="list-style-type: none"> <li>As required, in accordance with <b>Section 7</b>.</li> </ul>	<ul style="list-style-type: none"> <li>As required, in accordance with <b>Section 8</b>.</li> </ul>
Position of Decision Making	<ul style="list-style-type: none"> <li>Underground Technical Manager.</li> </ul>	<ul style="list-style-type: none"> <li>Underground Technical Manager.</li> </ul>	<ul style="list-style-type: none"> <li>Underground Technical Manager.</li> </ul>	<ul style="list-style-type: none"> <li>Underground Technical Manager.</li> </ul>

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_LMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal