

# NARRABRI MINE



## EXTRACTION PLAN

## LAND MANAGEMENT PLAN

LW 203 – LW 206


	<b>NARRABRI MINE ENVIRONMENTAL MANAGEMENT SYSTEM</b>	Document owner:	Environmental Superintendent
		Document approver:	Environmental Manager
		Revision period:	5 years
		Revision:	0B
		Last revision date:	20 August 2024
<b>WHC_PLN_NAR_ LAND MANAGEMENT PLAN - LW 203 – LW 206</b>			

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## Acronyms and abbreviations

Acronym	Description
°	degrees
AHD	Australian Height Datum
AoD	Angle of Draw
CF	Cut and flit
cm	centimetre
Cwlth	Commonwealth
DEM	digital elevation model
DGS	Ditton Geotechnical Services
DPE	The NSW Department of Planning and Environment
DPHI	The NSW Department of Planning, Housing and Infrastructure
EA	Environmental Assessment
EP 203-206	Extraction Plan for LW 203 to LW 206
EP-BMP	Extraction Plan - Biodiversity Management Plan
EP-LMP	Extraction Plan - Land Management Plan (this document)
EP-WMP	Extraction Plan – Water Management Plan
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cwlth)
ha	hectare
IEA	Independent Environmental Audit
km	kilometre
LiDAR	light detection and ranging
LSC	Land and Soil Capability
LW	longwall panel
m	metre
mg/l	milligrams per litre
ML	mining lease; megalitre
mm	millimetre
mm/m	millimetre per metre
MOD 5	Modification 5
MOD 7	Modification 7
Mtpa	million tonnes per annum
NCOPL	Narrabri Coal Operations Pty Ltd
NDVI	normalised difference vegetation index
NSC	Narrabri Shire Council
ROM	run of mine
U95%CL	upper 95 % confidence level

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Acronym		Description
WHC	Whitehaven Coal Limited	
XL	Cross section cross-line across the longwall panels	



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## 1. Introduction

### 1.1 Background

The Narrabri Mine is an existing underground coal mining operation situated in the Gunnedah Coalfield. It is located approximately 25 kilometres (**km**) south-east of Narrabri and approximately 60 km north-west of Gunnedah, within the Narrabri Shire Council (**NSC**) Local Government Area in New South Wales (**NSW**). The Narrabri Mine includes an underground coal mine, a coal handling and preparation plant and associated rail siding and surface infrastructure.

The Narrabri Mine is operated by Narrabri Coal Operations Pty Ltd (**NCOPL**), on behalf of the Narrabri Mine Joint Venture, which consists of two Whitehaven Coal Limited (**WHC**) wholly owned subsidiaries, and other joint-venture partners<sup>1</sup>. The underground mine is covered by Mining Lease (**ML**) 1609 which covers an area of 5,298 hectares (**ha**) for the predominant purpose of mining for coal from the Hoskissons Coal Seam.

Stage 1 of the Narrabri Mine was approved in November 2007 under Part 3A of the *Environmental Planning and Assessment Act 1979* (**EP&A Act**). Construction of the mine and supporting infrastructure commenced in 2008, with production using a continuous miner commencing in 2010. Following the approval of the Stage 2 Environmental Assessment (R.W Corkery & Co., 2009) (the **EA**) and the issue of the Stage 2 Project Approval 08\_0144 (**Project Approval**) in July 2010, and *Environmental Protection and Biodiversity Conservation Act 1999* (**EPBC Act**) approval (**2009/5003**) in January 2011, the Narrabri Mine was converted to an 8 million tonnes per annum (**Mtpa**) run of mine (**ROM**) longwall mining operation, which commenced in 2012.

The Project Approval has subsequently been modified on a number of occasions. The environmental assessment for Modification 5 (Resource Strategies, 2015) (**MOD 5**), approved in December 2015, changed the mine geometry by reducing the number of longwall (**LW**) panels from 26 to 20, increased some LW panel widths and increased the production to 11 Mtpa of ROM coal until July 2031.

Modification 7, the most recent modification of the Project Approval, was approved on 23 November 2021. The environmental assessment for Modification 7 (Resource Strategies, 2021) (**MOD 7**) describes the change in mining method within the extent of the previously approved LW 201 and LW 202 and allows for up to 0.7 Mtpa via bord and pillar extraction at pillar reduction panels Cut and Flit (**CF**) 201 to CF 205. There is no change to the previously approved longwall panels LW 203 to LW 209. The bord and pillar mining will occur concurrently with existing longwall operations for a period of approximately five years, with the maximum ROM coal production rate remaining within the approved limit of 11 Mtpa.


### 1.2 Purpose and scope

This Extraction Plan - Land Management Plan (**EP-LMP** or **Plan**) for LW 203 to LW 206 has been prepared in accordance with Schedule 3 Condition 4(h) of the Project Approval and the Department of Planning, Housing and Infrastructure (**DPHI**) (formerly the Department of Planning and Environment [**DPE**] *Extraction Plan Guideline* (DPE, 2022).

The EP-LMP sets out the objectives, performance measures and management actions required to manage the potential impacts and/or environmental consequences of the proposed second workings on land in general above LW 203 to LW 206 (the **Extraction Plan Area**<sup>2</sup>). This Plan forms Appendix B of the Extraction Plan for LW 203 to LW 206 (**EP 203-206**).

<sup>1</sup> For full details on the joint venture ownership, refer to the introduction of the Extraction Plan.

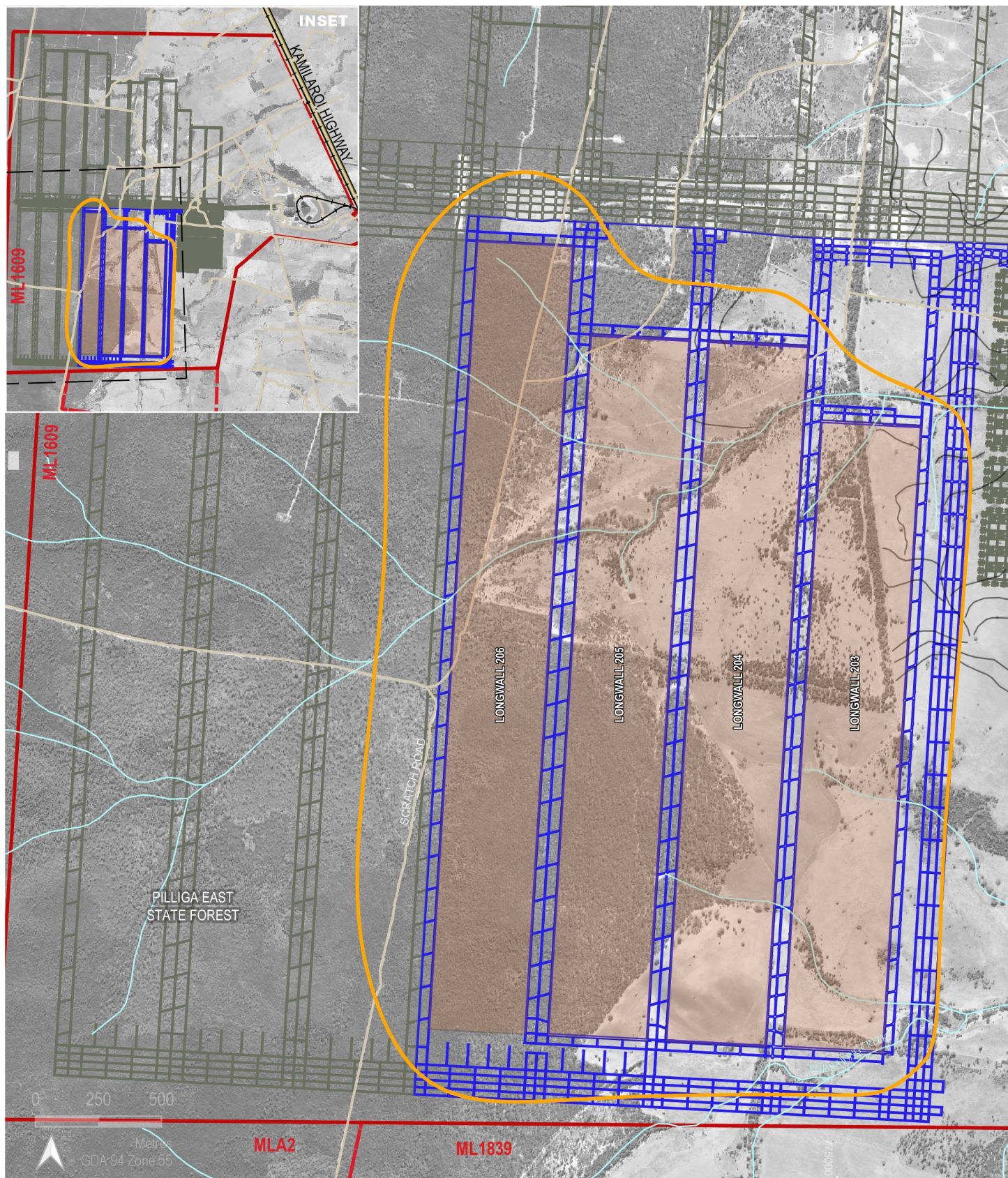
<sup>2</sup> The area located within the 45° Angle of Draw as shown on Figure 1-1.

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The Ditton Geotechnical Services Pty Ltd (**DGS**) *Mine Subsidence Assessment Report for LW 203 to LW 206* (DGS, 2022) (**Mine Subsidence Assessment Report**) has been used as a basis for developing the performance measures and management actions in response to the predicted impacts on land within the Extraction Plan Area. The Mine Subsidence Assessment Report is presented in full as Appendix J to EP 203-206.

The Extraction Plan Area and underground mining layout is presented in Figure 1-1. A detailed description of the underground mining method is provided within EP 203-206.





# LEGEND


- ML 1609
- ML 1839
- MLA2
- Underground mining layout
- Longwalls 203 to 206
- Proposed longwall voids (LW203-206)
- 45 degree angle of draw
- Road
- Watercourse
- Contour bank

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FIGURE 1-1

Extraction Plan Area and Underground Mining Layout for LW 203 to LW 206



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### 1.3 Objectives

The objectives of this EP-LMP are to:

- provide details of the relevant statutory requirements, including any relevant approval, licence or lease conditions;
- provide a description of the management of potential impacts and/or environmental consequences on land in general;
- provide a monitoring program that:
  - monitors for potential impacts to land as a result of subsidence; and
  - evaluates the effectiveness of the management actions.
- provide triggers to inform additional and/or adaptive management actions;
- describe the protocol for managing and reporting any incident, non-compliance or exceedance of any impact assessment criteria or performance criteria, complaint, or failure to comply with other statutory requirements;
- detail the regulatory reporting requirements;
- describe the protocol for periodic review of this Plan; and
- identify the roles and responsibilities for implementation of this Plan.

### 1.4 Statutory requirements

#### 1.4.1 Project Approval

This Plan has been developed in accordance with Schedule 3 Condition 4 of the Project Approval which requires NCOPL to prepare an Extraction Plan for all second workings within the area of the Approved Mine Plan (Appendix H of EP 203-206) to the satisfaction of the Secretary.


In accordance with Schedule 3 Condition 4(h), the Extraction Plan must 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 upon land in general.

Schedule 3 Condition 4(b) of the Project Approval requires the Extraction Plan and its sub plans to be approved by the Secretary prior to NCOPL carrying out any of the second workings covered by EP 203-206.

Project Approval Schedule 6 Condition 2 lists the requirements for the preparation of management plans which must be prepared in accordance with any relevant guidelines (section 1.2) and include details of the relevant approval, licence or lease conditions. Attachment 1, Table A1-1 provides a summary of the Project Approval conditions relevant to this Plan and outlines the section of the EP-LMP in which each of these conditions have been addressed. Table A1-2 provides the relevant SoCs and a cross reference table to where these commitments have been addressed.

#### 1.4.2 Mining lease

NCOPL are the holder of ML 1609 (issued in January 2008 and varied 19 August 2022).

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### 1.4.3 EPBC Act approval

The Narrabri Mine was granted EPBC 2009/5003 in 2011 issued under the EPBC Act (last varied on 24 March 2021).

EPBC 2009/5003 prescribes conditions to minimise potential impacts on EPBC Act listed threatened species and communities within the mine site. Condition 3 of EPBC 2009/5003 states that in order to minimise potential impacts on EPBC Act listed threatened species and communities within the mine site, prior to any Works commencing and in accordance with the NSW Director General's Assessment Report and approval conditions (26 July 2010), the person undertaking the action must develop and implement an Extraction Plan.

## 1.5 Risk assessment

A subsidence risk assessment has been undertaken to identify the risks associated with subsidence at the Narrabri Mine. It builds on previous risk assessments completed for LW 101 to LW 110 and Panels 201 to 202 and is presented as Appendix I to EP 203-206. The updated risk assessment for LW 203 to LW 206 assessed all risks identified within the Extraction Plan Area as either low or moderate.

The potential environmental impacts and consequences relevant to land in general are further discussed in section 3.

## 1.6 Preparation and consultation

In accordance with Schedule 3 Condition 4(h) of the Project Approval, NCOPL is required to prepare this EP-LMP in consultation with any affected public authorities to manage the potential impacts and/or environmental consequences of the proposed second workings upon land in general. The draft EP-LMP (Revision A) was provided to NSC as Appendix B to EP 203-206 on 8 November 2022.

Attachment 2 provides evidence of the consultation process, including a cross reference table addressing the comments received, and detailing the section of the Plan where these comments have been addressed (Table A2-1).


Any further amendments or updates to this Plan will be referred to NSC for further review and comment.

## 1.7 Access to information

In accordance with Schedule 6 Condition 10 of the Project Approval, the approved Extraction Plan and all appendices, audits and reports, and summaries of all monitoring data (where relevant) will be made publicly available on the WHC website. All information will be kept up to date.

Note that any printed copies of this EP-LMP are uncontrolled.



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## 2. Baseline information

### 2.1 Topography and landforms

Topography in the vicinity of the Narrabri Mine is characterised by the vegetated, hilly country of Jacks Creek State Forest and the Pilliga East State Forest to the west, grading down to the alluvial plains associated with the Namoi River approximately 5 km east of the underground mining area. Further east, topography is dominated by the ranges of the Mount Kaputar National Park.

Topographic relief within the Extraction Plan Area ranges from 279 m Australian Height Datum (**AHD**) to 340 m AHD. The surface terrain is generally flat with slopes ranging from 1° to 5°. Slopes increase to 10° to 35° in several rocky 'hillock' locations, including the ephemeral creeks and tributaries (or gullies), which drain the Extraction Plan Area towards the north-east. The hillocks have Pilliga Sandstone exposures with local topographic relief ranging between 10 m and 15 m above the surrounding plains.

### 2.2 Geology

The western portion of ML 1609 is located within the Pilliga Sandstone, a formation within the Jurassic Surat Basin. The lithology of this unit consists of fine to coarse grained quartzitic sandstone. The eastern portion of ML 1609 is located in the Purlawaugh Formation and Garrawilla Volcanics, which form the lower stratigraphy of the Surat Basin.

The Purlawaugh Formation comprises thinly bedded, fine grained lithic sandstone, siltstone, and minor claystone. The Garrawilla Volcanics unconformably overlie the Triassic Napperby Formation and consist of basaltic flows with minor mudstone. The Napperby Formation consists of quartz-lithic sandstone over laminite and siltstone. A dolerite sill intrusion exists in the lower units of the Napperby Formation.

Underlying the above units are conglomerate and sandstone beds of the Triassic Digby Formation and the Permian Black Jack Group, which include the Hoskissons Seam and Arkarula Sandstone.

There are several northwest and north east trending normal and reverse faults, which have throws ranging from 1 m to 5 m within the Hoskissons Seam.

### 2.3 Soils

Silty sand and sandy clay surface soils to 4 m are present within the Extraction Plan Area and are mildly to highly erosive/dispersive. Clayey soils are associated with the outcropping Garrawilla Volcanics and overlying Purlawaugh formation.

Sandy alluvial deposits exist along the creek channels with no rock exposures present. The channels are typically incised with steep to very steep banks between 0.5 m and 3.5 m high.

Table 2-1 and Table 2-2 detail the typical soil attributes associated with the geological formations within the Extraction Plan Area.

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**Table 2-1 Soil attributes of Purlawaugh Formation and Piliga Sandstone**


Geological formation		Purlawaugh Formation			Pilliga Sandstone	
Landform	Major drainage line	Crests	Floodplains	Lower slopes	Midslopes	Upper slopes
Surface condition	Loose, soft or firm, surface stone absent	Loose to firm, surface stone absent or low to medium amounts of rounded angular surface stone (to 15 centimetres [cm])	Loose to firm or hard setting, surface stone absent	Loose, surface stone absent or some rounded surface stone (1-2 cm)	Firm, sometimes self-mulching and cracked, surface stone absent or some angular surface stone (<1 cm) and some flat sandstone to 15 cm present	Firm, surface stone absent
Topsoil	<ul style="list-style-type: none"> <li>Up to 103 cm deep</li> <li>Sand, clayey sand to sandy light clay</li> <li>pH 6.0 - 7.5</li> <li>Poorly structured (massive/single-grained), although sometimes well structured</li> <li>Slight dispersibility (D% and EAT)</li> <li>Non-saline</li> </ul>	<ul style="list-style-type: none"> <li>Up to 27 cm deep</li> <li>Clayey sand or sandy medium clay</li> <li>pH 5.0 - 5.5</li> <li>Moderately to well structured</li> <li>Moderate dispersibility (D%)</li> <li>Slight dispersibility (EAT)</li> <li>Non-saline</li> </ul>	<ul style="list-style-type: none"> <li>Up to 39 cm deep</li> <li>Sandy loam to medium clay</li> <li>pH 6.0 - 6.5</li> <li>Well structured</li> <li>Slight dispersibility (D% and EAT)</li> <li>Non-saline</li> </ul>	<ul style="list-style-type: none"> <li>Up to 25 cm deep</li> <li>Sandy clay loam to light clay</li> <li>Well structured</li> <li>Slight dispersibility (D% and EAT)</li> <li>Non-saline</li> </ul>	<ul style="list-style-type: none"> <li>Up to 37 cm deep</li> <li>Silty clay to medium clay</li> <li>pH 6.0 - 7.5</li> <li>Well structured</li> <li>Slight dispersibility (D% and EAT)</li> <li>Non-saline</li> </ul>	<ul style="list-style-type: none"> <li>Up to 21 cm deep</li> <li>Clayey sand to light to medium clay</li> <li>pH 4.5 - 6.5</li> <li>Moderately to well structured</li> <li>Slight dispersibility (D%)</li> <li>Not or slightly dispersible (EAT)</li> <li>Non-saline</li> </ul>
Subsoil	<ul style="list-style-type: none"> <li>Up to 3 horizons (to 300 cm)</li> <li>Sand to medium to heavy clay (sometimes sandy)</li> <li>pH 5.5 - 7.0, although sometimes pH 9.0-10 at depth</li> <li>Poorly structured (massive) or well-structured in more clayey horizons</li> <li>Very highly dispersible (D%)</li> <li>Slightly to high to moderately dispersible (EAT)</li> <li>Lowest horizon sometimes slightly saline</li> </ul>	<ul style="list-style-type: none"> <li>2 horizons (to 127 cm)</li> <li>Medium clay (sometimes sandy)</li> <li>pH 5.5 - 8.5</li> <li>Well structured, although sometimes poorly structured</li> <li>Moderate dispersibility (D%)</li> <li>Slight dispersibility (EAT)</li> <li>Non-saline</li> </ul>	<ul style="list-style-type: none"> <li>Up to 4 horizons (to 255 cm)</li> <li>Sandy loam to medium (gritty) clay</li> <li>pH 6.5 - 7.54 sometimes pH 8.0-9.0</li> <li>Well structured, occasionally massive</li> <li>Slight to very high dispersibility (D%)</li> <li>High to moderate and very high dispersibility (EAT)</li> <li>Lowest horizon slightly saline</li> </ul>	<ul style="list-style-type: none"> <li>Up to 4 horizons (to 260 cm)</li> <li>Clay loam to heavy clay</li> <li>pH 6.5 - 7.5, sometimes pH 8.0 - 9.0 (pH 4.0 recorded at lowest horizon)</li> <li>Well structured</li> <li>Negligible to very high dispersibility (D%)</li> <li>Very high dispersibility (EAT)</li> <li>Most subsoil horizons slightly to moderately saline</li> </ul>	<ul style="list-style-type: none"> <li>Up to 5 horizons (to 270 cm)</li> <li>Light to medium clay to heavy clay</li> <li>pH 7.5 - 9.9 (pH 4.5 in some lowest horizons)</li> <li>Usually well structured, sometimes massive</li> <li>Slight to moderate dispersibility (D%)</li> <li>High to moderate or very high dispersibility (EAT)</li> <li>Lower horizons slightly to moderately saline</li> </ul>	<ul style="list-style-type: none"> <li>Up to 4 horizons (to 230 cm)</li> <li>Sandy clay loam to medium to heavy clay</li> <li>pH 4.5 - 6.5, up to pH 9.5 at depth</li> <li>Poorly structured (massive), at times well structured</li> <li>Slight dispersibility (D% and EAT)</li> <li>Non-saline</li> </ul>

**Note:**  
D% - dispersion percentage  
EAT - Emerson Aggregate Test

Table 2-2 Soil attributes of Garrawilla Volcanics

Geological formation		Garrawilla Volcanics	
Landform	Drainage line	Floodplain	Upper slopes
Surface condition	Firm, surface stone absent	Loose to firm, surface stone absent or sometimes medium amounts (angular) to 15 cm	Loose or self-mulching, some angular surface gravel and stone (1-15 cm) in upper layers
Topsoil	<ul style="list-style-type: none"><li>Up to 30 cm</li><li>Medium to heavy clay</li><li>pH 6.5</li><li>Well structured</li><li>Slightly dispersible (D% and EAT)</li><li>Non-saline</li></ul>	<ul style="list-style-type: none"><li>Up to 46 cm</li><li>Light sandy clay loam to sandy clay loam</li><li>pH 5.5 - 6.0</li><li>Well structured</li><li>Slightly dispersible (D% and EAT)</li><li>Non-saline</li><li></li></ul>	<ul style="list-style-type: none"><li>Up to 36 cm</li><li>Medium to heavy clay or heavy clay</li><li>pH 6.0 - 9.0</li><li>Well structured</li><li>Slightly dispersible (D%)</li><li>Not or slightly dispersible (EAT)</li><li>Non-saline</li></ul>
Subsoil	<ul style="list-style-type: none"><li>3 horizons (to 250 cm)</li><li>Medium clay or medium to heavy clay</li><li>pH 8.0 - 9.0</li><li>Well structured</li><li>Very high dispersibility (D%)</li><li>High or high to moderate dispersibility (EAT)</li><li>Non-saline</li></ul>	<ul style="list-style-type: none"><li>3 horizons (to 250 cm)</li><li>Light to medium clay to heavy clay</li><li>pH 6.0 - 7.5 (sometimes pH 8.0 - 9.0 at depth)</li><li>Well structured</li><li>Slight to moderate dispersibility (D%)</li><li>Slight to very high dispersibility (EAT)</li><li>Non-saline</li></ul>	<ul style="list-style-type: none"><li>Up to 4 horizons (to 250 cm)</li><li>Light to medium clay to heavy clay</li><li>pH 7.0 - 9.0</li><li>Well structured</li><li>Slight dispersibility (D%)</li><li>Not or slightly dispersible (EAT)</li><li>Non-saline</li></ul>

**Note:**  
D% - dispersion percentage  
EAT - Emerson Aggregate Test

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## 2.4 Land and soil capability classification

The land within the Extraction Plan Area is exclusively owned by NCOPL, with the Pilliga East State Forest located in close proximity to the west. Land holdings have historically been used for livestock grazing and limited cereal crop farming with occasional orchard farming (e.g. olive groves).

The *Land and Soil Capability Assessment Scheme - second approximation* (OEH, 2012) uses the biophysical features of the land and soil including landform position, slope gradient, drainage, climate, soil type and soil characteristics to derive detailed rating tables for a range of land and soil hazards. The land and soil capability classification (**LSC**) gives an indication of the land management practices that can be applied to a parcel of land.

Land and soil capability classes have been mapped across the Extraction Plan Area. The LSC classes associated with the Extraction Plan Area are classes 4, 5 and 7 (Figure 2-1), with a small portion mapped as class 3 over the south eastern portion of LW 203.

Consistent with the current and historical land use practices, land within the Extraction Plan Area is capable of supporting land uses such as cropping, high intensity grazing and horticulture.

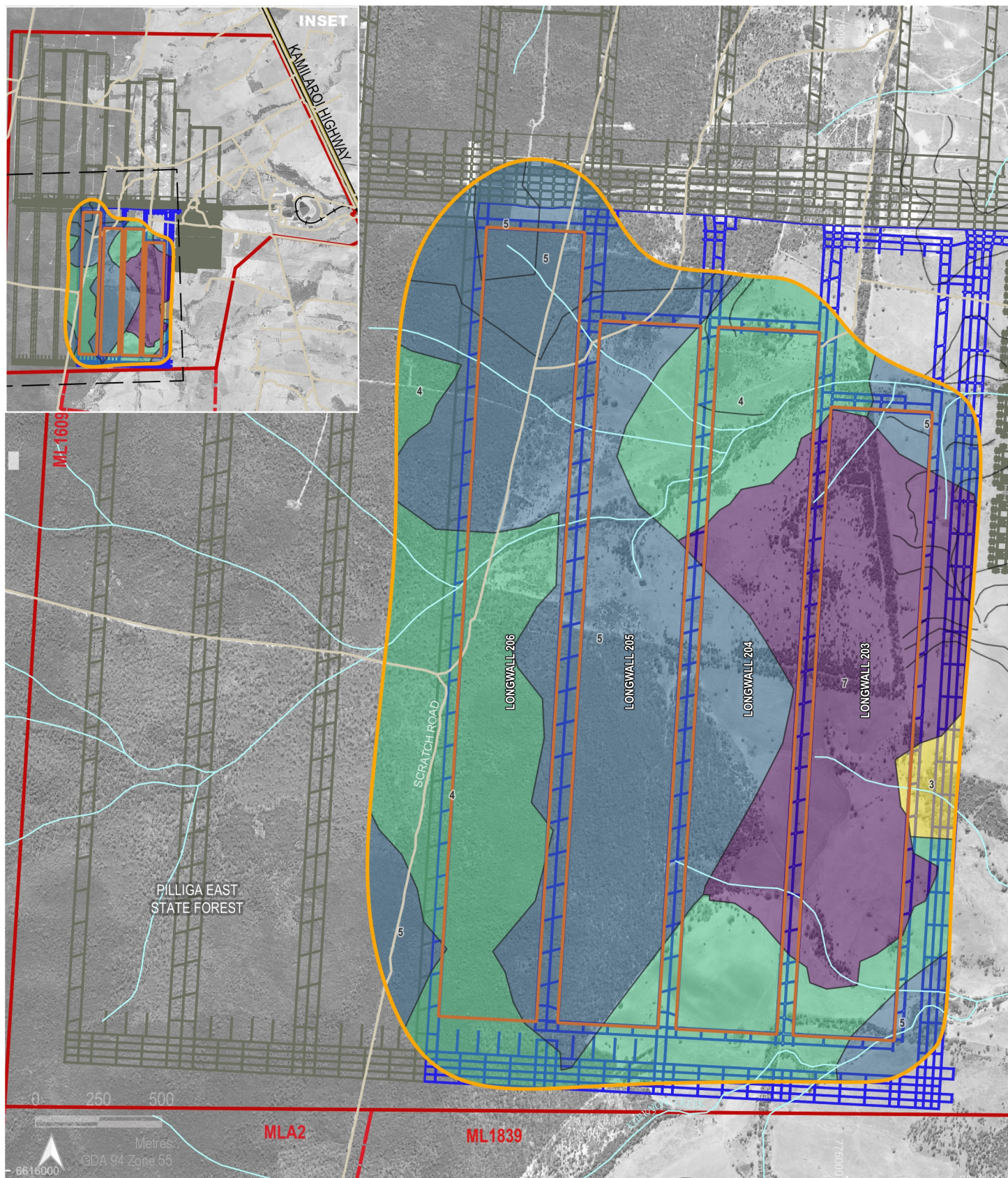
Table 2-3 provides the land uses associated with LSC class 3, 4, 5 and 7.

**Table 2-3 Land and soil capability classes**

LSC class	General definition
<b>Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation).</b>	
3	<b>High capability land:</b> Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
<b>Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation).</b>	
4	<b>Moderate capability land:</b> Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment, and technology.
5	<b>Moderate to low capability land:</b> Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
<b>Land generally incapable of agricultural land use (selective forestry and nature conservation)</b>	
7	<b>Very low capability land:</b> Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.

Source: Table 2 (OEH, 2012)





## LEGEND

- ▬ ML 1609
- ▬ ML 1839
- ▬ MLA2
- ▬ Underground mining layout
- ▬ Longwalls 203 to 206
- ▬ Proposed longwall voids (LW203-206)
- ▬ 45 degree angle of draw
- ▬ Roads
- ▬ Watercourse
- ▬ Contour bank

## Land and soil capability


- 3 - Moderate limitations
- 4 - Moderate to severe limitations
- 5 - Severe limitations
- 7 - Extremely severe limitations

## NARRABRI MINE

### FIGURE 2-1

Land and Soil Capability Classes  
within the Extraction Plan Area



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## 2.5 Drainage

The Extraction Plan Area is located within the Kurrajong Creek catchment. The headwaters of Kurrajong Creek and Kurrajong Creek Tributary 1 rise in the Pilliga East State Forest to the west. The watercourses travel north-east towards the Namoi River, converging downstream of the Narrabri Mine Pit Top Area (Figure 1-1).

The main Kurrajong Creek channel traverses the southern boundary of LW 203 and drains in a north-easterly direction. It is predominately a third order watercourse. Kurrajong Creek Tributary 1 and its tributaries traverse the northern portion of the Extraction Plan Area before flowing into Tulla Mullen Creek to the east of ML 1609. Kurrajong Creek Tributary 1 drains in a north-easterly direction and is predominately a third order watercourse.

Kurrajong Creek is ill-defined to the downstream boundary of LW 203, consisting of a broad flow path with no recognised low flow channel. Creek bed material predominantly consists of a sandy loam with intermittent sand deposition. The bed slope is between approximately 0.40% to 0.95%. There is a 4 metre (**m**) headcut separating the downstream incised channel and the upstream ill-defined channel immediately east of LW 203. The drop is associated with historical headward erosion of the channel bed (i.e. not due to the existing Narrabri Mine) and will likely continue to progress upstream with successive flood events. Kurrajong Creek and its tributaries are ephemeral with minimal to no baseflow. Downstream of the headcut, Kurrajong Creek is incised with a channel width of approximately 10 m wide and vertical banks approximately 0.8 m deep.

In relation to assessing effectiveness of erosion and sediment controls, the surface water quality in the watercourses associated with the Narrabri Mine can be characterised as having variable levels of Total Suspended Solids, with median values ranging from approximately 20 milligrams per litre (**mg/L**) to 132 mg/L. Baseline surface water quality and monitoring is discussed in detail in the Water Management Plan (Appendix A to EP 203-206).

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### 3. Subsidence impacts and potential environmental consequences

#### 3.1 Subsidence predictions

Subsidence predictions for the Extraction Plan Area were assessed and are presented in detail in the Mine Subsidence Assessment Report (DGS, 2022), provided as Appendix J to EP 203-206. The Mine Subsidence Assessment Report details the potential impacts to natural features within the Extraction Plan Area based on the predictions of conventional and non-conventional subsidence. The predictions include a review of the subsidence effects measured above previously undermined LW 101 to LW 109.

The predicted maximum subsidence estimates for the Extraction Plan Area are summarised in Table 3-1 and shown on Figure 3-1.

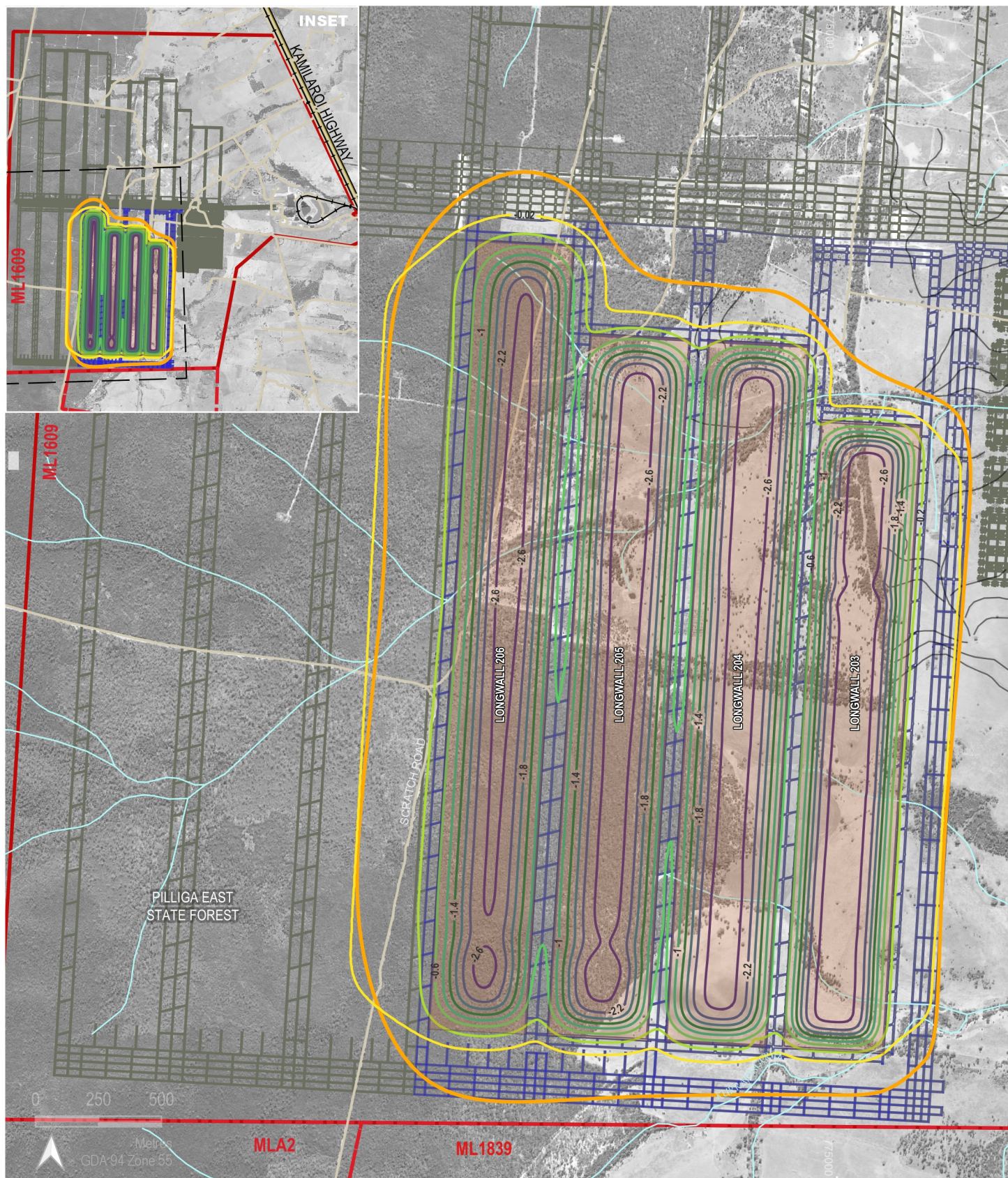
Note that the predicted values may be occasionally exceeded (up to 5% of the time) due to discontinuous strata behaviour associated with near surface cracking, joint displacement, geological features (e.g. faults) and/or rapid changes in topography (creek beds).

**Table 3-1 Maximum final subsidence effect predictions**

LW	Cover depth (m)	Subsidence (m)	Tilt (mm/m)	Tensile strain (mm/m)	Compressive strain (mm/m)
203	200-208	2.63 - 2.80	34 - 54	15 - 32	16 - 35
204	230-242	2.72 - 2.80	29 - 47	11 - 26	12 - 27
205	248-282	2.75 - 2.80	24 - 39	9 - 19	9 - 21
206	280-311	2.75 - 2.80	20 - 33	7 - 15	7 - 16

Source: adapted from Table 4 (DGS, 2022)





## LEGEND

- ML1609 ML1609
- ML1839 ML1839
- MLA2 MLA2
- Underground mining layout
- Longwalls 203 to 206
- Proposed longwall voids (LW203-206)
- 45 degree angle of draw
- Roads
- Watercourse
- Contour bank

## Subsidence contours (m)


- -0.02
- -0.2
- -0.6
- -1
- -1.4
- -1.8
- -2.2
- -2.6

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### FIGURE 3-1

Predicted Subsidence Contours  
for LW 203 to LW 206



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### 3.1.1 Surface cracking

Based on the predicted range of maximum transverse tensile strains for the proposed longwall panels (i.e. 7 mm/m to 32 mm/m), surface crack widths are estimated to range from approximately 210 millimetres (mm) to 330 mm in cohesionless soils and from approximately 420 mm to 650 mm in cohesive soils or shallow rock (Table 3-2). Cracks usually develop within several days after a longwall face has retreated beneath a given location, with some of the cracks closing in the compression zone in the middle of the fully developed subsidence trough, together with new cracks developing in the tensile zones along and inside the panel sides approximately two to three weeks later.

Surface crack widths are upper 95 % confidence level (**U95%CL**) values (to the nearest 10 mm), which means they may be exceeded 5% of the time (by definition) due to adverse topographic or geological conditions. Whilst this effect is unlikely to occur within the Extraction Plan Area, crack widths may exceed the predicted range near the crests of steep creek banks or elevated ridges. The steep rocky slopes above LW 204 and LW 205 are considered likely to be impacted by surface cracking more than 300 mm wide. Based on the above, it is estimated that approximately 0.02 km<sup>2</sup> to 0.04 km<sup>2</sup> of the surface will be crack affected. This represents 0.13% to 0.27% of the extracted longwall area.


Based on reference to the Australian Coal Industry's Research Program (2003), surface cracks will likely develop by the time the longwall face has retreated past a given location for a distance equal to one to two times the cover depth (i.e. ranging from 170 m to 840 m, based on cover depths at the Narrabri Mine).

**Table 3-2 Predicted maximum crack width in flat terrain**

LW	Cross section cross-line [XL]	Panel width [W] (m)	Cover depth [H] (m)	Panel W/H	Effective bay length* (m)	Predicted maximum tensile strain (mm/m)		Predicted U95%CL crack width (mm)	
						Mean	U95%	Sand or Loam	Clay or Rock
203	6	402.8	208	1.94	10.4	15	29	300	600
	7	402.8	200	2.01	10.0	15	31	310	620
	8	402.8	204	1.97	10.2	16	32	330	650
204	6	402.8	232	1.74	11.6	12	24	280	560
	7	402.8	242	1.66	12.1	11	23	280	560
	8	402.8	230	1.75	11.5	13	26	300	600
205	6	399.7	248	1.61	12.4	10	20	250	500
	7	399.7	282	1.42	14.1	9	17	240	480
	8	399.7	275	1.45	13.8	9	19	260	520
206	6	395.3	280	1.41	14.0	8	15	210	420
	7	395.3	311	1.27	15.6	7	14	220	440
	8	395.3	304	1.3	15.2	8	15	230	460

Source: DGS, 2022 (Table 7)

\* - max (H/20, 10m)

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### 3.1.2 Sub-surface cracking

The void created by extracting coal invariably results in the collapse of the immediate roof strata, which is subject to bending and shearing stresses, as the overburden tries to span the void created by mining. The extent of fracturing and shearing up through the strata is dependent on mining geometry and overburden geology.

Overburden may be divided into zones of surface and sub-surface fracturing. These zones are defined (in descending order) as follows:

- Surface Cracking Zone (D-Zone) – Unconstrained;
- Elastic Deformation Zone (C-Zone) – Constrained;
- Discontinuous or Minor Fracture Zone (B-Zone) – Constrained;
- Continuous Fracture Zone (A-Zone) – Unconstrained; and
- Caved Zone (included in the A-Zone) – Unconstrained.

Continuous (A-Zone) fracturing will most likely develop below the surface, with surface to seam connectivity predicted as 'likely'. The predicted heights of cracking are also estimated to extend to within 20 m depth below the surface (i.e. within the limits of the surface cracking zone).

Based on the Mine Subsidence Assessment Report Geology and Geometry Pi-Term model, direct hydraulic-fracture connection to the mine workings is estimated to encroach within 26 m to 55 m depth below the surface above LW 203 to LW 206. The U95%CL A/H ratios range from 0.87 to 0.82 for these panels.

The Pilliga Sandstone outcrops may develop deeper cracking than the more thinly bedded Purlawaugh formation sequences. As the Pilliga Sandstone units exist only above LW 204 to LW 206 where cover depth is more than 220 m, it is considered 'unlikely' that A-Zone cracking will encroach within 20 m of the surface and cause a surface to seam connection in these areas. The Mine Subsidence Assessment Report concluded only LW 203 is considered a 'possible' or 25% probability case that connective cracking could reach the surface.


Discontinuous fracturing (B-zone) will be expected to occur within the Extraction Plan Area, resulting in an increase in rock mass storage capacity and horizontal permeability without direct hydraulic connection to the workings. Discontinuous fracturing is likely to interact with surface cracks (D-Zones) where cover depths are less than 375 m above the proposed longwalls (i.e. all of the proposed longwalls). Creek flows may be temporarily re-routed into open cracks to below-surface pathways and re-surface downstream of the mining extraction limits in the mining area.

### 3.1.3 Steep slopes

The predicted subsidence effects (tilting, curvature and horizontal strain) may cause impacts such as cracking and instability of steep slopes and minor cliff faces situated above extracted longwall panels. Crack widths on subsided slopes are likely to be larger than those that develop in relatively flat terrain due to rotation and strain effects.

Cracking impacts that may develop on the steep slope features inside the limits of longwall extraction include:

- Crack widths from 385 mm to 770 mm;
- Crack depths between 3 m and 15 m;
- Crack lengths from 30 m to 100 m; and

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- Crack spacing (in groups of 2 to 3) between 8 m and 13 m.

A summary of the predicted crack widths for the steep slope (S12) located above LW 204 are presented in Table 3-3. The location of S12 is shown on Figure 15a and Figure 15b in the Mine Subsidence Assessment Report, and the locations of major surface contours are shown on Plan 2 (Appendix H to EP 203-206).

**Table 3-3 Predicted crack widths on steep slopes**

Slope height Z (m)	Cover depth (m) (slope aspect)	Maximum subsidence (m)	Maximum feature strain (mm/m)	Maximum feature tilt (mm/m)	Crack width from strain (mm)	Crack width from tilt (mm)	Crack width from tilt & strain (mm)
6 - 12	245 (SE)	2.8	-13 to 15 (30)	10 - 15	185 (370)	120 (240)	385 (770)

Source: adapted from Table 8C (DGS, 2022)

S12 = Steep Rocky Slope No. 12. Crack widths assume a single crack may develop along the upslope rib side of the given longwall beneath steep slopes > 18°. (brackets) - discontinuous strain due to cracking.

Impacts to S12 have been estimated based on a transitional subsidence crack width of 840 mm that is sub-parallel to the longwall face and extends the full width of the undermined slope (or two 150 mm to 420 mm wide cracks spaced at 10 m apart). The slope will be located within the compressive strain zone after subsidence is completed.

### 3.1.4 Erosion

Surface cracks on steep slopes may allow surface runoff to enter the rock mass. The seepage pathways could result in internal erosion and local instability to develop. Water pressures or concentrated flow may contribute to future instability such as reducing the effective frictional strength along the potential slide plane or contact surface. The likelihood of significant water pressures developing behind the slope faces is low, as water is likely to drain through open joints or cracks and limit the head of water that can develop.

The rate of soil erosion is expected to increase significantly in areas with exposed dispersive/reactive soils and slopes less than 10° are expected to have low erosion rate increases, except for the creek channels, which are expected to re-adjust to any changes in gradient for predicted gradient changes in the Extraction Plan Area of +/- 1.5°.


Erosion along the creek beds is expected to develop above chain pillars between the panels and on the side where the gradients increase. Sediment is expected to accumulate where gradients decrease.

Table 3-4 details the soil attributes associated with the Extraction Plan Area and limitations associated with land degradation following subsidence.

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**Table 3-4 Soil attributes and limitations associated with land degradation following subsidence**

Soil attribute	Surface geology								
	Purlawaugh formation			Pilliga sandstone			Garrawilla volcanics		
Soil depth	Usually very deep profiles on the crests where profiles tend to be shallower			Generally less than 0.25 m; shallower on crests and slopes			Deep profiles on slopes, floodplains and in drainage lines. More likely to be shallower on upper slopes and crests.		
	<i>Not limiting</i>			<i>Not limiting</i>			<i>Not limiting</i>		
Typical soil depths	Drainage lines	Floodplains	Slopes	Upper slopes	Upper slopes	Mid slopes	Drainage lines	Floodplain	Crests
Topsoil	0<1.0 m	0~0.35 m	0~0.30 m	0 ~0.35 m	0~0.15 m	0~0.40 m	0-0.30 m	0~0.40 m	0~0.25 m
Subsoil	1.0-3.0 m	0.35-2.5 m	0.30-2.6 m	0.35-2.5 m	0.15-1.38 m	0.40~2.20 m	0.30-2.5 m	0.4-2.50 m	0.25-1.30 m
Soil texture	A mix of often coarse textured topsoil and more clayey subsoils			Generally the most sandy soils across the mine site			Usually finer textured (more clayey).		
	<i>Not limiting</i>			<i>Not limiting</i>			<i>Not limiting</i>		
Soil surface characteristics	Surface stone often absent but noted on slopes; surface sometimes self-mulching; not hydrophobic			Surface stone usually absent but noted on upper slopes; surface sometimes self-mulching; often hydrophobic			Surface stone usually absent, but noted on upper slopes; surface sometimes self-mulching; not hydrophobic		
	<i>Not limiting</i>			<i>Not limiting</i>			<i>Not limiting</i>		
pH	Generally favourable to plant growth; usually increasing with depth but some lower horizons quite acidic			Generally lower than in the other Geological Formations and not increasing much with depth			Generally favourable to plant growth; usually increasing with depth		
	<i>Not limiting</i>			<i>Not limiting</i>			<i>Not limiting</i>		
Erodibility	May be some limitations where subsidence results in slope increases and in drainage lines			May be some limitations where subsidence results in slope increases and in drainage lines			Some limitations where subsidence results in slope increases		
	<i>Low to moderate limitations</i>			<i>Low limitations</i>			<i>Low to moderate limitations</i>		
Topsoil dispersibility	Topsoils usually slightly dispersible			Topsoils usually slightly or moderately dispersible; may be limiting near subsidence cracks or where slope gradient increases following subsidence			Topsoils generally not or only slightly dispersible		
	<i>Usually not limiting</i>			<i>Usually not limiting</i>			<i>Not limiting</i>		
Subsoil dispersibility	Often moderately to highly dispersible			Slight to very highly dispersible, particularly in drainage lines			Variable but often moderate to high		
	<i>May be limiting near subsidence cracks or where slope gradient increases following subsidence but may be an advantage in filling in cracks</i>			<i>May be limiting near subsidence cracks or where slope gradient increases following subsidence but may be an advantage in filling in cracks</i>			<i>Limitation in vicinity of subsidence cracks</i>		
Salinity	Slight to moderate salinity detected in drainage line, floodplain and some slopes areas			Salinity not recorded			Salinity not recorded		
	<i>Limitation in areas associated with subsidence cracks where down slope saline areas may develop after erosion</i>			<i>Not limiting</i>			<i>Not limiting</i>		

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### 3.1.5 Valley closure and uplift

‘Valley closure’ (or opening) movements can be expected across deep valleys whenever longwalls are mined beneath them. Valley closure can also occur across broader drainage gullies where shallow surface rock is present.

When creeks and river valleys are subsided, the observed subsidence in the base of the creek or river is generally less than is normally expected in flat terrain. This reduced subsidence is due to the floor rocks of a valley floor ‘buckling’ upwards when subject to compressive stresses generated by surface deformation. This phenomenon is termed ‘upsidence’.

As the valleys across the Extraction Plan Area (characterised by the ephemeral creek lines) are very broad between crests, the development of ‘upsidence’ and closure along the creek beds is likely to be ‘negligible’.

No damage to creeks as a result of valley closure or uplift has been detected at the Narrabri Mine to date.

### 3.1.6 Ponding

The Mine Subsidence Assessment Report predicts a maximum panel subsidence of up to 2.8 m, which may result in closed form depressions forming in some of the central areas of the longwall panels with flatter surface gradients and disrupt natural drainage pathways to watercourses and farm dams. Analysis of the pre and post-mining surface levels suggests that ponding (if it occurs) is likely to develop along Kurrajong Creek and its tributaries.

A total of six potential ponding locations have been assessed within the Extraction Plan Area. Five of the potential ponding areas already exist along the watercourses and dams. Existing (pre-mining) and post-mining pond depths are estimated to range from 0.1 m to 4.7 m. Pond depths are estimated to increase by up to 1.3 m or decrease by up to 0.04 m.

The maximum changes in pond area (where positive represents an increase in pond area) are estimated to range from -0.42 ha to 2.92 ha. The maximum changes in pond volume (where positive represents an increase in pond volume) are estimated to range from -0.23 megalitres (**ML**) to 20.6 ML<sup>3</sup>. The largest ponding increases are estimated over LW 203 and LW 205.


Overall, the existing ponds are expected to extend laterally from the watercourses for distances ranging from 50 m to 410 m. Existing ponded areas extend up to 270 m, indicating a potential lateral increase of up to 140 m.

## 3.2 Potential environmental consequences to land

The predicted subsidence impacts may trigger a number of environmental consequences related to land. The assessment of the predicted impacts and potential consequences on land may include:

- agricultural consequences:
  - soil erosion and deposition;
  - altered soil moisture and nutrient distribution;

<sup>3</sup> The actual ponding depths, areas and volumes will also depend upon several other factors, such as rain duration, surface cracking and effective percolation rates of the surface soils along the creeks/drainage lines.

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- disruption to ponded areas used for agriculture; and/or
- the grazing of livestock.
- natural features consequences:
  - ponding;
  - alteration of creek flows;
  - disruption to natural drainage pathways to watercourses;
  - creek bed erosion; and/or
  - accumulation of sedimentation in lower gradients.

For the period of active mining and remediation, it will be necessary to remove small areas from agricultural production to manage the safety of people and livestock.

It is expected that impacts to agricultural land use in the Extraction Plan Area from subsidence will be short-term, with minimal to no impacts to production. In addition, subsidence will not result in significant changes to LSC classes.

### 3.2.1 Summary of environmental consequences


The potential environmental consequences associated with subsidence within the Extraction Plan Area are summarised in Table 3-5.



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**Table 3-5 Environmental consequences of subsidence**

Subsidence impact	Subsidence consequence	Potential environmental hazard to land	Potential ecological/agricultural impact
Surface subsidence troughs	Altered surface and sub-surface flow	<ul style="list-style-type: none"> <li>Re-routed surface flows into areas not currently subject to concentrated flows leading to redirection of soil moisture and material/chemicals transported by flow</li> <li>Increased risk of erosion</li> </ul>	<ul style="list-style-type: none"> <li>Altered drainage / erosion patterns, altered soil moisture and/or nutrient distribution patterns reducing vegetation condition</li> <li>Soil loss, bank instability, loss of agricultural land, decrease of water quality (elevated turbidity and total suspended solids) of flows during rainfall events</li> <li>Decreased land and agricultural capability</li> </ul>
	Damage to contour banks	<ul style="list-style-type: none"> <li>Increased erosion</li> </ul>	<ul style="list-style-type: none"> <li>Soil loss, bank instability, loss of agricultural land, decreased land and agricultural capability</li> </ul>
	Ponding (in-stream and overbank)	<ul style="list-style-type: none"> <li>Drainage channel re-alignment</li> <li>Localised water logging of pasture</li> <li>Potential decrease in water quality (elevated electrical conductivity) of receiving catchment (where ponding occurs over saline soils)</li> <li>Increased surface infiltration</li> </ul>	<ul style="list-style-type: none"> <li>Altered soil moisture or nutrient distribution patterns</li> <li>Reduced land and agricultural capability, loss of agricultural land</li> <li>Reduction in surface water quality</li> </ul>
	Landslip of surface terrain	Increased erosion	<ul style="list-style-type: none"> <li>Soil loss and exposure of sub-soils</li> <li>Sedimentation of drainage lines</li> <li>Loss of agricultural land</li> </ul>
	Altered ground surface, including sequence of troughs and ridges akin to chain-of-ponds (corresponding with subsidence troughs and chain pillars respectively)	<ul style="list-style-type: none"> <li>Altered overbank surface gradients</li> <li>Altered channel gradients and/or alignments</li> <li>Headcuts associated with increased land surface slope</li> </ul>	<ul style="list-style-type: none"> <li>Increase or decrease in surface flow velocity, including deposition of suspended solids</li> <li>Increased erosion of creek bed / banks leading to loss of riparian vegetation, loss of soils, loss of agricultural land, increased sedimentation of drainage lines</li> <li>Altered drainage / erosion patterns, altered soil moisture and/or nutrient distribution patterns reducing vegetation condition</li> </ul>
Surface and sub-surface cracking	Exposure of dispersive subsoils	<ul style="list-style-type: none"> <li>Increased rate of soil erosion</li> </ul>	<ul style="list-style-type: none"> <li>Potholes</li> <li>Soil loss</li> <li>Bank instability</li> <li>Loss of agricultural land</li> <li>decreased land and agricultural capability</li> </ul>
	Tensile strain	<ul style="list-style-type: none"> <li>Risk to safety of livestock and/or mine personnel</li> </ul>	Impact to fence lines including the following: <ul style="list-style-type: none"> <li>Straining of fencing wire strands</li> <li>Sagging of fence wire strands</li> <li>Loss of fence serviceability</li> <li>Loss of gate function</li> <li>Tilting of fence, gate and strainer posts</li> </ul>
	Discontinuous fracturing (B-Zone)	<ul style="list-style-type: none"> <li>Likely to interact with surface cracks (D-Zones) where cover depths are &lt; 300 m above the 306 m wide longwall panels and &lt; 375 m above 400 m wide longwall panels (i.e. all of the longwalls)</li> </ul>	<ul style="list-style-type: none"> <li>Potential re-routing of creek flows into open cracks to below-surface pathways</li> <li>Lowering of the water table</li> <li>Disruption of tree root systems</li> </ul>



NARRABRI MINE

ENVIRONMENTAL

MANAGEMENT

SYSTEM

Document owner:

Environmental Superintendent

Document approver:

Environmental Manager

Revision period:

5 years

Revision:

0B


Last revision date:

20 August 2024

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Subsidence impact	Subsidence consequence	Potential environmental hazard to land	Potential ecological/agricultural impact
Steep slopes	Erosion	<ul style="list-style-type: none"><li>Surface runoff into rock mass</li><li>Increased rate of soil erosion</li></ul>	<ul style="list-style-type: none"><li>Internal erosion, resulting in the development of local instability</li><li>Erosion along creek beds</li><li>Accumulation of sediments</li></ul>
Valley closure and uplift	Localised deviation/re-routing of surface flows	<ul style="list-style-type: none"><li>Localised loss of surface flows</li></ul>	<ul style="list-style-type: none"><li>Redirection/loss of soil moisture and material/chemicals transported by flow</li><li>Decreased land and agricultural capability</li></ul>
Ponding and drainage lines	Closed form depressions forming	<ul style="list-style-type: none"><li>Disrupt natural drainage pathways to watercourses and farm dams</li><li>Increase in pond depth range and pond volume</li><li>Existing ponds extend laterally from watercourses</li></ul>	<ul style="list-style-type: none"><li>Waterlogging of vegetation</li></ul>




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## 4. Performance measures and indicators

Specific performance measures and indicators have been developed for the preservation of land within and surrounding the Extraction Plan Area as presented in Table 4-1.

**Table 4-1 Performance measures and indicators**

Performance measure	Indicator
To maintain the pre-mining land and agricultural capability of the mine site.	Surface cracks are remediated within two months of identification or when safe to do so.
	No ongoing or significant erosion.
	Change to overall drainage pattern is not more than predicted and detected alteration in channel dimensions or processes within normal range compared to baseline data.
	Detected alteration in topography/landscape morphology within normal range compared to baseline data.

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## 5. Management measures

In accordance with Schedule 2 Condition 1 of the Project Approval, NCOPL will implement all practicable measures to prevent and/or minimise any harm to the environment that may result from the construction, operation, or rehabilitation activities at the Narrabri Mine.

NCOPL will implement the management measures detailed in the following sections to ensure compliance with the performance measures listed in Table 4-1, and to manage or remediate any impacts and/or environmental consequences of the proposed second workings on land in general.

### 5.1 Surface cracking

The measures for managing surface cracks are (in order of increasing impact to mining):

- Conduct visual inspections of the surface during active subsidence in accordance with section 6.1.1.
- Repair larger surface cracks (more than 50 mm) following active subsidence (rip or grade where necessary).
- Decrease mining height and/or panel width to limit subsidence and hence tensile strains.
- Leave a barrier pillar or increase set-back distances from a sensitive area or limit mining to first workings.

Minor cracks (i.e. less than 50 mm wide) are not expected to require remediation as geomorphological processes will likely result in these cracks filling naturally over time. However, if larger surface cracks (i.e. more than 50 mm wide) have not self-corrected within two months, remediation will be required. Remediation of larger surface cracks will generally be undertaken using conventional earthmoving equipment (such as backhoe or grader) and will involve ground disturbance associated with in-filling by cultivation of the ground surface or in-filling with suitable soil or other material obtained from stockpiles at nearby gas drainage or ventilation sites, or material from within the footprint of the Reject Emplacement Area.


Prior to any remediation, NCOPL will undertake a review of environmental impacts that may result from the remediation at the specific location and consider whether remediation will create an increased impact (e.g. clearing native vegetation to enable machinery access or major drainage works that will cause a greater impact from excavation). If the assessment concludes that there may be the potential to increase impacts on biodiversity, alternative methods of remediating the crack are warranted (e.g. without machinery).

After surface cracks have been remediated, NCOPL will conduct an inspection within three months to identify if further remediation is required.

### 5.2 Sub-surface cracking

The management measures for controlling sub-surface fracturing include (in order of increasing impact to mining):

- Monitoring rainfall deficit and underground water during longwall mining to detect surface to seam connectivity.
- Repairing surface cracks following active subsidence in accordance with section 5.1.
- Decrease mining height and/or panel width to limit continuous fracture heights.

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- Leave a barrier pillar beneath a sensitive area or limit mining to first workings.

A borehole extensometer and vibrating wire piezometer has been installed above LW 203 to monitor the height of fracturing development after supercritical conditions develop (refer to the Extraction Plan – Water Management Plan [EP-WMP]). Inspections and monitoring of underground workings and groundwater make will also be recorded and plotted against rainfall deficit data to detect surface to seam connectivity. Further detail on the groundwater monitoring program is presented in the Water Management Plan (Appendix A to EP 203-206).

### 5.3 Steep slopes

To minimise the hazards associated with steep slope instability, the following management strategies will be implemented:

- Conduct surface slope displacement monitoring above LW 204 (combined with general subsidence monitoring). Cracking impacts will be visually and spatially mapped (start and end coordinates, width, depth, length, and photographed) after subsidence development has ceased via light detection and ranging (**LIDAR**).
- In-fill surface cracking to prevent excessive ingress of run-off into the slopes by backfilling the cracks with either durable, free-draining gravel or sand with some erosion control measures such as re-vegetation. Repairs to cracks may require additional vegetation clearing and non-conventional repair methods (due to poor access for conventional equipment). Methods such as remote pumping of sands (sluicing) and/or cementitious grout may be needed and will require environmental spill and safety management controls.
- Areas that are significantly affected by erosion following mining may need to be repaired and protected with mitigation works such as re-grading, installation of new contour banks and re-vegetation of exposed areas.
- Communication of the hazard to employees and contractors and restrict access to the impacted area to only authorised mine personnel engaged in assessment and rehabilitation activities.

In addition to the above, in the unlikely event of large-scale slope instability, erosion stabilisation works will be conducted and will include:


- Installation of deep sub-surface drainage trenches and the construction of catch drains along slope crests so that surface run-off is controlled.
- Stabilisation of damaged or steeply eroded sections of creek bank conducted in accordance with the Erosion and Sediment Control Plan which forms part of the Water Management Plan for the site.

### 5.4 Erosion

Management measures for gully erosion are commensurate with the measures for surface crack remediation as detailed in section 5.1.

For significant gully erosion, the following measures may be considered:

- grade banks to stop the upslope concentration of flow and stabilise through revegetation:
  - graded bank diversionary structures may need to be installed on a suitable grade to ensure flows that are diverted away from the gullies with consideration of ground surface, soil type and design

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flows; and

- sow perennial pasture species in accordance with the Rehabilitation Management Plan.
- fill using rocks or rubble sourced from site or reshape using an excavator, or a combination of both. After filling, it is recommended that they be dressed with topsoil to encourage rapid establishment of vegetation; or
- diversion banks to convey flows to a safe disposal area where water will naturally spread and not concentrate into erosive volumes and velocities. Where safe disposal areas are not available, the construction of a suitable drop structure to safely convey diverted flows into creek lines will need to be considered.

Depending on the nature of the soils and the availability and quality of topsoil, consideration will be given to the use of soil ameliorants to improve the soil structural stability. This will improve rehabilitation and revegetation outcomes. Soils may respond particularly well to the use of gypsum to address the highly dispersible soils. Temporary sediment fencing will be installed below any areas to be disturbed and be maintained until such time as disturbed areas have revegetated.

## 5.5 Valley closure and uplift

The impact of upsidence and valley bending effects along creek lines will continue to be managed as follows:


- Implementation of the creek line monitoring program (section 6.1.2);
- Review the predictions of ‘upsidence’ and valley crest movements after each longwall is mined; and
- Assess whether repairs (i.e. cementitious grouting or crushed rock) to cracking (as a result of ‘upsidence’) or gully stabilisation works are required to minimise the likelihood of long-term degradation or risks to personnel and the general public.

## 5.6 Ponding

Remediation of ponded areas will consider the following:

- ponding located in areas where vegetation is not affected, will be allowed to self-correct;
- ponding located in areas with affected vegetation, or if ponding significantly alters or affects flows, will be assessed and remedial actions (that present the lowest environmental impact) developed in consultation with a geomorphologist; and
- if Endangered Ecological Communities are impacted, or downstream water quality analysis indicates a change in EC trends, the ponding will be assessed, and remediation options will be developed to afford the maximum practical protection to the affected feature.

A set of criteria to determine the most suitable option for the management and remediation of ponding is presented in the EP-WMP.

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## 6. Subsidence impact monitoring

### 6.1 Methods

#### 6.1.1 Visual subsidence inspections

Monthly visual inspections behind the longwall face (i.e. during active subsidence) will be conducted to determine surface crack locations, depth, width and length, the extent of any ponding and presence of vegetation, and observations of erosion and/or sedimentation. Surface cracks with widths more than 50 mm will be remediated within two months of being identified in accordance with section 5.1.

Surface cracking and ponding are also assessed following a significant rainfall event (defined as a 5-day 90th percentile rainfall event which is 38.4 mm over 5 consecutive days).

After surface cracks have been remediated, NCOPL will conduct an inspection within three months to identify if further remediation is required.

#### 6.1.2 Creek line monitoring

Baseline surveys of watercourses and drainage lines will be conducted via remote sensing (multi-spectral image or LiDAR) prior to longwall mining to record creek bank condition and natural drainage patterns. Remote sensing will then be utilised during and following mining to determine changes in creek bank condition, cross sectional changes, and/or overall changes to drainage patterns. If changes are detected, NCOPL will conduct a direct field survey to ground truth and develop appropriate remediation measures.

Visual watercourse inspections (including photographs) will also be conducted as a baseline and then quarterly for a period of two years to monitor for bed and bank stability, vegetation health within ponded areas, and erosion and sedimentation. If vegetation is identified as being impacted (e.g. canopy dieback), NCOPL will determine the most suitable option for the management and remediation of the ponded area in accordance with the EP-WMP.


Following a significant rainfall event (defined as a 5-day 90<sup>th</sup> percentile rainfall event which is 38.4 mm over 5 consecutive days), restriction of flows and hence restriction of fish passage will be assessed to facilitate appropriate restorative measures (if required).

#### 6.1.3 Remote sensing

NCOPL will utilise remote sensing light detection and ranging (**LiDAR**) and multi-spectral imaging to provide a quantitative comparison of landscape condition and vegetation cover above LW 203 to 206 to that of the selected control sites. Control sites will be established within zones where no subsidence impacts have been predicted and the sites will have similar characteristics and biological conditions to the target area. If changes in landscape condition and/or vegetation cover are detected, targeted field surveys will be conducted to examine the cause of change, followed by the implementation of appropriate management measures.

#### LiDAR

LiDAR processing and analysis will be undertaken every three years (triennially). LiDAR data is processed into a land surface digital elevation model (**DEM**) across the mine. Subsequent LiDAR captures will be processed similarly, and each new dataset will be subtracted from those produced from earlier captures, creating a series

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of DEM change images. Each dataset produced will be used to create a map for visual interpretation and analysis and for communication of results.

Reporting of LiDAR analysis and any additional surveys undertaken in response to a change will be reported in summer following the spring survey.

Table 6-1 details the surface zones utilised in the DEM analysis.

**Table 6-1 Surface zones**

Surface zone	Definition	
Longwall	Zone of maximum subsidence.	>2 m predicted subsidence.
Transition	Zone of maximum stress and tilt.	0.1 – 1.5 m predicted subsidence.
Pillar	Zone above the pillar with minimal subsidence.	
Control	Zones of no impact located outside of any predicted subsidence zone.	

### Multi-spectral image processing and analysis

The primary purpose for this monitoring is to detect changes in vegetation cover and erosion over time. The high-resolution multi-spectral imagery (World View, Geoeye, Quickbird or similar) will be stratified into four impact zones (i.e., longwall, transition, pillar, control) and processed into a normalised difference vegetation index (**NDVI**). Each subsequent dataset will be subtracted from those produced from earlier captures creating a series of change images.

Each dataset produced will be used to create a map for visual interpretation and analysis and for communication of results. Multi-spectral image processing will be undertaken as baseline prior to mining and then annually in spring for two years after the completion of each longwall.

Reporting of multi-spectral imagery and any additional surveys undertaken in response to a change will be reported annually following the spring survey.

## 6.2 Monitoring program summary

Table 6-2 summarises the EP-LMP monitoring program.

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**Table 6-2 - Land monitoring program**

Aspect/feature	Frequency	Method and analysis	Parameters
Subsidence inspections	<ul style="list-style-type: none"> <li>During active subsidence, monthly and following a significant rainfall event *</li> <li>Three months following remediation of surface cracks</li> </ul>	Visual inspections directly behind the longwall face to: <ul style="list-style-type: none"> <li>Identify areas of surface cracking and ponding, including presence of vegetation</li> <li>Identify erosion/potential erosion</li> <li>Record sedimentation</li> <li>Determine appropriate management response</li> </ul>	<ul style="list-style-type: none"> <li>Surface crack GPS location, depth, width and length.</li> <li>Ponding GPS location, width, depth, area, presence of vegetation</li> <li>Bed and bank stability</li> <li>Watercourse erosion and potential for erosion (e.g., knickpoints, head cuts)</li> <li>Sedimentation</li> </ul>
Watercourses and ponding	Baseline and then quarterly for a period of two years	Visual inspection and photographs to: <ul style="list-style-type: none"> <li>Identify areas of ponding, including observational impacts to vegetation health</li> <li>Identify erosion/potential erosion</li> <li>Record sedimentation</li> <li>Determine appropriate management response</li> </ul>	<ul style="list-style-type: none"> <li>Ponding GPS location, width, depth, area, presence/impacts to vegetation</li> <li>Bed and bank stability</li> <li>Watercourse erosion and potential for erosion (e.g., knickpoints, head cuts)</li> <li>Sedimentation</li> </ul>
Creek line surveys	Baseline then annually/triennially (refer to remote sensing below)	<ul style="list-style-type: none"> <li>Assessment of creek bank condition and altered drainage patterns compared to baseline</li> <li>Assessment of bed and bank slopes following subsidence and likely effects of increased channel gradients (e.g. upstream and downstream of chain pillars)</li> <li>Effectiveness of gully erosion stabilisation methods</li> <li>Field survey if changed detected following remote sensing</li> </ul>	<ul style="list-style-type: none"> <li>Refer to remote sensing below</li> </ul>
Remote sensing	<b>LiDAR</b> Baseline then every three years (triennially).	LiDAR over entire site.	<ul style="list-style-type: none"> <li>Topographic form and change</li> <li>Creek line slope and volumes</li> </ul>
	<b>Multi spectral imaging</b> Baseline and then annually in spring for two years after the completion of each longwall	Multi-spectral imaging (NDVI) over LW 203 to LW 206	<ul style="list-style-type: none"> <li>Vegetative biomass and cover within Extraction Plan Area</li> <li>Weed presence</li> <li>Erosion</li> </ul>
Direct field survey	Following changes detected during remote sensing	<ul style="list-style-type: none"> <li>Field inspection</li> <li>Sampling/testing as required</li> </ul>	Determined during field survey

**Notes:**

\* defined as a 5-day 90th percentile rainfall event which is 38.4 mm over 5 consecutive days.



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## 7. Contingency response

In the event that a non-compliance against a performance measure has occurred, or is likely to occur, NCOPL will:

1. Report the non-compliance as soon as practicable to the relevant agencies as required under the Project Approval and relevant legislation in accordance with section 8.
2. Identify and implement an appropriate course of action with respect to the non-compliance in consultation with a suitably qualified person/s and the relevant agencies.
3. Review the effectiveness of the EP-LMP management measures in accordance with section 9.4.

A Trigger Action Response Plan (Table 7-1) has been developed to identify, assess and respond to triggers and manage risks associated with meeting the biodiversity performance measures.




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**Table 7-1 Land management TARP**

Aspect	Performance measure	Response	
		Trigger	Action
Remediation of surface cracks	Surface cracks are remediated within two months of identification or when safe to do so.	<b>Level 1</b> <ul style="list-style-type: none"> <li>Surface cracks &gt;50 mm but &lt;320 mm present. and/or</li> <li>Erosion as a result of cracking identified.</li> </ul>	<b>Level 1</b> <ul style="list-style-type: none"> <li>Provide safety fencing and signage if required.</li> <li>Advise relevant stakeholders.</li> <li>Implement remediation measures as appropriate. These may include ripping of surface cracks, filling of cracks with grout, spoil or other suitable material.</li> <li>Implement appropriate erosion control measures as outlined in the site Erosion and Sediment Control Plan.</li> <li>Monitor remediated surface cracks within 3 months following remediation.</li> </ul>
		<b>Level 2</b> <ul style="list-style-type: none"> <li>Surface cracks &gt;320 mm and/or crack widths more than predicted for specific soil type or natural feature.</li> </ul>	<b>Level 2</b> <ul style="list-style-type: none"> <li>As for Level 1</li> <li>Make area safe.</li> <li>Investigate the reasons for exceedance of predictions.</li> <li>Review and update predictions and assessment of potential impacts.</li> <li>On-going review and appraisal of any significant changes to surface slopes such as cracking along ridges, increased erosion down slopes, foot slope seepages and drainage path adjustments observed after each longwall is extracted.</li> </ul>
Sediment and erosion controls	No ongoing or significant erosion.	<b>Level 1</b> <ul style="list-style-type: none"> <li>Evidence of active rill erosion, gully erosion &lt;200 mm in depth or slumping.</li> </ul>	<b>Level 1</b> <ul style="list-style-type: none"> <li>Document occurrence.</li> <li>Continue monitoring.</li> <li>Summarise occurrence in relevant reports.</li> </ul>
		<b>Level 2</b> <ul style="list-style-type: none"> <li>Evidence of active rill or gully erosion &gt;200 mm in depth or significant slumping/slope instability.</li> </ul>	<b>Level 2</b> <ul style="list-style-type: none"> <li>As per Level 1</li> <li>Review adequacy of existing erosion and sediment controls.</li> <li>Undertake repairs and implement additional controls as required.</li> <li>Engage a specialist if ongoing erosion/slope instability is observed following repair and implementation of additional controls.</li> <li>On-going review and appraisal of any significant changes to surface slopes such as cracking along ridges, increased erosion down slopes, foot slope seepages and drainage path adjustments observed after each longwall is extracted.</li> </ul>
Creek line surveys	Change to overall drainage pattern is not more than predicted and detected alteration in channel dimensions or processes within normal range compared to baseline data.	<b>Level 1</b> <ul style="list-style-type: none"> <li>Field survey indicates &lt;20% increase in length of eroding creek line. and/or</li> <li>Surface drainage pattern is unchanged.</li> <li>Bed and banks are stable.</li> </ul>	<b>Level 1</b> <ul style="list-style-type: none"> <li>Document observed changes.</li> <li>Continue monitoring.</li> <li>Summarise occurrence in relevant reports.</li> </ul>

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Aspect	Performance measure	Response	
		Trigger	Action
		<b>Level 2</b> <ul style="list-style-type: none"> <li>Monitoring indicates &gt;20% increase in length of eroding creek line. and/or</li> <li>Surface drainage pattern is significantly altered.</li> <li>Changes in bed and bank stability.</li> </ul>	<b>Level 2</b> <ul style="list-style-type: none"> <li>As for Level 1</li> <li>Consult with a geomorphologist or other appropriately qualified and experienced specialist to determine the extent of the impact, identify contributing factors and determine appropriate remediation measures.</li> <li>Review and implement contingency measures required by other plans as relevant (e.g. the Subsidence Monitoring Program).</li> <li>Review monitoring program as required.</li> <li>Relevant agencies to be notified and actions discussed.</li> </ul>
Topography and landscape morphology form	Detected alteration in channel dimensions or topography/landscape morphology within normal range compared to baseline data.	<b>Level 1</b> <ul style="list-style-type: none"> <li>Surface gradient change as detected by LiDAR is &gt;1.5% and &lt;3%.</li> </ul>	<b>Level 1</b> <ul style="list-style-type: none"> <li>Document observed changes.</li> <li>Continue monitoring.</li> <li>Summarise occurrence in relevant reports.</li> </ul>
		<b>Level 2</b> <ul style="list-style-type: none"> <li>Surface gradient change as detected by LiDAR is &gt;3% and &lt;5%.</li> </ul>	<b>Level 2</b> <ul style="list-style-type: none"> <li>As for Level 1</li> <li>Consult geomorphologist or other appropriately qualified and experienced specialist to review DEM and conduct site investigation to assess changes and provide recommendations for remediation which may include re-establishing drainage pathways with earthworks and implementation of erosion control measures.</li> <li>Notify relevant agencies if in-stream works are to be undertaken.</li> </ul>
Ponding (riparian vegetation)	Surface water ponding does not result in adverse impacts to vegetation health.	<b>Level 1</b> <p>Identified minor impacts to vegetation due to creation of small ephemeral ponds or minor increase or decrease in size and distribution of in-stream ponds.</p>	<b>Level 1</b> <ul style="list-style-type: none"> <li>Record visual observations, including photographs.</li> <li>Investigate options to remediate based on risk assessment (low risk to ecological and/or agricultural function). Remediation options may include: <ul style="list-style-type: none"> <li>Re-establish any affected contour banks and revegetate.</li> <li>Stabilise pond inlet and outlet using graded rock and vegetation enhancement.</li> </ul> </li> </ul>
		<b>Level 2</b> <p>Significant impacts to vegetation identified (e.g. canopy dieback, tree death) due to creation of large semi-permanent ponds or moderate to significant increase or decrease in size and/or distribution of in-stream ponds.</p>	<b>Level 2</b> <ul style="list-style-type: none"> <li>Record visual observations, including photographs.</li> <li>Investigate options to remediate based on risk assessment (moderate to high risk to ecological and/or agricultural function). Remediation options may include: <ul style="list-style-type: none"> <li>Construct drainage channels to create free draining areas and restore affected contour banks</li> <li>Revegetate fringing areas around residual pond</li> <li>Exclude stock access from riparian areas</li> <li>Construct in-stream barriers or drainage channels to reduce or increase the effective size and spatial distribution of pond(s)</li> <li>Stabilise pond inlet and outlet using graded rock and vegetation enhancement</li> <li>Dewater ponded area</li> <li>Reshape surface and infill pond</li> <li>Re-establish natural drainage channel</li> </ul> </li> </ul>

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## 8. Incidents and non-compliance

### 8.1 Incident notification

An incident is defined under the Project Approval as *a set of circumstances that causes or threatens to cause material harm, and/or breaches or exceeds the limits of performance measures/criteria*. Material harm to the environment is defined under the Project Approval as *involving actual or potential harm to the health or safety of human beings or to the environment that is not trivial*. This definition excludes “harm” that is authorised under the Project Approval or any other statutory approval (e.g., the Environmental Protection License).

In the event of any exceedance of the performance criteria, NCOPL will advise the Secretary and any other relevant agencies as soon as practicable after becoming aware of the incident, in accordance with Schedule 6 Condition 4. Within 7 days of the event, NCOPL will also provide the Secretary and any relevant agencies a detailed report which 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.

Notifications to the NSW Environment Protection Authority will be made by contacting the Environment Line on 131 555 and written details of the notification will be provided within 7 days of the date on which the incident occurred.

Incident reporting and emergency response is further described in NCOPLs Environmental Management Strategy.


### 8.2 Non-compliance

In accordance with Schedule 6 Condition 2, where a non-compliance with a statutory requirement/s or an exceedance of the relevant criteria or performance measures has occurred, NCOPL will, at the earliest opportunity, take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur. Once this has been achieved, all reasonable and feasible options for remediation (where relevant) will be considered.

In accordance with Schedule 6 Condition 4, within seven days of becoming aware of a non-compliance, NCOPL will notify DPHI of the non-compliance<sup>4</sup>. The notification will be made in writing via the Major Projects website and identify the development (including the development application number and name), set out the condition or requirement that the development is non-compliant with, why it does not comply and the reasons for the non-compliance (if known) and what actions have been, or will be, undertaken to address the non-compliance.

NCOPL will implement any reasonable remediation measures as directed by the Secretary, to the satisfaction of the Secretary.

<sup>4</sup> A non-compliance which has been notified as an incident under section 8.1 does not need to also be notified as a non-compliance under section 8.2.

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## 9. Reporting, evaluation and review

### 9.1 Annual review

In accordance with Schedule 6 Condition 6, NCOPL will review the performance of its environmental management for the previous calendar year and report the relevant results within the Annual Review, to the satisfaction of the Secretary. The Annual Review will at minimum provide information regarding the effectiveness of the management measures to prevent, and if prevention is not reasonable and feasible, to minimise any impact on land features.

Further, the Annual Review requires a number of items to be reviewed or assessed. In summary these are:

- monitoring results and complaints;
- non-compliances and incidents;
- compliance with performance measures;
- discrepancies between predicted and actual impacts; and
- measures to be implemented to improve environmental performance.

The Annual Review may also make recommendations for any additions, changes, or improvements to NCOPLs environmental management procedures.

The Annual Review will be made available on the WHC website.

### 9.2 Independent environmental audits

Prior to 13 September 2010, and every 3 years thereafter, unless the Secretary directs otherwise, NCOPL will commission and pay the full cost of an Independent Environmental Audit (**IEA**) of the development (Stages 1 and 2), to be conducted in accordance with the requirements of Schedule 6 Condition 7.

The audit team will be led by a suitably qualified auditor and the IEA will be conducted by suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Secretary.


### 9.3 Management plan review and evaluation

As required by Schedule 6 Condition 3 of the Project Approval, within three months of any of the following:

- completion of an IEA (as required by Schedule 6 Condition 7);
- submission of an Incident Report (as required by Schedule 6 Condition 4);
- submission of an Annual Review (as required by Schedule 6 Condition 6); and
- any modification to the conditions of the Project Approval (unless the conditions require otherwise).

NCOPL will then review, and if necessary, revise this EP-LMP. This is to ensure that the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the Narrabri Mine operations.

Condition 3 of Schedule 6 further states that if the review determines that this EP-LMP requires revision, then this will be completed to the satisfaction of the Secretary. A dedicated review register will be maintained which will provide the details of the review of all relevant strategies, plans and programs that need to be reviewed as

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required by Schedule 6 Condition 3 of the Project Approval. The revision status of this EP-LMP is indicated in section 14.


## 9.4 Improvement measures

Project Approval Schedule 6 Condition 2(f) requires this Plan to include a program to investigate and implement ways to improve the environmental performance of the development over time. Improvement measures may be investigated through review of the following:

- monitoring data, and any assessment of trends;
- audit outcomes, including audits of land management measures; and
- incident reports, including any community complaints.

Reasonable and feasible improvement measures will be implemented and documented as a management measure in a revision to the Plan as described in section 9.3.

In accordance with Schedule 6 Condition 2(g) a protocol for periodic review of this Plan has been addressed under section 9.3.

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## 10. Complaints management

Any complaints received in relation to land will be managed in accordance with the complaints management protocol as follows:

- Publicly advertised telephone complaints line, 1800WHAVEN, will be in place to receive complaints.
- Each complaint received will be recorded in a Complaints Register, which will include the following details:
  - date and time of complaint;
  - method by which a complaint was made;
  - personal details the complainant wishes to provide or, if no such details are provided, a note to that effect;
  - nature of the incident that led to the complaint;
  - action taken by NCOPL in relation to the complaint (i.e., any required remedial actions), including any follow-up contact with the complainant; and
  - if no action was taken, the reason why no action was taken.
- The Environmental Superintendent will be responsible for ensuring that an initial response is provided within 24 hours of receipt of a complaint (except in the event of complaints recorded when the mine is not operational or outside of usual business hours).
- Once the identified measures are undertaken, the Environmental Superintendent will sign off on the relevant complaint within the Complaints Register.
- If necessary, follow-up monitoring will take place to confirm the source of the complaint is adequately mitigated.
- A summary of the complaints will be maintained by NCOPL and made available to the Community Consultative Committee, the complainant (on request) and on the WHC website. A summary of complaints received every 12 months will be provided in the Annual Review.

In the event that any complainant considers that NCOPL has not adequately addressed their concerns, the NCOPL representative will convene additional meetings with the complainant.



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## 11. Plan implementation

### 11.1 Roles and responsibilities

During the operational phases of the development, the Narrabri Mine will be managed by the General Manager who will have overall responsibility for ensuring contractors, employees and service providers comply with all laws, regulations, licences, and approvals. Table 11-1 outlines the roles and responsibilities applicable to this EP-LMP.

**Table 11-1 Roles and responsibilities**

<b>Roles</b>	<b>Responsibilities</b>
General Manager	<ul style="list-style-type: none"> <li>Ensure that adequate resources are available to NCOPL personnel to facilitate the completion of their responsibilities under this EP 203-206.</li> </ul>
Mining Engineering Manager	<ul style="list-style-type: none"> <li>Ensure all contractors, sub-contractors and service-personnel are appropriately qualified, competent, and licensed to undertake the required work under this EP 203-206.</li> </ul>
Environmental Manager	<ul style="list-style-type: none"> <li>Review and authorisation of changes to this EP 203-206</li> <li>Responsible for decision making in relation to the activation of TARP responses and/or contingency planning.</li> <li>Manage incident, non-compliance and other reporting requirements.</li> <li>Communicate with statutory agencies and departments, public authorities, and the community.</li> </ul>
Environmental Superintendent	<ul style="list-style-type: none"> <li>Ensure that all environmental monitoring and reporting is undertaken in accordance with this EP 203-206 and various approval requirements, and is checked, processed, and filed appropriately.</li> <li>Advise on matters identified in all approval, permit, licence, and consent documents and ensure all operations are conducted in compliance with those conditions, and all other environmental obligations.</li> </ul>
Surface Operations Manager	<ul style="list-style-type: none"> <li>Provides notification to all mine personnel advising of potential subsidence hazards and impacts.</li> <li>Maintains access to critical surface infrastructure and facilitates inspections and remedial works.</li> </ul>
Civil Services Coordinator	<ul style="list-style-type: none"> <li>Inspect and monitor the condition and safety of roads and tracks around the mine site.</li> <li>Remediates subsidence impacts to maintain trafficability of access roads and tracks.</li> </ul>
Technical Services Manager	<ul style="list-style-type: none"> <li>Provide technical advice to support decision making in relation to the activation of TARP responses and/or contingency planning.</li> <li>Liaise with stakeholders regarding subsidence impact management.</li> <li>Decommission mining infrastructure prior to subsidence impacts.</li> </ul>
Registered Mine Surveyor	<ul style="list-style-type: none"> <li>Ensure the subsidence monitoring program is implemented and adhered to.</li> </ul>

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## 12. References


Department of Planning and Environment (October 2022). *Extraction Plan Guideline*

Ditton Geotechnical Services (2022) *Mine Subsidence Assessment for Longwalls LW203 to LW206 at the Narrabri Underground Mine*. Prepared for Narrabri Coal Operations Pty Ltd.

NSW Department of Planning, Industry and Environment (November 2021). *Project Approval Narrabri Coal Project – Stage 2*


NSW Office of Environment and Heritage (October 2012). *The land and soil capability assessment scheme – second approximation*.

RW. Corkery & Co. Pty. Limited. (2009). *Environmental Assessment for the Narrabri Coal Mine Stage 2 Longwall Project*. Prepared for Narrabri Coal Operations Pty Ltd.


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## 13. Glossary

Term	Definition
Active subsidence	The period of time that movement of the ground can occur after underground mining.
Angle of Draw	The angle with the vertical, made by a straight line extending away from the limits of extraction at seam level to the ground surface, spanning the horizontal distance in which subsidence may occur.
Chain pillar	The pillar(s) of coal left between adjacent longwall panels. This forms a barrier that allows the goaf to be sealed off and facilitates tailgate roof stability.
Compressive strain	A decrease in the distance between two points on the surface. This can cause shear cracking or steps at the surface if > 3 millimetres per metre (mm/m).
Cover depth	The depth of coal seam from the ground surface (metres).
Department	Planning and Assessment Group within the NSW Department of Planning, Housing and Infrastructure (DPHI).
Development	The Stage 2 development described in the EA as modified by the Project Approval.
Environmental consequences	The environmental consequences of subsidence impacts including: damage to built features; loss of surface flows to the sub-surface; loss of standing pools; adverse water quality impacts; development of iron bacterial mats; cliff falls; rock falls; damage to Aboriginal heritage sites; impacts to aquatic ecology; ponding.
Extraction Plan Area	The area predicted to be affected by the proposed secondary extraction of the approved longwall panels LW 203 to LW 206.
First workings	Development of the main headings and gate roads to establish access to the coal in the mining area.
Incident	A set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits of performance measures/criteria in the Project Approval.
Massive	Soil horizons which appear to be coherent or solid and devoid of peds (i.e. grouping of soil particles). It should be greater than 6 mm in thickness. When displaced, the soil separates into fragments which may be crushed into individual particles.
Material harm	Material harm to the environment is defined in section 147 of the POEO Act.
MOD 5	Reduced the number of longwall panels from 26 to 20; increased the longwall panel widths for LW 107 to LW 120 from approximately 295 m to approximately 400 m; extended the western footprint approximately 60 m; and increased the maximum ROM coal processing rate from 8 Mtpa to 11 Mtpa.
MOD 7	Describes the change in mining method within the extent of the previously approved LW 201 and LW 202 and allows for up to 0.7 Mtpa via bord and pillar extraction at pillar reduction panels CF 201 to CF 205.
Narrabri Mine	The development approved under the Project Approval 05_0102 and Project Approval 08_0144.
Non-compliance	An occurrence, set of circumstances or development that is a breach of the conditions of the statutory approvals.
Project Approval	Development consent (PA 08_0144) issued on 26th July 2010 under Section 75J of the <i>Environmental Planning and Assessment Act 1979</i> by the Department of Planning & Infrastructure (as modified).

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Term	Definition
Rehabilitation	The treatment or management of land disturbed by the project for the purpose of establishing a safe, stable and non-polluting environment including the remediation of impacts.
Second workings	Extraction of coal from longwall panels, mini-wall panels, or pillar extraction.
Secretary	Planning Secretary under the EP&A Act, or nominee
Stage 1	The project approval granted by the Minister Planning for the Narrabri Coal Project, dated 14 November 2007.
Stage 2	Narrabri Mine Stage 2 approved under Project Approval 08_0144.
Statement of Commitments	The Proponent's revised commitments in Appendix 3 of the Project Approval, dated May 2010.
Subsidence	The totality of subsidence effects, subsidence impacts and environmental consequences of subsidence impacts.
Subsidence effects	Deformation of the ground mass due to mining, including all mining-induced ground movements, such as vertical and horizontal displacement, tilt, strain and curvature.
Subsidence impacts	Physical changes to the ground and its surface caused by subsidence effects, including tensile and shear cracking of the rock mass, localised buckling of strata caused by valley closure and upsidence and surface depressions or troughs.
Tensile strain	An increase in the distance between two points on the surface. This is likely to cause cracking at the surface if it exceeds 2 mm/m. Tensile strains are usually associated with convex (hogging) curvatures near the sides (or ends) of the panels.
the Proponent	Narrabri Coal Operations Pty Ltd
Tilt	The rate of change of subsidence between two points (A and B), measured at set distances apart (usually 10m). Tilt is plotted at the mid-point between the points and is a measure of the amount of differential subsidence.
Upsidence	Relative vertical upward movements of the ground surface associated with subsidence.
Valley closure	The inward (or outward) movement of valley ridge crests due to subsidence trough deformations or changes to horizontal stress fields associated with longwall mining. Measured movements have ranged between 10 mm and 400 mm in the NSW Coalfields and are usually visually imperceptible.
Valley uplift	The phenomenon of upward movements along the valley floors due to Valley Closure and buckling of sedimentary rock units. Measured movements have ranged between 10 mm and 400 mm in the NSW Coalfields and may cause surface cracking in exposed bedrock on the floor of the valley (or gorge).
Vertical subsidence	Vertical downward movements of the ground surface caused by underground coal mining.
Watercourse	A river, creek or other stream, including a stream in the form of an anabranch or tributary, in which water flows permanently or intermittently, regardless of the frequency of flow events: In a natural channel, whether artificially modified or not, or in an artificial channel that has changed the course of the stream. It also includes weirs, lakes and dams.


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## 14. Review history

Table 14-1 provides the EP-LMP document review history.


Table 14-1 Document review history

Revision	Comments	Author	Authorised by	Date
0B	Issued as final	Onward Consulting	B. Baker	20 August 2024

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## Attachment 1 Compliance conditions relevant to this Plan




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**Table A1-1 Project Approval conditions relevant to this Plan**


Condition	Requirement	Document reference
Schedule 2 Condition 1	The Proponent shall implement all practicable measures to prevent and/or minimise any harm to the environment that may result from the construction, operation, or rehabilitation of the project.	Section 5
Schedule 2 Condition 11	<p>With the approval of the Secretary, the Proponent may submit any management plan or monitoring program required by this approval on a progressive basis.</p> <p><b>Note:</b> <i>The conditions of this approval require certain strategies, plans, and programs to be prepared for the project. They also require these documents to be reviewed and audited on a regular basis to ensure they remain effective. However, in some instances, it will not be necessary or practicable to prepare these documents for the whole project at any one time, particularly as these documents are intended to be dynamic and improved over time. Consequently, the documents may be prepared and implemented on a progressive basis, subject to the conditions of this approval. In doing this however, the Proponent will need to demonstrate that it has suitable documents in place to manage the existing operations of the project.</i></p>	No staging of the EP-LMP proposed
Schedule 3, Condition 4 (h)	<p>The Proponent shall prepare and implement Extraction Plans for any second workings to be mined to the satisfaction of the Secretary. Each Extraction Plan must include a:</p> <p><b>Land Management Plan</b>, 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><b>Notes:</b> <i>Management plans prepared under condition 4(h) should address all potential impacts of proposed underground coal extraction on the relevant features. Other similar management plans required under this approval (eg under conditions 13 and 23 of schedule 4 or condition 3 of schedule 5) are not required to duplicate these plans or to otherwise address the impacts associated with underground coal extraction.</i></p>	Section 1.6
Schedule 3, Condition 5	<p>The Proponent shall ensure that the management plans required under Schedule 3 Condition 4(h) 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;</p> <p>(b) a detailed description of the measures that would be implemented to remediate predicted impacts; and</p> <p>(c) a contingency plan that expressly provides for adaptive management.;</p>	<p>Section 3</p> <p>Section 5</p> <p>Section 7</p>
Schedule 6, Condition 2	<p>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>	<p>Section 2</p>

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Condition	Requirement	Document reference
	<ul style="list-style-type: none"> <li>the relevant statutory requirements (including any relevant approval, licence or lease conditions);</li> </ul>	Section 1.4 Attachment 1
	<ul style="list-style-type: none"> <li>any relevant limits or performance measures/criteria;</li> </ul>	Section 4
	<ul style="list-style-type: none"> <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>	Section 4
	(c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	Section 5
	(d) a program to monitor and report on the;	
	<ul style="list-style-type: none"> <li>impacts and environmental performance of the project;</li> </ul>	Section 6
	<ul style="list-style-type: none"> <li>effectiveness of any management measures (see (c) above);</li> </ul>	
	(e) a contingency plan to manage any unpredicted impacts and their consequences;	Section 7
	(f) a program to investigate and implement ways to improve the environmental performance of the project over time;	Section 9.4
	(g) a protocol for managing and reporting any;	
	<ul style="list-style-type: none"> <li>incidents;</li> </ul>	Section 8.1
	<ul style="list-style-type: none"> <li>complaints;</li> </ul>	Section 10
	<ul style="list-style-type: none"> <li>non-compliances with statutory requirements; and</li> </ul>	Section 8.2
	<ul style="list-style-type: none"> <li>exceedances of the impact assessment criteria and/or performance criteria; and</li> </ul>	
	(h) a protocol for periodic review of the plan.	Section 9.3
Schedule 6 Condition 3	Within 3 months of the submission of an:	Section 9.3
	(a) audit under condition 7 of Schedule 6;	
	(b) incident report under condition 4 of Schedule 6; and	
	(c) annual review under condition 5 of Schedule 6; and	
	(d) any modification to the conditions of this approval (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.	
Schedule 6 Condition 4	The Proponent shall notify the Secretary in writing via the Major Projects website and any other relevant agencies of any incident associated with the project as soon as practicable after the Proponent becomes aware of the incident. Within 7 days of the date of the incident, the Proponent shall provide the Secretary and any relevant agencies with a detailed report on the incident.	Section 8.1
Schedule 6 Condition 5	The Proponent shall provide regular reporting on the environmental performance of the project on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of this approval, and to the satisfaction of the Secretary.	Section 1.7 Section 9.1


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Condition	Requirement	Document reference
Schedule 6 Condition 6	By the end of March each year, the Proponent must submit a review of the environmental performance of the project for the previous calendar year to the satisfaction of the Secretary.	Section 9.1
Schedule 6 Condition 7	Prior to 13 September 2010, and every 3 years thereafter, unless the Secretary directs otherwise, the Proponent shall commission and pay the full cost of an Independent Environmental Audit of the project (Stages 1 and 2).	Section 9.2
Schedule 6 Condition 10	<p>The Proponent shall:</p> <p>(a) make copies of the following publicly available on its website:</p> <ul style="list-style-type: none"> <li>the documents referred to in Condition 2 of Schedule 2;</li> <li>all current statutory approvals for the project;</li> <li>all approved strategies, plans and programs required under the conditions of this approval;</li> <li>a comprehensive summary of the monitoring results of the project, reported in accordance with the specifications in any conditions of this approval, or any approved plans and programs;</li> <li>a complaints register, updated on a monthly basis;</li> <li>minutes of CCC meetings;</li> <li>the annual reviews of the project;</li> <li>any independent environmental audit of the project, and the Proponent's response to the recommendations in any audit;</li> <li>any other matter required by the Secretary; and</li> </ul>	Section 1.7
	(b) keep this information up-to-date, to the satisfaction of the Secretary.	Section 1.7

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**Table A1-2 Relevant Statement of Commitments**

SoC requirements		EP-LMP reference
SoC	Summary of the requirement	
5.1	Inspect the identified 'cracking zones' above each longwall panel to identify occurrence of cracks.	Section 6.1
5.5	Inspect local drainage lines above the active and completed longwall panels. Monitoring should assess any restriction of flows and hence restriction of fish passage to facilitate appropriate restorative measures.	Section 6.1
5.8	Inspect areas of the Mine Site susceptible to landslip or accelerated erosion, e.g., drainage lines and steeply sloped areas of exposed Purlawaugh Formation derived subsoils.	Section 6.1
5.11	Establish survey lines along ephemeral drainage gullies and along gully crests and monitor during and after mining of each longwall panel to identify any signs of cracking or 'upsidence'.	Section 6.1
5.15	Inspect the watercourses over the subsidence zone to identify the location and extent of ponding.	Section 6.1
5.16	For ponding where there is little or no vegetation of conservation significance, monitor the location and extent of ponding.	Section 6.1
12.12	Minimise erosion on the Mine Site as a consequence of subsidence.	Section 5.4

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		Last revision date:	20 August 2024
<b>WHC_PLN_NAR_LAND MANAGEMENT PLAN - LW 203 – LW 206</b>			

## Attachment 2 Consultation records

Our Reference: DLA:MH:2029147  
Your Reference: PAE-50417206  
Contact Name: Michelle Henry

Narrabri Coal Operations Pty Ltd  
Whitehaven Coal Ltd  
10 Kurrajong Creek Rd  
BAAN BAA NSW 2390

Via: Major Projects site

Thursday 8 December 2022

**Re: Narrabri Coal Stage 2- Post Approval Consultation (PAE-50417206) Draft Extraction Plan for LW 203 to LW 206 - Built Features Management Plan and Land Management Plan - Council Review**

To whom it may concern,

Thank you for the opportunity to provide comment on the abovementioned Plans.

Council understands that due to delays in receiving Commonwealth approval for the Stage 3 project, NCOPL are revising the secondary approval strategy to ensure the continuation of mining operations under the current Stage 2 Project Approval (PA 08\_0144). This will require the draft Extraction Plan for LW 203 to LW 206 to be prepared to comply with the conditions under PA 08\_0144 (Stage 2).

In accordance with Schedule 3, Condition 4(g), of the Project Approval (PA 08\_0144), NCOPL are required to prepare a Built Features Management Plan in consultation with the owner of potentially affected features. In addition, Condition 4(h) of the Stage 2 Project Approval (PA 08\_0144) requires NCOPL to prepare a Land Management Plan 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.

Narrabri Shire Council have now reviewed the provided plans and whilst the Built Features Management Plan does mention a potential impact to a public road, Scratch Road is identified as a Forestry Road only and not a Council Road. Therefore, given that these two documents do not directly impact Council's Infrastructure Assets, the following comments are provided:

- NCOPL should ensure they continue to comply with the requirements of any existing and future consents/approvals.
- NCOPL should continue to be transparent and maintain open lines of communication with Narrabri Shire Council and the wider community,
- NCOPL should continue to regularly update their website with any new or modified approvals, the minutes of any public meetings and any complaints registers.
- NCOPL should continue to investigate and implement ways to improve the environmental performance of the development.
- Council generally concurs with the contents of the Plan and is supportive of ongoing monitoring and assessment in accordance with the project approval.



  
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- Council requests any further amendments or updates to the plan/s should be referred for further review and comment.

Thank you for the opportunity to provide feedback. Should you require any additional information or clarification in relation to this matter you are invited to contact Council's Planning and Sustainability Department or the undersigned on (02) 6799 6866, or by emailing [council@narrabri.nsw.gov.au](mailto:council@narrabri.nsw.gov.au).

Yours faithfully




**Michelle Henry**  
Manager Planning and Development

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**Table A2-1 Consultation feedback - NSC**

Consultation feedback	Outcome	Document reference
<p>Narrabri Shire Council have now reviewed the provided plans and whilst the Built Features Management Plan does mention a potential impact to a public road, Scratch Road is identified as a Forestry Road only and not a Council Road.</p>	<p>A paragraph has been added to section 1.5 of the EP-BFMP which states “Narrabri Shire Council provided a response (dated 8 December 2022) regarding Scratch Road which states that Scratch Road is identified as a Forestry Road only and not a Council Road.”</p> <p>Reference to Scratch Road being a public road has been amended throughout this EP-BFMP.</p> <p>Attachment 3 Table A3-2 of the EP-BFMP has been updated to state “Road maintenance with respect to Forestry Corporation NSW (FCNSW) access roads will need to consider the conditions of the Forest Permit.”</p>	<p>Section 1.5 and Attachment 3 of the EP-BFMP</p>
<p>Given that these two documents do not directly impact Council’s Infrastructure Assets, the following comments are provided:</p> <p>NCOPL should ensure they continue to comply with the requirements of any existing and future consents/approvals.</p>	<p>Section 1.4 Statutory requirements provides an overview of the applicable approvals. Attachment 1 provides a compliance table which lists all applicable approval conditions with a cross reference to the section of the Plan where these conditions have been addressed.</p>	<p>Section 1.4 Attachment 1</p>
<ul style="list-style-type: none"> <li>NCOPL should continue to be transparent and maintain open lines of communication with Narrabri Shire Council and the wider community.</li> </ul>	<p>Communication with NSC and the wider community is conducted in accordance with Section 4.7 (Information Dissemination, Complaints, Incident Management and Dispute Resolution) of the Narrabri Mine Environmental Management Strategy EMS) which states “Dissemination of information to the local community and relevant agencies regarding the mining operation, its progress and environmental management performance, will be achieved by both formal and informal means including the following:</p> <ul style="list-style-type: none"> <li>CCC Meetings</li> <li>Annual Review (AR)</li> <li>Other methods such as regular formal and informal contact with relevant government agencies, non-compliance reporting, local press, and the provision of newsletters.</li> </ul>	<p>Section 4.7 of the EMS</p>

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Consultation feedback	Outcome	Document reference
<ul style="list-style-type: none"> <li>NCOPL should continue to regularly update their website with any new or modified approvals, the minutes of any public meetings and any complaints registers.</li> </ul>	<p>Section 1.7 Access to information states “In accordance with Schedule 6 Condition 10 of the Project Approval, the approved Extraction Plan and all appendices, audits and reports, and summaries of all monitoring data (where relevant) will be made publicly available on the WHC website. All information will be kept up to date.”</p> <p>Section 10 Complaints management states that “A summary of the complaints will be maintained by NCOPL and made available to the Community Consultative Committee, the complainant (on request) and on the WHC website”</p> <p>Section 4.7 of the EMS states “The minutes of the CCC meetings will be available on the Whitehaven website.”</p> <p>All new or modified approvals will continue to be uploaded to the Whitehaven website.</p>	<p>Section 1.7</p> <p>Section 10</p> <p>Section 4.7 of the EMS</p>
<ul style="list-style-type: none"> <li>NCOPL should continue to investigate and implement ways to improve the environmental performance of the development.</li> </ul>	<p>Section 9.4 Improvement measures states “Project Approval Schedule 6 Condition 2(f) requires this Plan to include a program to investigate and implement ways to improve the environmental performance of the development over time. Improvement measures may be investigated through review of the following:</p> <ul style="list-style-type: none"> <li>monitoring data, and any assessment of trends;</li> <li>audit outcomes, including audits of built features management measures; and</li> <li>incident reports, including any community complaints.</li> </ul> <p>Reasonable and feasible improvement measures will be implemented and documented as a management measure in a revision to the Plan as described in section 9.3.”</p>	<p>Section 9.4</p>
<ul style="list-style-type: none"> <li>Council generally concurs with the contents of the Plan and is supportive of ongoing monitoring and assessment in accordance with the project approval.</li> </ul>	<p>Noted</p>	<p>N/A</p>

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Consultation feedback	Outcome	Document reference
<ul style="list-style-type: none"> <li>Council requests any further amendments or updates to the plan/s should be referred for further review and comment.</li> </ul>	A sentence has been added to section 1.6 which states “Any further amendments or updates to this Plan will be referred to NSC for further review and comment.”	Section 1.6