



UG4 LONGWALLS 409 TO 414 SUBSIDENCE MONITORING PROGRAM

Version	Issue Date (Month/YYYY)	Revision Detail (Include the main areas reviewed, trigger / why the change)	Author(s)	Review Team
1	October 2024	Original SMP for the UG4 Longwalls 409-414 Extraction Plan	MCO	MCO
2	January 2025	Updated to Address Agency Consultation	MCO	MCO
3	April 2026	Updated in response to Comments from the IEAPM	MCO	MCO
4	June 2026	Minor Administrative Updates for Consistency Across the UG4 Longwalls 409 to 414 Extraction Plan	MCO	MCO

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1.0 INTRODUCTION

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

Moolarben Coal Operations Pty Ltd (MCO) is the operator of the Moolarben Coal Complex on behalf of the Moolarben Joint Venture. MCO is a wholly owned subsidiary of Yancoal Australia Limited.

The UG4 Underground Mine (UG4) is a component of the approved Moolarben Coal Complex (**Figure 2**). First workings for UG4 commenced in October 2020 (**Figure 3**). Secondary extraction in UG4 of the first Longwall (LW) 401 commenced in July 2022. LW401 to 407 were completed in January 2026. The extraction of LW 409 to 414 (hereafter referred to as LW409-414) within UG4 is scheduled to commence in September 2026.

Mining operations at the Moolarben Coal Complex are currently approved until 31 December 2038 and continue to be carried out in accordance with Project Approval (05_0117) (Moolarben Coal Project Stage 1) (as modified) and Project Approval (08_0135) (Moolarben Coal Project Stage 2) (as modified).

1.1 PURPOSE AND SCOPE

This UG4 Longwalls 409 to 414 Subsidence Monitoring Program (LW409-414 SMP) has been prepared to satisfy the requirements of Condition 77(m), Schedule 3 of Project Approval (05_0117) for the management of potential impacts due to secondary extraction of LW409-414.

This LW409-414 SMP forms a part of the Extraction Plan developed for LW409-414 of the approved UG4. This LW409-414 SMP has been prepared by MCO, with input from suitably qualified experts including Mine Subsidence Engineering Consultants Pty Ltd (MSEC), WRM Water & Environment Pty Ltd (WRM), Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) and Niche Environment and Heritage Pty Ltd (Niche), to satisfy the requirements of Project Approval (05_0117) and *Extraction Plan Guideline* (NSW Department of Planning and Environment [DPE], 2022).

The appointment of the team of suitably qualified and experienced persons (which includes representative of MCO, MSEC, WRM, AGE and Niche) was endorsed by the Secretary of the Department of Planning, Housing and Infrastructure (DPHI) on 9 May 2024 and 28 June 2024 (**Attachment 2** of the Extraction Plan).

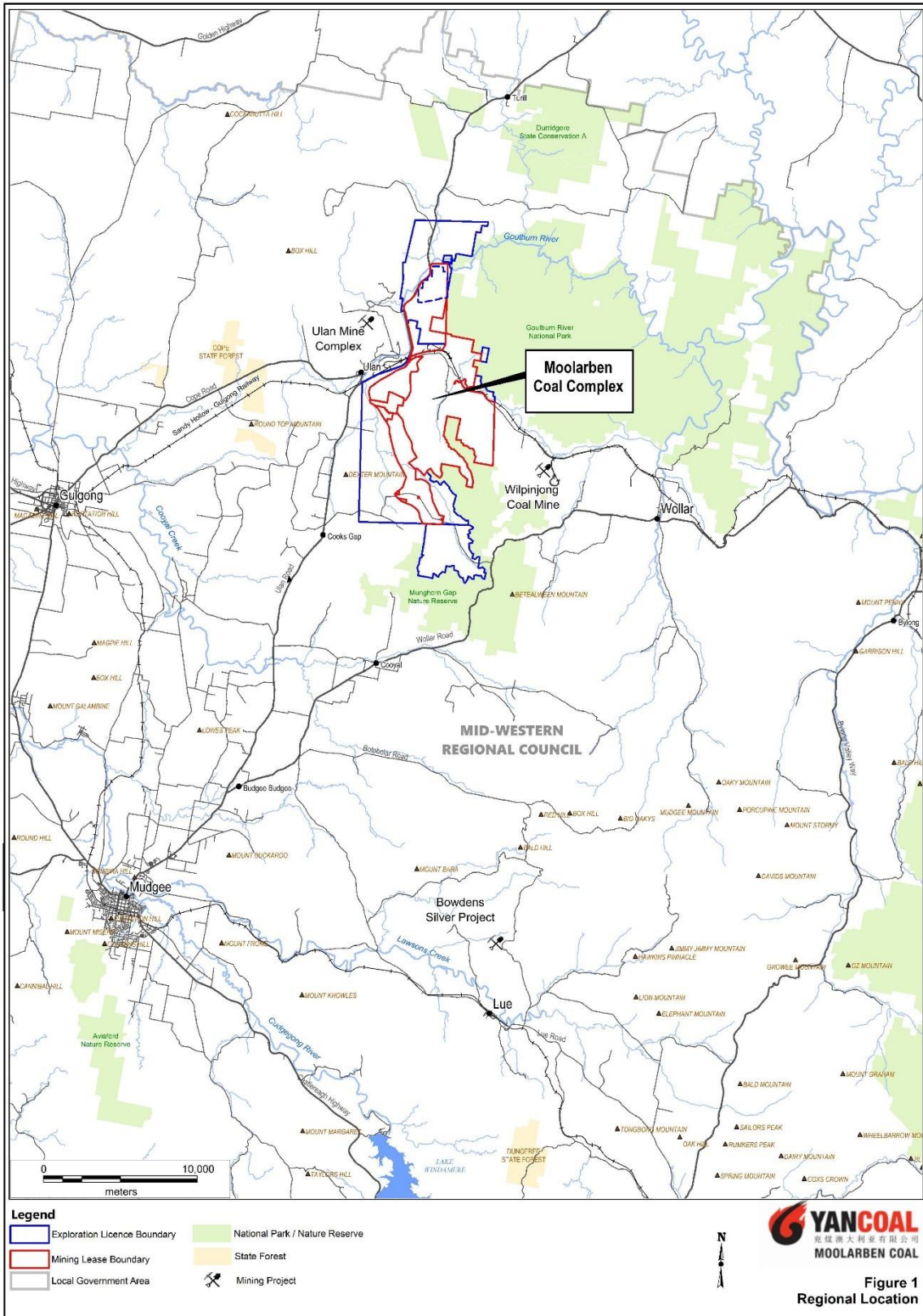
Purpose: This LW409-414 SMP describes the subsidence monitoring program (subsidence impacts and subsidence effects) that forms part of the overall management of the consequential environmental impacts associated with the extraction of LW409-414.

Scope: This LW409-414 SMP covers areas within and in the vicinity of the LW409-414 Study Area¹ (**Figure 3**).

¹ The LW409-414 Study Area is defined as the area of land within the furthest extent of the 26.5 degree (°) angle of draw and 20 millimetres (mm) predicted subsidence contour.

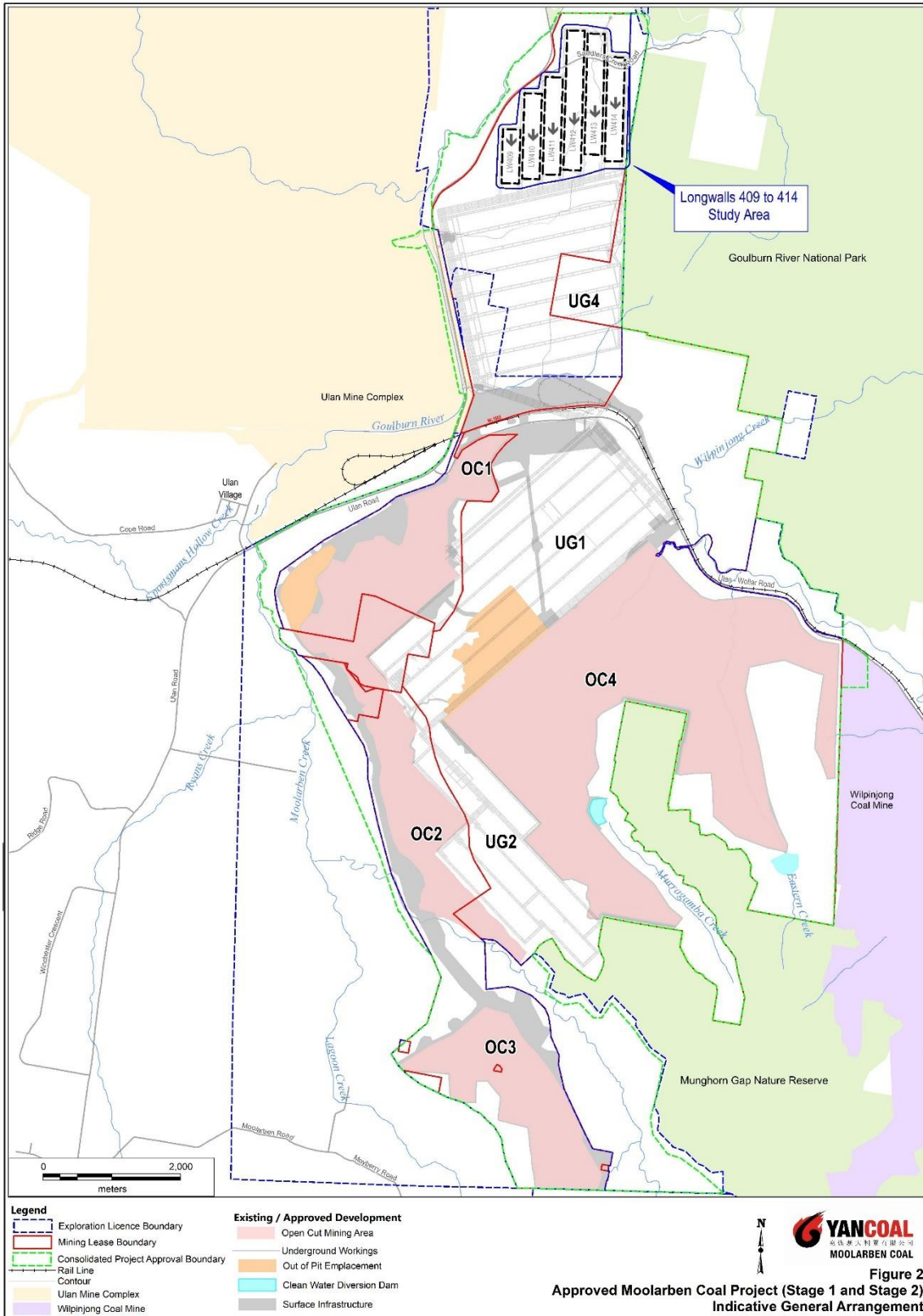
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Figure 1: Regional Location



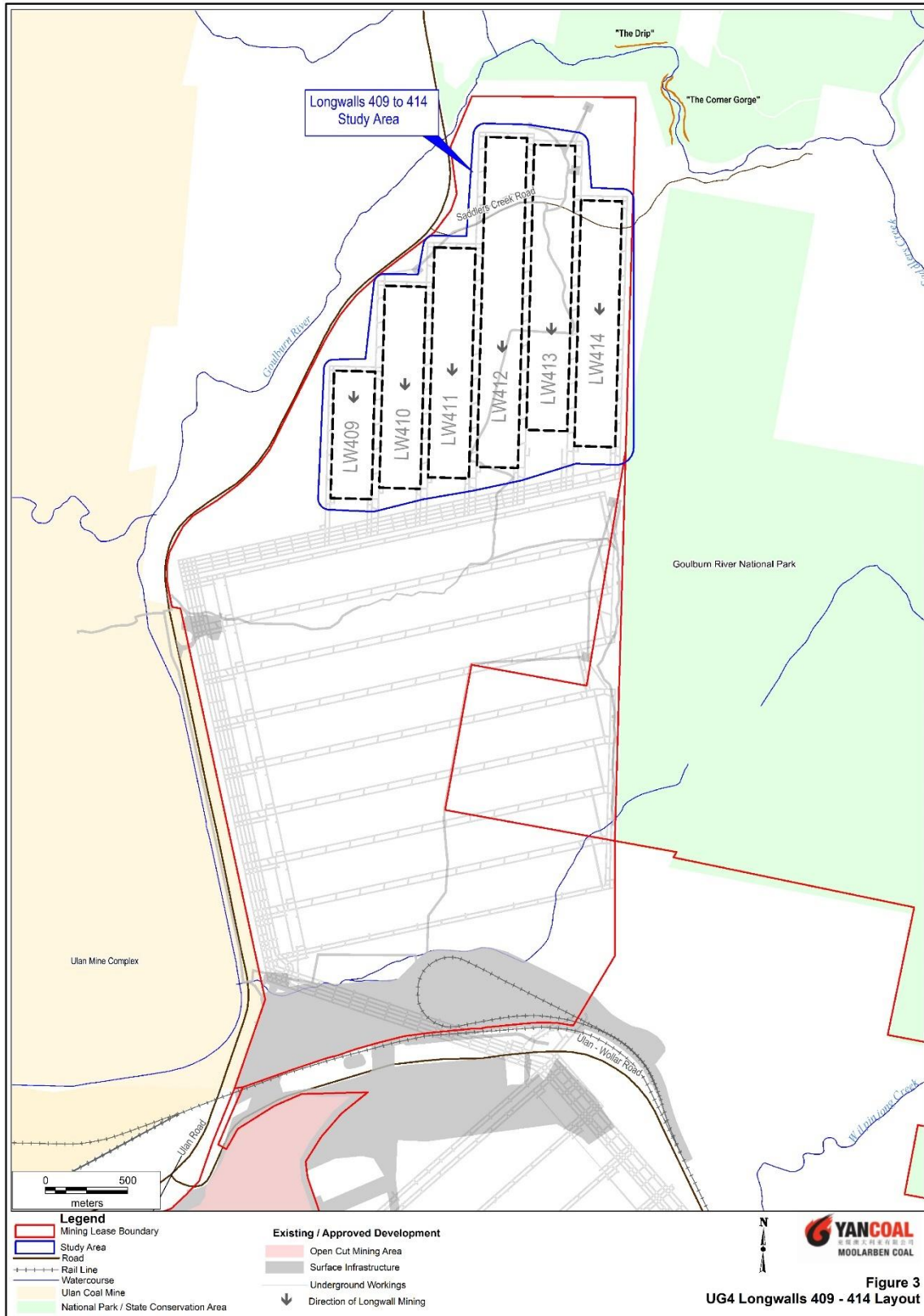
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Figure 2: Moolarben Coal Complex Layout



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Figure 3: UG4 Longwalls 409 to 414 Layout



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1.2 STRUCTURE OF THE LONGWALLS 409 TO 414 SUBSIDENCE MONITORING PROGRAM

The remainder of the LW409-414 SMP is structured as follows:

- Section 2** Describes the LW409-414 SMP revision status.
- Section 3** Outlines the statutory requirements applicable to the LW409-414 SMP.
- Section 4** Describes the LW409-414 Extraction Layout and schedule.
- Section 5** Describes the natural and built features at the surface.
- Section 6** Summarises the predicted subsidence parameters and impacts due to the secondary extraction of LW409-414.
- Section 7** Describes the monitoring program.
- Section 8** Describes the program to analyse subsidence effects, subsidence impacts, and environmental consequences.
- Section 9** Describes the roles and responsibilities for MCO personnel and key contacts.
- Section 10** Lists the references cited in this LW409-414 SMP.

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2.0 LONGWALLS 409 TO 414 SUBSIDENCE MOINTORING PLAN REVIEW AND UPDATE

In accordance with Condition 5, Schedule 5 of Project Approval (05_0117), this LW409-414 SMP will be reviewed as follows:

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

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

2.1 ACCESS TO INFORMATION

In accordance with Condition 11, Schedule 5 of Project Approval (05_0117), MCO will make the approved LW409-414 SMP publicly available on the Yancoal's website.

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3.0 STATUTORY REQUIREMENTS

MCO's statutory obligations are contained in:

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

Obligations relevant to this LW409-414 SMP are described below.

3.1 ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979 APPROVAL

Condition 77(m), Schedule 3 of Project Approval (05_0117), requires the preparation of a Subsidence Monitoring Program as a component of the Extraction Plan (i.e. this LW409-414 SMP). Condition 77(m), Schedule 3 of Project Approval (05_0117) states:

SUBSIDENCE

...

Extraction Plan

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

...

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

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

...

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The following graphical plans have been prepared in accordance with the *Extraction Plan Guideline* (DPE, 2022) and are provided in **Attachment 2**:

- Plan 1: Extraction area: existing and proposed workings.
- Plan 2: Surface Features.
- Plan 3: Proposed workings: seam and depth of cover.
- Plan 4: All workings: seam and depth of cover.
- Plan 5: Mining titles and land ownership.
- Plan 6: Geological strata.
- Plan 7: Subsidence monitoring.

The *Moolarben Project Stage 1 – Longwalls 409 to 414 – Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan* (MSEC, 2024) (**Technical Report 1**) includes predictions of the conventional and non-conventional subsidence impacts and subsidence effects of the Extraction Plan, incorporating any relevant information that has been obtained since Project Approval (05_0117). The LW409-414 SMP is, among other things, designed to compare and validate the subsidence predictions outlined by MSEC (2024).

3.2 OTHER LEGISLATION

MCO operates the Moolarben Coal Complex consistent with Project Approval (05_0117) (as modified) and Project Approval (08_0135) (as modified) and any other legislation that is applicable under the *Environmental Planning and Assessment Act 1979*.

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

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

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

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4.0 PREDICTED SUBSIDENCE IMPACTS

4.1 LONGWALLS 409 TO 414 EXTRACTION SCHEDULE

LW409-414 and the area of land within the Study Area are shown on **Figure 3**. Longwall extraction will occur from the north to south for each panel. The longwall layout includes approximately 260 metre (m) panel widths (void) with 35 m width pillars (solid). The provisional extraction schedule for LW409-414 is provided in **Table 1**.

Table 1: Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration (months)	Estimated Completion Date
LW409	September 2026	3	November 2026
LW410	December 2026	3	March 2027
LW411	April 2027	3	July 2027
LW412	August 2027	4	December 2027
LW413	January 2028	4	May 2028
LW414	June 2028	4	September 2028

4.2 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

Revised subsidence predictions of the potential subsidence effects, subsidence impacts and environmental consequences of the proposed second workings, have been prepared by MSEC (2024) incorporating any relevant information obtained since approval (e.g. additional data from underground mining UG1 and LW401 to 408 [LW401-408] to date), in accordance with condition 77(e), Schedule 3 of Project Approval (05_0117).

MSEC (2024) were engaged by MCO to prepare a Subsidence Technical Report to support the Extraction Plan for LW409-414 (**Technical Report 1**). The predictions and impact assessments provided in this Extraction Plan are based on the Extraction Plan Layout (**Figure 3**). The Extraction Plan Layout is the same as the Approved Layout, with the exception of LW413, which will be shorter at the southern end by 125 m, and LW414, which will be 20 m shorter at the northern end.

A comparison of the maximum predicted subsidence parameters resulting from the extraction of LW409-414 (the Extraction Plan Layout), with those based on the Approved Layout is provided in Table 8 of the Extraction Plan and Table 4.3 of **Technical Report 1**. MSEC (2024) has concluded that the maximum predicted total subsidence parameters based on the Approved Layout are the same as those for the Extraction Plan Layout for LW409-414. Further details related to predicted subsidence impacts are provided in **Section 6.0**.

Monitoring and management recommendations from MSEC and the endorsed suitably qualified experts have been incorporated throughout this LW409-414 SMP.

Further description of the geology, seam structure, seam thickness, and depth of cover is provided in the Extraction Plan and **Technical Report 1**.

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5.0 SURFACE FEATURES INCLUDED IN THE MONITORING PROGRAM

5.1 THE LONGWALLS 409 TO 414 STUDY AREA

The Study Area (**Figure 3**) for the LW409-414 Extraction Plan is defined as the surface area that is likely to be affected by the proposed mining of LW409-414 (Extraction Plan Layout) in the Ulan Seam. The extent of the Study Area has been calculated by MSEC combining the areas bounded by the following limits:

- The 26.5° angle of draw line; and
- The predicted vertical limit of subsidence, taken as the 20 mm subsidence contour.

As the depth of cover above the longwalls varies between 120 and 215 m, the 26.5° angle of draw line has been conservatively determined by drawing a line around the outer edge of the longwall voids at a horizontal distance that varies between 60 and 108 m.

There are features that lie outside the defined the Study Area that are expected to experience either far-field movements, or valley related movements. The surface features which are sensitive to such movements have been identified and have also been included in the assessments provided in **Technical Report 1**.

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

Natural and cultural features that have been identified outside the Study Area include the Goulburn River, the Drip and the Corner Gorge, cliffs and minor cliffs, the Goulburn River National Park (GRNP), the Goulburn River State Conservation Area (GRSCA), native vegetation and Aboriginal heritage sites. There are no historic heritage sites within the Study Area. Historic heritage sites in the vicinity of the Study Area are not considered sensitive to subsidence movements; therefore, no environmental consequences requiring management or monitoring are expected in the Extraction Plan.

There are a number of built features that have been identified outside the Study Area including assets owned by Mid-Western Regional Council (MWRC), Telstra, Tilt Renewables, State Survey control marks, MCO and private landholders.

5.2 NATURAL FEATURES

5.2.1 Drainage Lines

There are no perennial drainage lines within the Study Area. The only drainage line flowing through the Study Area is Drainage Line (DL) 2. A number of other small ephemeral drainage lines have been identified above LW409-414 and within the Study Area. The drainage lines located across the Study Area are likely to be to be subjected to the full range of predicted systematic subsidence and valley related movements (MSEC, 2024).

Further details related to Drainage Lines are provided in the UG4 Longwalls 409 to 414 Water Management Plan (LW409-414 WMP).

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5.2.2 Goulburn River

The Goulburn River is located outside the Study Area. The Goulburn River is located on the north-western side of LW409-412 at distances of 180 m to 440 m from the longwall commencing ends, and to the north and north-east of LW412-414 at distances of 460 m to 500 m. At its nearest point of 180 m from LW409-414, the distance to the Goulburn River represents about 1.3 times the depth of cover from LW409-414. Elsewhere, the Goulburn River is two or more times the depth of cover from LW409-414. At these distances, it is possible that where horizontal movement is observed at a valley location then valley related closure movement could be observed. However, it is considered unlikely that fracturing of the bed of the Goulburn River would occur (MSEC, 2024).

Further details relevant to the Goulburn River are provided in the *UG4 Longwalls 409 to 414 Drip, Corner Gorge and Goulburn River Monitoring and Reporting Program* (the Monitoring Program) (**Appendix H**).

5.2.3 Groundwater

There is no ‘highly productive’ groundwater, as defined under the *NSW Aquifer Interference Policy* (AIP), mapped in the vicinity of the Moolarben Coal Complex. The aquifers in the vicinity of LW409-414 are “less productive” as per the AIP classification. The nearest ‘highly productive’ groundwater is a portion of the alluvial aquifer associated with Wilpinjong Creek downstream of the Wilpinjong Coal Mine (AGE, 2024).

There are no high priority groundwater dependent ecosystems (GDEs) listed in the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* within or in the vicinity of the Study Area (AGE, 2024).

The Drip is a GDE with local cultural and community significance. The groundwater seepage is observed in a cliff on the northern side of the Goulburn River and is derived from the perching of groundwater in zones that are exposed in the cliff faces. The perching occurs in the Triassic Narrabeen Group sediments and is formed by accumulations of groundwater above less permeable horizons in the Triassic sequence to the north of the Goulburn River. As described above, the perched aquifer is effectively disconnected from the underlying regional water table and therefore depressurisation caused by mining of LW409-414 will not impact the water supply to the Drip (AGE, 2024).

Further details relevant to groundwater features are provided in the LW409-414 WMP. Further details relevant to the Drip are provided in the Monitoring Program (**Appendix H**).

5.2.4 Land in General

Land in general refers to the general landscape other than cliffs within the Study Area, including other land features such as fire trails and vehicular tracks, however excludes surface features such as drains, diversions, and other MCO assets. Unsealed vehicular tracks and fire trails are located throughout the Study Area and above LW409-414 and are predicted to experience the full range of predicted subsidence movements (MSEC, 2024)

Further details relevant to land in general are provided in the UG4 Longwalls 409 to 414 Land Management Plan (LW409-414 LMP).

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5.2.5 Cliffs

A detailed assessment to identify all possible cliffs and minor cliffs² within and in the vicinity of the LW409-414 Study Area was completed by MSEC (2024), using 1 m surface level contour generated from a Light Detection and Ranging survey and from site investigations (MSEC, 2024).

There is one cliff (CL3) and three minor cliffs (CL1, CL2 and CL4) within and in the vicinity of the Study Area.

CL3 is located adjacent to the finishing end of LW413 and is over 165 m to the north of LW408. The length of LW413 has been reduced by 125 m for the Extraction Layout compared to the Approved Layout to reduce the predicted impacts at CL3. The maximum predicted conventional subsidence parameters based on the Extraction Plan Layout are less than those for the Approved Layout (MSEC, 2024).

Within the GRNP, the nearest cliff is the Corner Gorge located 450 m from LW414 (**Section 5.2.6**) and the nearest minor cliff is located 313 m from the commencing end of LW414. There are no other cliffs or minor cliffs within the GRNP within 400 m of the longwalls. Within the GRSCA, the nearest cliff is 330 m from LW412 and the nearest minor cliff is 300 m from LW412 (MSEC, 2024). It is unlikely that the cliffs and minor cliffs within the GRNP and GRSCA would be adversely impacted by the far-field horizontal movements (MSEC, 2024).

Further details related to cliffs and minor cliffs within and in the vicinity of the Study Area are provided in the LW409-414 LMP.

5.2.6 The Drip and Corner Gorge

The Drip is located approximately 645 m from the commencing end of LW413 and is 770 m from the commencing end of LW412. The distance of 645 m to the Drip represents approximately 4.5 times the depth of cover of 145 m from LW413.

The Corner Gorge is located approximately 450 m from LW414 and is approximately 575 m from LW413. The distance of 450 m to the Corner Gorge represents approximately 3.5 times the depth of cover of 130 m from LW414.

At distances of over 450 m, the Drip and Corner Gorge will not experience measurable conventional tilts, curvatures or strains from the extraction of LW409-414 (MSEC, 2024). Existing Global Navigation Satellite Systems (GNSS) monitoring data has been reviewed by MSEC (2024), which has identified that the Drip and Corner Gorge currently experience a level of baseline natural movements and may experience far-field movements from mining of LW409-414.

² The definitions of cliffs and minor cliffs provided in the NSW DP&E *Standard and Model Conditions for Underground Mining* (DP&E, 2012) are:

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

Minor Cliff A continuous rock face, including overhangs, having a minimum length of 20 metres, heights between 5 metres and 10 metres and a minimum slope of 2 to 1 (>63.4°); or a rock face having a maximum length of 20 metres and a minimum height of 10 metres”

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Due to the significant distance and low magnitude of expected far-field movement at the cliffs, mining-related impacts to the Drip and Corner Gorge due to the extraction of LW409-414 are considered unlikely to occur (MSEC, 2024). Valley closure movements greater than the model tolerance (i.e. 20 mm of differential movement, ± 5 mm to account for GNSS monitor accuracy) are unlikely to be observed at the Drip and Corner Gorge (MSEC, 2025).

Further details relevant to the Drip and Corner Gorge are provided in the Monitoring Program (Appendix H).

5.2.7 Biodiversity

No Plant Community Types (PCTs) within the Study Area are associated with Threatened Ecological Communities (TECs).

No threatened flora species were detected within the Study Area during the Stage 1 EIS (Moolarben Biota, 2006) or *Moolarben Coal Complex UG4 Ancillary Works Modification Biodiversity Development Assessment Report* (Eco Logical Australia [ELA], 2019). However, a population of *Androcalva procumbens* (listed as Vulnerable under the BC Act and EPBC Act) was identified during baseline surveys (Niche, 2024b). The population is comprised of five individuals in PCT 3781, occurring approximately 30 m south of LW413. No other threatened flora species were detected during the baseline assessment survey (Niche, 2024b).

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

- Mammals
 - Corben’s Long-eared Bat *Nyctophilus corbeni* (Vulnerable, EPBC Act and BC Act)
 - Eastern Cave Bat *Vespadelus troughtoni* (Vulnerable, BC Act)
 - Large Bent-winged Bat *Miniopterus orianae oceanensis* (Vulnerable, BC Act) formerly Eastern Bentwing-bat
 - Large-eared Pied Bat *Chalinolobus dwyeri* (Endangered, EPBC Act and BC Act)
 - Yellow-bellied Sheathtail Bat *Saccolaimus flaviventris* (Vulnerable, BC Act)
- Birds
 - Black-chinned Honeyeater – eastern subspecies *Melithreptus gularis gularis* (Vulnerable, BC Act)
 - Brown Treecreeper – eastern subspecies *Climacteris picumnus victoriae* (Vulnerable, BC Act)
 - Diamond Firetail *Stagonopleura guttata* (Vulnerable, BC Act)
 - Dusky Woodswallow *Artamus cyanopterus cyanopterus* (Vulnerable, BC Act)
 - Gilbert’s Whistler *Pachycephala inornata* (Vulnerable, BC Act)
 - Glossy Black Cockatoo *Calyptorhynchus lathami* (Vulnerable, BC Act)
 - Hooded Robin – south-eastern form *Melanodryas cucullata cucullata* (Vulnerable, BC Act)
 - Painted Honeyeater *Grantiella picta* (Vulnerable, BC Act and EPBC Act)

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- Powerful Owl *Ninox strenua* (Vulnerable, BC Act)
- Speckled Warbler *Cthonicola sagittata* (Vulnerable, BC Act)
- Square-tailed Kite *Lophoictinia isura* (Vulnerable, BC Act)
- Varied Sittella *Daphoenositta chrysoptera* (Vulnerable, BC Act).

Further details relevant to biodiversity are provided in the UG4 Longwalls 409 to 414 Biodiversity Management Plan (LW409-414 BMP).

5.3 ABORIGINAL HERITAGE

There are 33 Aboriginal heritage sites identified within and in close proximity (within 100 m) to the Study Area including 23 sites that are recorded within the Study Area and 10 sites which are recorded in proximity to the Study Area (Niche, 2024a).

Of the 23 Aboriginal heritage sites within the Study Area, four sites have been managed under existing approvals (i.e. 19 remain *in situ*). Of the 10 sites in proximity to the Study Area, one site has been managed (i.e. nine sites remain *in situ*). Another site within the Study Area has been partially managed (Niche, 2024a).

Aboriginal heritage site S1MC280 is located within the LW401-408 Study Area (south of the LW409-414 Study Area) and the likelihood of subsidence impacts to this feature from LW409-414 is considered to be very low. S1MC280 is described further in the UG4 LW401-408 Heritage Management Plan and the UG4 LW401-408 S1MC280 Subsidence Monitoring and Mitigation Program.

Aboriginal heritage site S1MC264, S1MC282, S1MC283, S1MC286 and S1MC287 have performance measures in accordance with Project Approval (05_0117). Aboriginal heritage sites S1MC264, S1MC282, S1MC283 and S1MC286 are located in proximity to the Study Area. The likelihood of subsidence impacts to these features is considered to be unlikely (MSEC, 2024). Aboriginal site S1MC287 is located immediately downslope of CL3 outside the 20 mm subsidence contour. Predicted subsidence parameters at this site are negligible, less than typical limits of survey accuracy, and impact to this shelter is considered unlikely to occur (MSEC, 2024).

Project Approval (05_0117) does not include any specific performance measures for the Aboriginal heritage site S1MC284. However, in consideration of the features associated with S1MC284 (i.e. shelter with art and artefacts) and the scientific significance (moderate), it is proposed that the performance measure of *reduce the likelihood of subsidence damage to low* is voluntarily applied to S1MC284. S1MC284 is located in proximity to the Study Area and the likelihood of subsidence impacts to this feature is considered to be unlikely (MSEC, 2024).

Impacts to open sites containing artefacts and isolated finds and rock shelters located outside the Study Area are considered to be unlikely (MSEC, 2024).

Sites within the Study Area would be subject to the full range of subsidence movements. Open sites inside the Study Area containing artefacts and isolated finds can potentially be affected by cracking of the surface soils as a result of mine subsidence movements. It is unlikely that the artefacts and isolated finds themselves would be impacted by surface cracking (MSEC, 2024).

Further details relevant to Aboriginal heritage sites are described in the UG4 Longwalls 409 to 414 Heritage Management Plan (LW409-414 HMP).

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5.4 PUBLIC UTILITIES

5.4.1 MWRC

MWRC infrastructure in the vicinity of the LW409-414 Study Area includes Ulan Road, the bridge over the Goulburn River (Ulan Road Bridge) and Saddlers Creek Road. Saddlers Creek Road is located on Crown Land but is managed by MWRC, and described separately in **Section 5.4.2**.

Ulan Road is a sealed bitumen pavement with no kerb and gutter located to the west of LW409-414 which is wholly outside of the Study Area. The road passes along the north western side of LW409-412 and is 65 m from the commencing end of LW410 at its nearest point, which equates to approximately 0.5 times the depth of cover at this location. Features along the road include three cuttings in sandstone with approximate heights up to 3 m at 400 m west of LW409, 2 m at 175 m west of LW412, and 5 m at 250 m north west of LW412. Culverts beneath Ulan Road are typically 400 mm to 800 mm diameter concrete pipes.

The Ulan Road Bridge is 210 m from LW412 at its nearest point.

Ulan Road, the road cuttings and Ulan Road Bridge are all located outside the Study Area and will not be subjected to measurable conventional subsidence, tilts, and curvatures; however, the road, cuttings and bridge may experience far-field horizontal movements (MSEC, 2024).

Further details relevant to MWRC infrastructure are provided in the UG4 Longwalls 409 to 414 Built Features Management Plan – Mid-Western Regional Council (LW409-414 BFMP-MWRC).

5.4.2 Saddlers Creek Road

Saddlers Creek Road is an unsealed dirt road that will be undermined by LW412-414 and experience subsidence movements from the extraction of these longwalls. The potential subsidence impacts on Saddlers Creek Road are expected to include cracking, stepping and rippling of the road surfaces. The road may also experience ponding and redirection of surface flow.

It is expected that Saddlers Creek Road can be maintained in serviceable condition with the implementation of the appropriate monitoring and management strategies (MSEC, 2024).

Further details relevant to Saddlers Creek Road are provided in the UG4 Longwalls 409 to 414 Built Features Management Plan – Saddlers Creek Road (LW409-414 BFMP-SCR).

5.4.3 Telstra

Telstra-owned telecommunications infrastructure in the vicinity of LW409-414 comprises copper cables that follow the general alignments of Ulan Road and Saddlers Creek Road.

The copper cables located along Ulan Road are not expected to be subjected to measurable conventional mine subsidence ground movements (i.e. less than limits of survey accuracy); however, the cables are expected to experience far-field horizontal movements (MSEC, 2024).

It is possible that the copper cables along Saddlers Creek Road could be impacted as a result of the proposed mining. However, it is unlikely that the proposed mining would result in any significant impacts on the copper telecommunications cables within the Study Area. Any impacts on these cables would be expected to be relatively infrequent and readily repairable (MSEC, 2024).

Further details relevant to Telstra infrastructure are described in the UG4 Longwalls 409 to 414 Built Features Management Plan – Telstra (LW409-414 BFMP-TELSTRA).

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5.4.4 Survey Control Marks

There are no survey control marks identified within the Study Area. The survey marks are predominantly located along road easements. At these locations the survey marks will not be subjected to measurable conventional mine subsidence ground movements due to the Extraction Plan Layout; however, they may experience far-field horizontal movements. It will be necessary on the completion of the longwalls (i.e. when the ground has stabilised) to re-establish the exact location of the survey marks (MSEC, 2024).

5.5 PRIVATELY OWNED BUILT FEATURES

A private property is located outside the Study Area boundary, to the east of LW414. The property consists of rental cottages (Goulburn River Stone Cottages) comprising three cottages (River Cottage, Saddlers Cottage and Barbara's Cottage) of stone and brick construction.

River Cottage is located 970 m from LW414, and Saddlers Cottage and Barbara's Cottage are greater than 1.5 km from LW414. At distances of over 970 m from LW409-414, the Goulburn River Stone Cottages are not expected to experience measurable conventional mine subsidence ground movements. However, the structures may experience low level far-field horizontal movements which are not expected to result in any impacts to the Cottages (MSEC, 2024).

5.6 MCO BUILT FEATURES

Dewatering infrastructure is located above the Extraction Plan Layout. The dewatering infrastructure includes dewatering bores, water pipelines and electrical cables. Potential impacts could occur as a result of irregular movements such as ground heave, stepping, large cracks, rock falls or tree falls (MSEC, 2024).

Exploration drill sites are located directly above and adjacent to the proposed longwalls and, therefore, could experience the full range of predicted subsidence movements. It is likely, therefore, that fracturing and shearing would occur in the drill holes as the result of mining (MSEC, 2024).

Fences are located within the Study Area and are constructed in a variety of ways, generally using either timber or metal materials. All fences are on MCO owned lands. The fences could experience the full range of predicted subsidence movements. There are three farm dams owned by MCO that have been identified within the Study Area (D1, D3 and D4). The dams are shallow but are no longer in use (MSEC, 2024).

There are a number of MCO owned four wheel drive tracks through the Study Area. These tracks are not publicly accessible. The tracks could experience the full range of predicted subsidence movements. Impacts are expected to include cracking, stepping and rippling of the track surfaces (MSEC, 2024).

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6.0 SUBSIDENCE PARAMETERS AND SUBSIDENCE IMPACTS DUE TO LONGWALLS 409 TO 414 EXTRACTION

MSEC (2024) has provided a detailed description of the development of mine subsidence and the method used to predict the mine subsidence movements resulting from the extraction of LW409-414. The report includes the maximum predicted conventional subsidence parameters for the longwalls including:

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

The maximum predicted incremental conventional subsidence from the extraction of LW409-414 is 1,800 mm, with a maximum predicted total conventional subsidence of 1,900 mm. The maximum predicted total subsidence parameters based on the Approved Layout are the same as the Extraction Plan Layout for LW409-414 (MSEC, 2024).

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

6.1 PREDICTED SUBSIDENCE PARAMETERS AND IMPACTS FOR THE NATURAL AND BUILT FEATURES WITHIN THE LONGWALLS 409 TO 414 STUDY AREA AND SURROUNDS

MSEC (2024) provides a comprehensive description of the predicted subsidence parameters and impact assessments for each of the natural and built features that are located within the Study Area, due to the extraction of LW409-414.

Additionally, natural and built features that are located outside the Study Area, which may be subjected to far-field movements and may be sensitive to the predicted subsidence parameters, were also included in the assessments. Further descriptions are provided in MSEC (2024).

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

- DL2;
- Goulburn River;
- land in general;
- cliff and minor cliff features (CL3, cliffs/minor cliffs in GRNP and GRSCA);
- the Drip and Corner Gorge;
- natural vegetation (including threatened, protected species or critical habitats);
- Aboriginal heritage sites;
- MWRC assets;
- Saddlers Creek Road;
- Telstra assets;

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- proposed Tilt Renewables assets;
- survey control marks; and
- MCO and private landholders.

The monitoring program described in **Section 7.2** was developed in consideration of the predicted subsidence parameters and subsidence impacts outlined by MSEC (2024) with input from MCO's suitably qualified experts WRM, AGE, and Niche.

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7.0 MONITORING

7.1 OBJECTIVES

The objectives of the subsidence monitoring program are:

- To monitor the subsidence effects associated with the extraction of LW409-414.
- To summarise and consolidate the various monitoring programs presented in each of the key component plans of the LW409-414 Extraction Plan. These include:
 - LW409-414 WMP;
 - LW409-414 LMP;
 - LW409-414 BMP;
 - LW409-414 HMP;
 - the UG4 Longwalls 409 to 414 Built Features Management Plans (BFMPs), including:
 - LW409-414 BFMP-MWRC;
 - LW409-414 BFMP-SCR;
 - LW409-414 BFMP-TELSTRA;
 - the UG4 Longwalls 409 to 414 Public Safety Management Plan (LW409-414 PSMP); and
 - the Monitoring Program.
- To analyse the relationship between the subsidence effects and subsidence impacts of the Extraction Plan and any ensuing environmental consequences.
- To validate subsidence predictions.
- To provide subsidence data to improve the predictive methods and provide a better understanding of the underlying factors contributing to ground movement.

7.2 SUBSIDENCE MONITORING PROGRAM

7.2.1 Subsidence Parameters Monitoring

The subsidence parameters monitoring program for the extraction of LW409-414 is summarised in **Table 2**. **Table 2** provides the description, subsidence parameters for monitoring, the frequency and relevant management plan. The subsidence parameters monitoring for LW409-414 includes establishing eight ground transect lines (i.e. subsidence lines) and monitoring points as displayed in Plan 7³ (**Attachment 2**). The subsidence lines will be composed of survey marks comprised of either stations set in rock or star pickets.

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

³ In accordance with *Extraction Plan Guideline* (DPE, 2022).

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Prior to the commencement of LW409, the subsidence lines and monitoring points will be installed and surveyed in three dimensions (3D) to establish the distance and nature of ground movements.

In addition to subsidence lines, MCO have installed several continuous GNSS monitoring sites above and adjacent to the Study Area and near the Drip and Corner Gorge. Additional GNSS units have also been installed north of LW412-414 to review and refine predictions of expected subsidence movements.

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

7.2.2 Monitoring Methods and Accuracy

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

- *Survey and Drafting Directions for Mining Surveyors 2020 (NSW Mines)*; and
- *Standards for the Australian Survey Control Network Special Publication 1 Version 2.2 December 2020 (ICSM SP1)*.

Section 3.4 ‘Correlation of Surface and Underground Surveys’ of the *Survey and Draft Directions for Mining Surveyors (NSW Mines)* (NSW Department of Customer Service – Spatial Services, 2020) will be consistent with Class “D” survey as prescribed in ICSM SP1 (Intergovernmental Committee on Surveying and Mapping - Geodesy Working Group, 2020). It is intended that all Control Surveys for mine subsidence of the central areas of LW409-414 to be surveyed to Class “D” using prescribed methods as described in ICSM SP1.

7.2.3 Subsidence Impact and Environmental Consequences Monitoring Components

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

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

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Table 2: Subsidence Parameter Monitoring Components

Monitoring Component	Description	Frequency	Relevant Management Plan
T Line	Longitudinal monitoring line at LW409 commencing end	<ul style="list-style-type: none"> Prior to the secondary extraction of LW409. Within three months following completion of LW409. 	Extraction Plan
V Line	Longitudinal monitoring line at LW410 commencing end	<ul style="list-style-type: none"> Prior to the secondary extraction of LW409. Within three months following completion of LW410. 	Extraction Plan
W Line	Longitudinal monitoring line at LW411 commencing end	<ul style="list-style-type: none"> Prior to the secondary extraction of LW409. Within three months following completion of LW411. 	Extraction Plan
X Line	Longitudinal monitoring line at LW412 commencing end	<ul style="list-style-type: none"> Prior to the secondary extraction of LW409. Within three months following completion of LW412. 	Extraction Plan
Y Line	Longitudinal monitoring line at LW413 commencing end	<ul style="list-style-type: none"> Prior to the secondary extraction of LW409. Within three months following completion of LW413. 	Extraction Plan
Z Line	Longitudinal monitoring line at LW414 commencing end	<ul style="list-style-type: none"> Prior to the secondary extraction of LW409. Within three months following completion of LW414. 	Extraction Plan
U Line	Ulan Road Monitoring	<ul style="list-style-type: none"> Prior to the secondary extraction of LW409. Within 1 month of first 300 m of secondary extraction of each LW409-412. Provide a copy of the results of the subsidence parameters measured along the 'U Line' to MWRC upon request or exceedance of subsidence predictions (unless otherwise agreed to by MWRC). 	LW409-414 BFMP-MWRC LW409-414 BFMP-TELSTRA
SCR Line	Saddlers Creek Road Monitoring	<ul style="list-style-type: none"> Prior to the secondary extraction of LW409. Prior to the secondary extraction of LW412. Within 1 month of secondary extraction of 300 m past Saddlers Creek Road for each of LW412-414. 	LW409-414 BFMP-SCR LW409-414 BFMP-TELSTRA
Ulan Road Bridge Monitoring Points	The Ulan Road Bridge (over the Goulburn River) Monitoring	<ul style="list-style-type: none"> Prior to the secondary extraction of LW409. Within 1 month of first 300 m of secondary extraction of LW412. Provide a copy of the results of the subsidence parameters measured along the Ulan Road Bridge (over the Goulburn River) to MWRC (unless otherwise agreed to by MWRC). 	LW409-414 BFMP-MWRC
UG4 GNSS Array	GNSS Monitoring Station array above and adjacent to the UG4 domain, at CL3 and around the Drip and Corner Gorge*	<ul style="list-style-type: none"> Prior to the secondary extraction of LW409. During mining of LW409-414. 	Extraction Plan LW409-414 LMP Monitoring Program

* Installation of additional monitors for differential movements (i.e. valley closure) for the section of the Goulburn River adjacent to LW409-412 is subject to negotiation with the relevant landowners regarding an access agreement.

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Table 3: Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
LW409-414 LMP	Cliffs	Visual inspection of cliff CL3.	<ul style="list-style-type: none"> Prior to the secondary extraction of LW409. 	Observations and description (e.g. baseline photography, existing rockfalls, cliff instabilities, surface cracking).
			<ul style="list-style-type: none"> At the completion of LW413. 	Observations and description (e.g. comparison to baseline photography).
	Cliffs and minor cliffs in GRNP and GRSCA and the 'natural rock arch feature' along the Drip walking track	Visual inspection of cliffs and minor cliffs in GRNP and GRSCA within 400m of longwalls and the 'natural rock arch feature' along the Drip walking track.	<ul style="list-style-type: none"> Prior to secondary extraction within 400 m of cliffs and minor cliffs in GRNP and GRSCA and the 'natural rock arch feature' along the Drip walking track. 	Observations and description (e.g. baseline photography, existing rockfalls, cliff instabilities, surface cracking).
			<ul style="list-style-type: none"> At the completion of secondary extraction within 400 m of cliffs and minor cliffs in GRNP and GRSCA and the 'natural rock arch feature' along the Drip walking track. 	Observations and description (e.g. comparison to baseline photography).
Land in general	Access tracks and surface features within the Study Area.	<ul style="list-style-type: none"> Opportunistic visual observations during mining. 	Evidence of subsidence impacts observations (e.g. photography, nature and extent of surface cracking, rockfalls, displacement or dislodgement of boulders or slabs, or fracturing).	
LW409-414 BMP	Biodiversity	Floristic monitoring plots	<ul style="list-style-type: none"> During spring, prior to longwall extraction beneath monitoring plots. Annually during spring, for two years following longwall extraction beneath monitoring plots. 	Floristic survey at specific locations in the Study Area and Reference Area consisting of a 50 x 20 m plot containing a nested 20 x 20 m plot along a fixed transect. The composition, structure and functional attributes of the PCT present and additional tree stress data will be recorded. Any evidence of subsidence within the 50 x 20 m plot will be quantified, described and photographed.
		Photo point monitoring	<ul style="list-style-type: none"> During spring, prior to longwall extraction beneath monitoring sites. Annually during spring, for two years following longwall extraction beneath monitoring sites. 	Two photographs (portrait and landscape) to be taken at the established pickets at the start and end of each 50 m transect of all study and reference sites.

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Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
		Threatened flora monitoring	<ul style="list-style-type: none"> During spring, prior to longwall extraction. Annually during spring until the completion of LW414. 	A population count of threatened flora, a description and photograph detailing population health will be described, quantified, and photographed.
		Acoustic monitoring (Microbats)	<ul style="list-style-type: none"> During survey season (November to January), prior to longwall extraction beneath monitoring sites. Twice per survey season (November to January), for two years following longwall extraction beneath monitoring sites. 	Four acoustic devices targeting bats (three in the Study Area and one in the Reference Site) to be deployed for four nights.
LW409-414 WMP	Water features	DL2	<ul style="list-style-type: none"> Prior to undermining of DL2. 	Identify and mark the upstream and downstream limits of LW409 and LW410 along DL2. Undertake a baseline inspection by walking along DL2 over LW409 and LW410 and noting the condition of vegetation in the channel and any areas of active erosion, sediment deposition, water ponding or streambed cracking. Collect photographic record of channel condition along DL2 over LW409 and LW410.
			<ul style="list-style-type: none"> Within 3 months of undermining of DL2. Ongoing inspections every 6 months for one year after undermining DL2. 	Undertake periodic walkover inspection and update photographic record.
		Surface Water Flow and Quality SW01 and SW24	Monthly (if flowing).	Flow – Observation for SW01 and SW24. Flow – Measurement for SW02 and SW22*. pH, EC, TSS, TDS, temperature, turbidity.
			Six-monthly (in addition to above).	Al, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr, Li, Ba, Sr, DO, Total P and Total N.
			After rainfall event (>30mm in 24 hours).	Flow – Observation. pH, EC, TSS, TDS, Zn, Fe.

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Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
		Groundwater Level and Quality PZ101C, PZ101B*, PZ102C, PZ105C, PZ105A, PZ192, PZ193, PZ103C, PZ103D^, PZ194, PZ194B, PZ194C, PZ195, PZ195B, PZ195C, PZ232^, PZ233A, PZ233B, PZ233C, PZ234A^^, PZ234B, PZ234C, PZ235B, PZ235C^^, PZ236B^, PZ236C^, PZ237A^^, PZ237B, PZ237C, PZ240, PZ241, PZ255A^^, PZ255B, PZ256A^^, PZ256B, PZ256C, PZ257A^^, PZ257B, PZ257C.	In accordance with the LW409-414 WMP, whilst serviceable.	In accordance with the LW409-414 WMP.
LW409-414 HMP	Aboriginal heritage	Aboriginal Heritage sites within the Study Area other than sites with performance measures/voluntary performance measures. S1MC263, S1MC265, S1MC266, S1MC267, S1MC270, S1MC285, S1MC288, S1MC297, S1MC432, S1MC467, S1MC466, S1MC470, S1MC480, S1MC481, S1MC482, S1MC492, S1MC493, S1MC541	In accordance with the LW409-414 HMP.	Monitoring of potential subsidence impacts will be undertaken for a number of rock shelter and open grinding groove sites (unless previously salvaged), in order to identify and document whether any subsidence impacts have arisen from mining.

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Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
		Sites within the Study Area with performance measures. S1MC287	<ul style="list-style-type: none"> Pre-mining salvage (for artefacts). Test excavation (and salvage if required). Pre-mining and post-mining inspections. 	
		Sites in proximity to the Study Area with performance measures/voluntary performance measures. S1MC264, S1MC282, S1MC283, S1MC284 and S1MC286	<ul style="list-style-type: none"> Pre-mining and post-mining inspections. 	

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Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
LW409-414 BFMP-MWRC	MWRC assets	Ulan Road – Visual inspection within 400 m of LW409-414.	<ul style="list-style-type: none"> Prior to the secondary extraction of LW409. Within 1 month of first 300 m of secondary extraction of each LW409-412. 	<p>Condition of road surface, culverts, bridge and cuttings.</p> <p>Condition of road surface, culverts, bridge and cuttings to compare against the baseline condition.</p>
		Ulan Road – Subsidence impact inspection within 400 m of LW409-414.	<ul style="list-style-type: none"> If ground surveys identify an exceedance of the predicted subsidence monitoring parameters measured along the ‘U Line’ or at Ulan Road Bridge. Opportunistic visual observations during routine works by MCO (and its contractors). At any time in case of an emergency and requested by MWRC. 	<p>Subsidence impact inspections will target the identification of:</p> <ul style="list-style-type: none"> impacts to the surface including cracks, buckling and stepping; impacts to the visible surfaces of pipes/culverts including cracking, buckling, shearing, and collapse; impacts to the bridge including cracking, buckling, shearing and collapse. impacts to road cuttings including slope failure, rock falls and pavement impacts; and visible impacts to furniture.
		Review of the Ulan Road Bridge (over the Goulburn River) by a structural engineer in consultation with MWRC.	<ul style="list-style-type: none"> Prior to secondary extraction of LW409. At the completion of LW412. If ground surveys identify an exceedance of the predicted subsidence monitoring parameters measured along the Ulan Road Bridge monitoring points. At any time in case of an emergency and requested by MWRC. 	Condition of bridge structure, abutments, and road surface.
		Survey monitoring program for ‘U Line’ and monitoring points.	<ul style="list-style-type: none"> In accordance with Table 2. 	In accordance with Table 2.

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Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
LW409-414 BFMP-SCR	Saddlers Creek Road	Saddlers Creek Road – Visual inspection within 100 m of LW409-414.	<ul style="list-style-type: none"> Prior to mining within 100 m of Saddlers Creek Road. 	Condition of road surface and culverts.
		Saddlers Creek Road – Visual inspection within 100 m of LW411.	<ul style="list-style-type: none"> Prior to secondary extraction of LW412. 	Condition of road surface to confirm no impacts to road at this distance (i.e. between LW411 and Saddlers Creek Road).
		Saddlers Creek Road – Visual inspection within 100 m of LW412-414.	<ul style="list-style-type: none"> When the longwall face is 100 m prior to undermining Saddlers Creek Road until the longwall face is 300 m post mining Saddlers Creek Road for each of LW412-414. If ground surveys identify an exceedance of the predicted subsidence monitoring parameters measured along the 'SCR Line'. 	Regular visual inspections will target the identification of impacts to the surface and culverts including cracks, buckling and stepping to confirm ability to maintain safe and serviceable condition.
		Saddlers Creek Road – Post-mining visual inspection within 100 m of LW412-414.	<ul style="list-style-type: none"> Within 1 month of secondary extraction of 300 m past Saddlers Creek Road for each of LW412-414. 	Condition of road surface and culverts to confirm permanent repair requirements.
		Survey monitoring program for 'SCR Line'.	<ul style="list-style-type: none"> In accordance with Table 2. 	In accordance with Table 2.
LW409-414 BFMP-Telstra	Telstra Infrastructure	Visual inspection of Ulan Road and Saddlers Creek Road.	<ul style="list-style-type: none"> In accordance with the LW409-414 BFMP-MWRC and LW409-414 BFMP-SCR. 	In accordance with the LW409 414 BFMP-MWRC and LW409-414 BFMP SCR.
		Survey monitoring program for 'U Line' and 'SCR Line'.	<ul style="list-style-type: none"> In accordance with Table 2. 	In accordance with Table 2.

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Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
LW409-414 PSMP	The Drip and Corner Gorge	Visual inspections	<ul style="list-style-type: none"> In accordance with the Monitoring Program (see below). 	In accordance with the Monitoring Program (see below).
	Cliffs Cliffs and minor cliffs in GRNP and GRSCA and the 'natural rock arch feature' along the Drip walking track.	Visual inspections	<ul style="list-style-type: none"> In accordance with the LW409-414 LMP (see above). 	In accordance with the LW409-414 LMP (see above).
	Land in general	Access tracks and surface features within the Study Area.	<ul style="list-style-type: none"> In accordance with the LW409-414 LMP (see above). 	In accordance with the LW409-414 LMP (see above).
Monitoring Program	The Drip and Corner Gorge	GNSS units	<ul style="list-style-type: none"> In accordance with Table 2 (see above). 	Real-time measurement of far-field and differential movements, reviewed in accordance with the Monitoring Program.
		Visual inspection	<ul style="list-style-type: none"> Baseline inspection prior to secondary extraction of LW409. At least every two months during mining of LW409-414 (and more frequently during the periods outlined in Monitoring Program). At the completion of LW414. Additional observations at the Drip and Corner Gorge if GNSS monitoring identifies an exceedance of the Level 1 trigger (Attachment 1 of the Monitoring Program). 	Observations and description features (including existing rockfalls, cliff instabilities, surface cracking and changes to water supply) and comparison to baseline photography, reviewed in accordance with the Monitoring Program.

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Extraction Plan Component	Aspect	Monitoring Component/Sites	Frequency	Parameters
		Groundwater Level PZ257A, PZ256A, PZ237A	<ul style="list-style-type: none"> Baseline monitoring once installed and up to commencement of secondary extraction of LW409. During mining of LW409-414. Additional review of data if visual inspection identifies any change in water supply to the Drip. 	Continuous measurement of water level, reviewed in accordance with Monitoring Program.
	Goulburn River**	Visual Inspection	<ul style="list-style-type: none"> Baseline inspection prior to completion of LW409. Every 6 months during mining of LW409-414 and for up to 1 year following completion of secondary extraction of LW414. 	Observations and descriptions (including photographic record) of condition of vegetation, any areas of active erosion, sediment deposition, water ponding or streambed cracking.
		Surface Water Flow and Quality SW02, SW22	<ul style="list-style-type: none"> Monthly (if flowing) prior to and during secondary extraction of LW409-414, data manually downloaded in accordance with Monitoring Program. 	Continuous measurement of flow. Monthly observation measurement of water quality (pH, EC, TSS, TDS, temperature, turbidity).
			<ul style="list-style-type: none"> Six-monthly (in addition to above). 	Al, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr, Li, Ba, Sr, DO, Total P and Total N
			<ul style="list-style-type: none"> After rainfall event (>30 mm in 24 hours). 	Flow – Observation. pH, EC, TSS, TDS, Zn, Fe.
	Groundwater Level PZ234A^^, PZ237A^^.	<ul style="list-style-type: none"> Baseline monitoring up to commencement of secondary extraction of LW409. During mining of LW409-414, data manually downloaded in accordance with Monitoring Program. 	Continuous measurement of water level.	

Notes:

+ Data is continuous but downloaded manually at different intervals in accordance with Monitoring Program.

* To be decommissioned prior to extraction for safety of underground operations or where impacted by subsidence. Will continue to be monitored until decommissioned.

** Installation of monitoring sites for differential movements (i.e. valley closure) is subject to negotiation with Crown Lands regarding an access agreement and technical specialist input.

^ To be monitored until impacted by mining.

^^ Triggers to be reviewed and updated (if required) to reflect the outcomes of the updated modelling.

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8.0 ANALYSIS OF SUBSIDENCE EFFECTS, SUBSIDENCE IMPACTS AND ENVIRONMENTAL CONSEQUENCES

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

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

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

The relationship between subsidence effects, impacts and environmental consequences will be determined through review and reporting of each component management plan (e.g. LW409-414 LMP, LW409-414 WMP, LW409-414 BMP, LW409-414 HMP, LW409-414 BFMPs and the Monitoring Program).

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9.0 ROLES AND RESPONSIBILITIES

Key responsibilities of MCO personnel in relation to this LW409-414 SMP are summarised in **Table 4**. Responsibilities may be delegated as required.

Table 4: Responsibility Summary

Responsibility	Task
General Manager	<ul style="list-style-type: none"> Ensure resources are available to MCO personnel to facilitate the completion of responsibilities under this LW409-414 SMP.
Underground Technical Services Manager	<ul style="list-style-type: none"> Ensure the LW409-414 SMP is implemented. Ensure monitoring required under this LW409-414 SMP is carried out within specified timeframes, adequately checked and processed and prepared to the required standard. Undertake relevant monitoring summarised in Section 7.
Environment and Community Manager	<ul style="list-style-type: none"> Ensure the LW409-414 SMP is implemented. Liaise with relevant stakeholders regarding subsidence impact management and related environmental consequences.
Registered Mine Surveyor	<ul style="list-style-type: none"> Undertake all subsidence monitoring to the required standard within the specified timeframes and ensure data are adequately checked, processed and recorded.

9.1 KEY CONTACTS

The details of key contacts and phone numbers in relation to this LW409-414 SMP are summarised in **Table 5**.

Table 5: Key Personnel Contact Details

Organisation	Position	Phone Number
MCO	Underground Technical Services Manager	02 6376 1500
	Environment and Community Manager	02 6376 1500
	Registered Mine Surveyor	02 6376 1500
	Moolarben Coal Hotline	1800 556 484
Resource Regulator	Principal Inspector – Subsidence Engineering	0422 551 293

Document	Version	Issue Date	Status	Author
MCO_UG4_LW409-414_SMP	4	June 2026	Approved	MCO

10.0 REFERENCES

- Australasian Groundwater and Environmental Consultants (2024) *Groundwater Technical Report for Moolarben UG4 LW409 to LW414 Extraction Plan*.
- Department of Planning and Environment (2022) *Extraction Plan Guideline*.
- Eco Logical Australia (2019) *Moolarben Coal Complex UG4 Ancillary Works Modification Biodiversity Development Assessment Report*.
- Intergovernmental Committee on Surveying and Mapping - Geodesy Working Group (2020) *Standard for the Australian Survey Control Network, Special Publication 1, Version 2.2*.
- Mine Subsidence Engineering Consultants (2024) *Moolarben Project Stage 1 – Longwalls 409 to 414 – Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan*.
- Mine Subsidence Engineering Consultants (2025) *Moolarben Coal Operations – Longwalls 409 to 414 - Subsidence predictions and impact assessments for the Drip and Corner Gorge*.
- Moolarben Biota (2006) *Flora, Fauna and Aquatic Ecology Assessment*, Appendix 11 in Wells Environmental Services (2006) *Moolarben Coal Project Environmental Assessment Report*. Prepared for Moolarben Coal Mines Pty Limited.
- Niche Environment and Heritage (2024a) *Moolarben Coal Complex UG4 Longwalls 409-414 Extraction Plan Aboriginal Cultural Heritage Technical Report*.
- Niche Environment and Heritage (2024b) *Moolarben UG4 – Longwall 409-414 Biodiversity Technical Report*.
- NSW Department of Customer Service – Spatial Services (2020) *Survey and Drafting Directions for Mining Surveyors 2020 (NSW Mines)*.
- WRM Water and Environment (2024) *UG4 Longwalls 409 to 414 Extraction Plan Surface Water Technical Report*.

Document	Version	Issue Date	Status	Author
MCO_UG4_LW409-414_SMP	4	June 2026	Approved	MCO

ATTACHMENT 1

**UG4 LONGWALLS 409 TO 414 SUBSIDENCE PARAMETERS MONITORING
TRIGGER ACTION RESPONSE PLAN**

Document	Version	Issue Date	Status	Author
MCO_UG4_LW409-414_SMP	4	June 2026	Approved	MCO

UG4 LONGWALLS 409 TO 414 SUBSIDENCE MONITORING PROGRAM
MOOLARBEN COAL OPERATIONS

Condition	Normal		Level 1	Level 2
	Baseline Conditions	Predicted Impacts	Implement Management Measures	Restoration/Contingency Phase
Trigger	Subsidence monitoring program (i.e. subsidence impacts and subsidence effects) that forms part of the overall management of the consequential environmental impacts associated with the extraction of LW409-414.	Subsidence parameters (i.e. maximum predicted total conventional subsidence, tilt and curvature) as predicted (Section 1.6 of the Extraction Plan) within the LW409-414 Study Area.	One or more subsidence parameters (i.e. maximum predicted total conventional subsidence, tilt and curvature) has exceeded prediction (Section 3.1 of the Extraction Plan) within the LW409-414 Study Area. Assessment of the relevant Performance Indicators (Section 5.1 of the Extraction Plan) have not been triggered. Assessment of the relevant Performance Measures (Section 3.2 of the Extraction Plan) has not been exceeded and is not likely to be exceeded.	One or more subsidence parameters (i.e. maximum predicted total conventional subsidence, tilt and curvature) has exceeded prediction (Section 3.1 of the Extraction Plan) within the LW409-414 Study Area. Assessment of the relevant Performance Indicators (Section 5.1 of the Extraction Plan) have been triggered. Assessment of the relevant Performance Measures (Section 3.2 of the Extraction Plan) has been exceeded and/or is likely to be exceeded.
Action	Establish baseline data: Pre-extraction subsidence survey as per the LW409-414 SMP (Section 7.2.1 to Section 7.2.3 and Table 2 and Table 3).	Conduct monitoring, consistent with LW409-414 SMP (Section 7.2.1 to Section 7.2.3 and Table 2 and Table 3).	Management measures implemented as described in Section 5 of the Extraction Plan (with regard to the specific circumstances of the subsidence impact [e.g. the nature and extent of the impact]). Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.	Implement Contingency Plan including notifications as described in Section 5.4 of the Extraction Plan.
Frequency	Prior to commencement of extraction of LW409 or in accordance with Table 2 and Table 3 .	As required, by the LW409-414 SMP (Section 7.2.1 to Section 7.2.3 and Table 2 and Table 3).	As required, by the LW409-414 SMP (Section 7.2.1 to Section 7.2.3 and Table 2 and Table 3).	As required, in accordance with Section 5 of the Extraction Plan.
Position of Decision Making	Underground Technical Services Manager.	Underground Technical Services Manager.	Environment and Community Manager and Underground Technical Services Manager.	Environment and Community Manager and Underground Technical Services Manager.

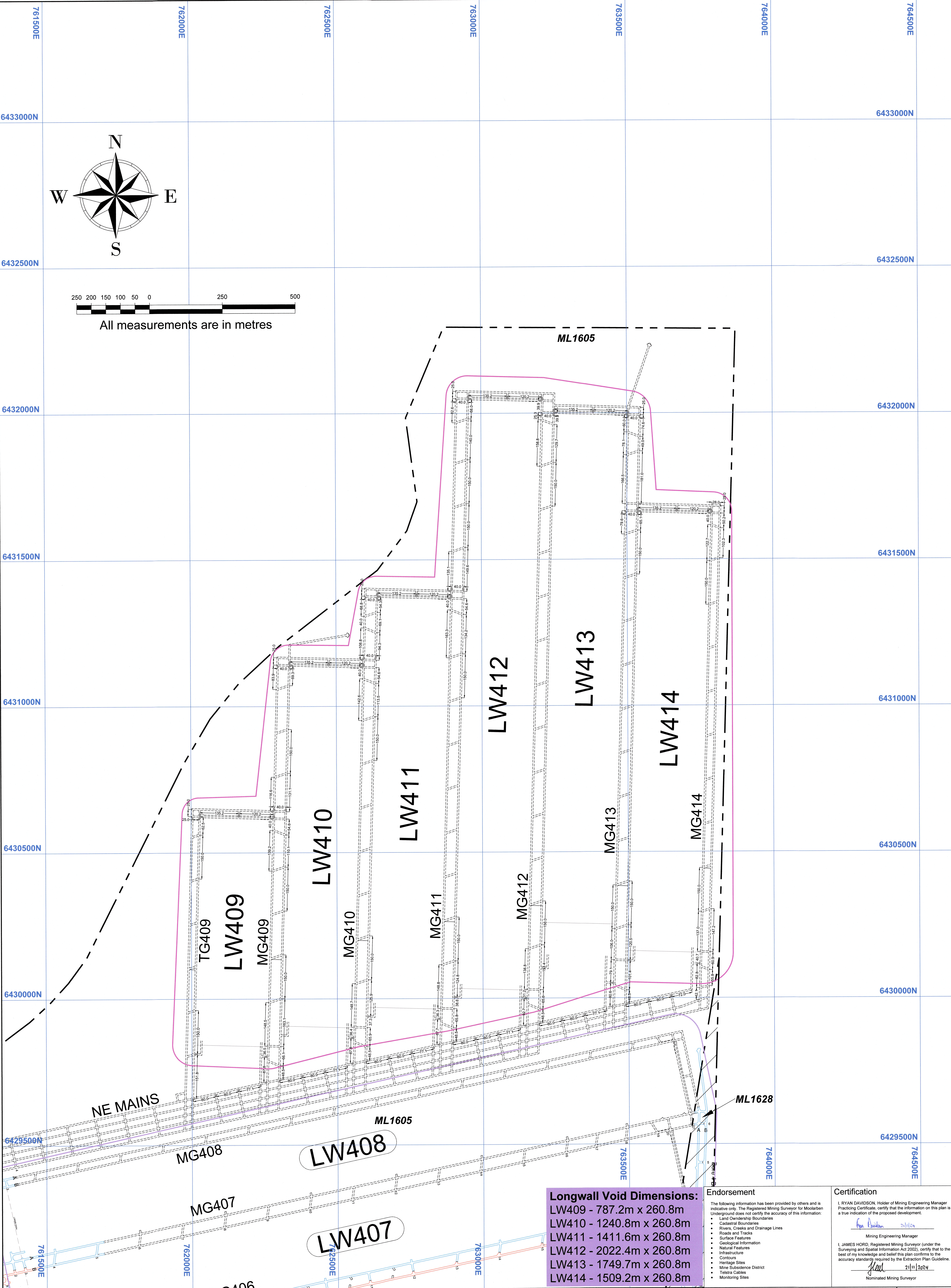
Document	Version	Issue Date	Status	Author
MCO_UG4_LW409-414_SMP	4	June 2026	Approved	MCO

ATTACHMENT 2

PLANS 1 TO 7

(IN ACCORDANCE WITH THE *EXTRACTION PLAN GUIDELINE* [DPE, 2022])

Document	Version	Issue Date	Status	Author
MCO_UG4_LW409-414_SMP	4	June 2026	Approved	MCO



Longwall Void Dimensions:

LW409	787.2m x 260.8m
LW410	1240.8m x 260.8m
LW411	1411.6m x 260.8m
LW412	2022.4m x 260.8m
LW413	1749.7m x 260.8m
LW414	1509.2m x 260.8m

- Endorsement**
- The following information has been provided by others and is indicative only. The Registered Mining Surveyor for Moolarben Underground does not certify the accuracy of this information:
- Land Ownership Boundaries
 - Cadastral Boundaries
 - Rivers, Creeks and Drainage Lines
 - Roads and Tracks
 - Surface Features
 - Geological Information
 - Natural Features
 - Infrastructure
 - Contours
 - Heritage Sites
 - Mine Subsidence District
 - Teletra Cables
 - Monitoring Sites

Certification

I, RYAN DAVIDSON, Holder of Mining Engineering Practising Certificate, certify that the information on this plan is a true indication of the proposed development.

Ryan Davidson 21/11/24
Mining Engineering Manager

I, JAMES HORD, Registered Mining Surveyor (under the Surveying and Spatial Information Act 2002), certify that to the best of my knowledge and belief this plan conforms to the accuracy standards required by the Extraction Plan Guideline.

James Hord 21/11/2024
Nominated Mining Surveyor

LEGEND	Extraction Plan Application Area LW409-414
	Extraction Plan Area LW401-408
Mining Lease Boundary	

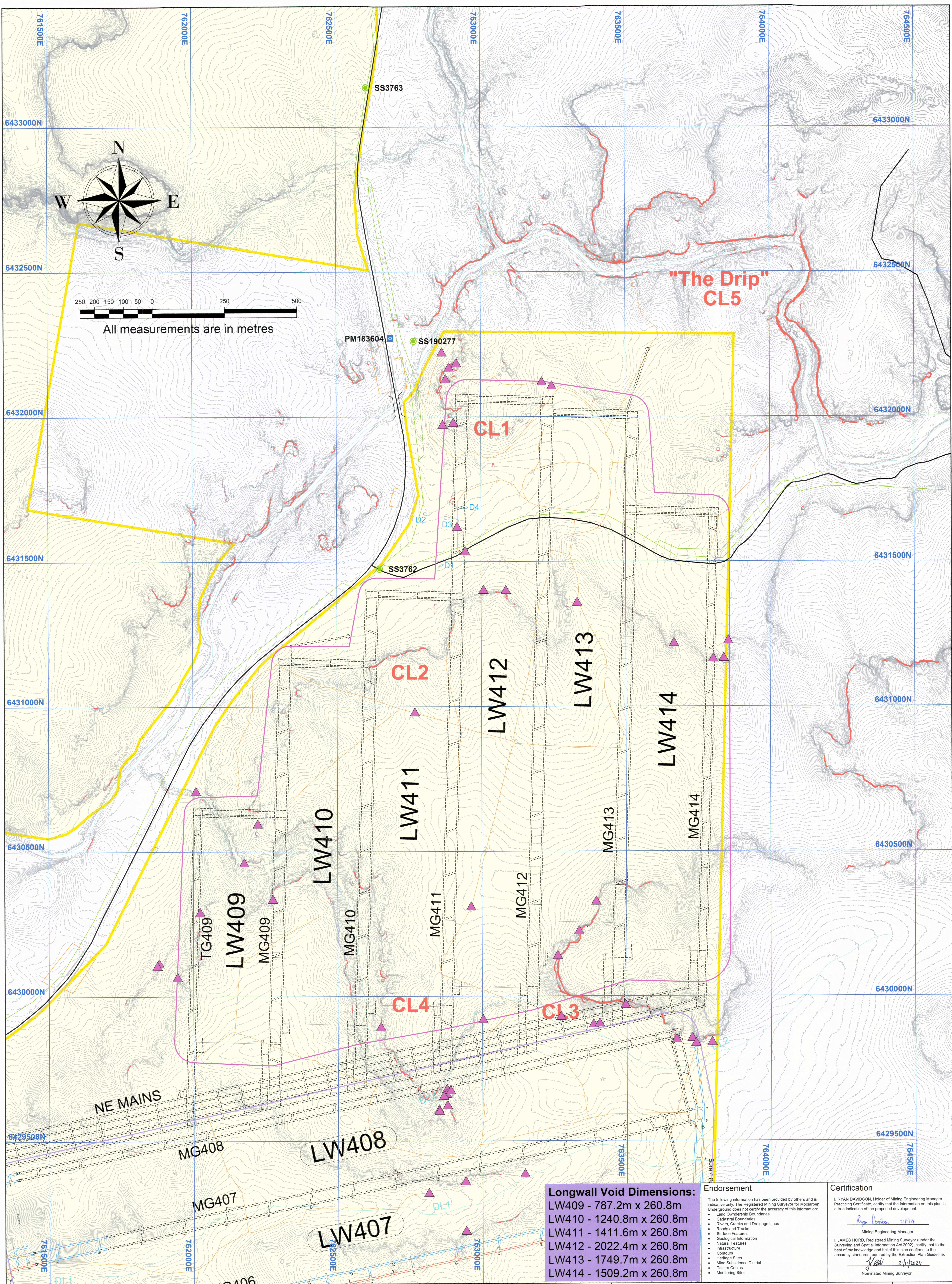
NOTES

- Proposed workings are in the Ulan Seam: Development - 3.4m basal section Longwall - up to 3.0m
- Pillar dimensions may be modified to suit geological or safety conditions as appropriate.

MOOLARBEN COAL OPERATIONS PTY LTD
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 ULAN NSW 2850
 Locked Bag 2003
 MUDGEES NSW 2850

YANCOAL
 宏源澳洲有限公司
 MOOLARBEN COAL
 ABN: 59 077 939 569

Moolarben Coal Operations - Underground Mine					Drawing No. MCUG04173/1
Extraction Plan LW409 - LW414					
Figure 1 - Extraction Area: Existing and Proposed Workings					
Date 21/11/2024	Scale 1:4000	Drawn JH	Approved RD	Revision 0	Revision Date N/A



Longwall Void Dimensions:
 LW409 - 787.2m x 260.8m
 LW410 - 1240.8m x 260.8m
 LW411 - 1411.6m x 260.8m
 LW412 - 2022.4m x 260.8m
 LW413 - 1749.7m x 260.8m
 LW414 - 1509.2m x 260.8m

Endorsement
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 • Geological Information
 • Natural Features
 • Infrastructure
 • Contours
 • Heritage Sites
 • Mine Subsidence District
 • Telstra Cables
 • Monitoring Sites

Certification
 I, RYAN DAVIDSON, Holder of Mining Engineering Manager Practising Certificate, certify that the information on this plan is a true indication of the proposed development.
 Ryan Davidson 21/11/24
 Mining Engineering Manager
 I, JAMES HORD, Registered Mining Surveyor (under the Surveying and Spatial Information Act 2002), certify that to the best of my knowledge and belief this plan conforms to the accuracy standards required by the Extraction Plan Guideline.
 J. Hord 21/11/2024
 Nominated Mining Surveyor

LEGEND

Extraction Plan Application Area LW409-414	Roads	Dams
Extraction Plan Area LW401-408	Tracks	Telstra
Mine Subsidence District - Mudgee	Surface Contours - 1m	Road Cutting
Survey Mark - PM	Watercourses	Bridge
Survey Mark - SS	Heritage Site	Building
	Cleftlines	

NOTES

- Proposed workings are in the Ulan Seam: Development - 3.4m basal section Longwall - up to 3.0m
- Pillar dimensions may be modified to suit geological or safety conditions as appropriate.

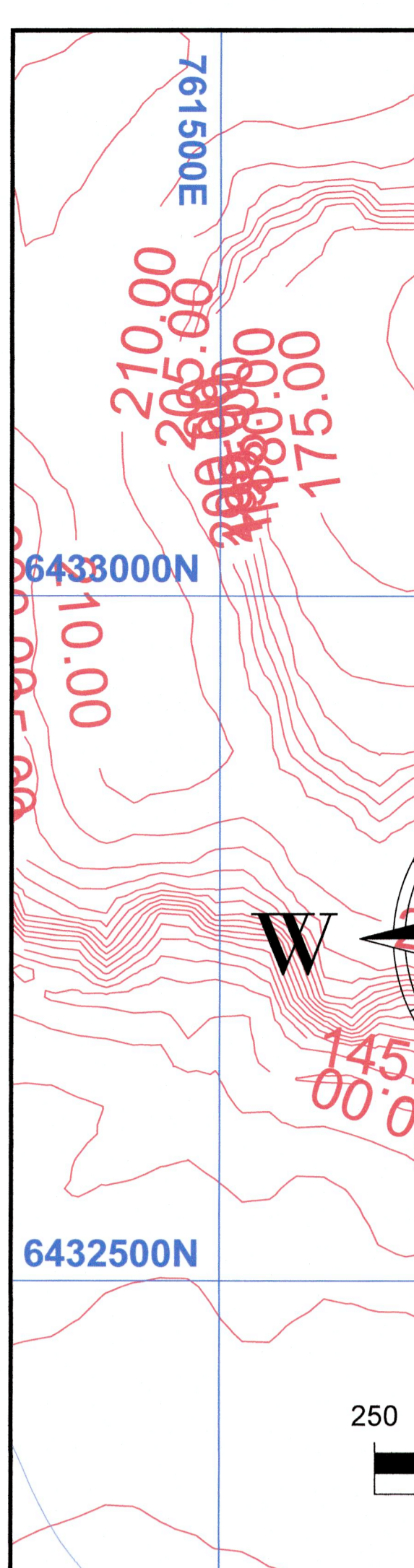
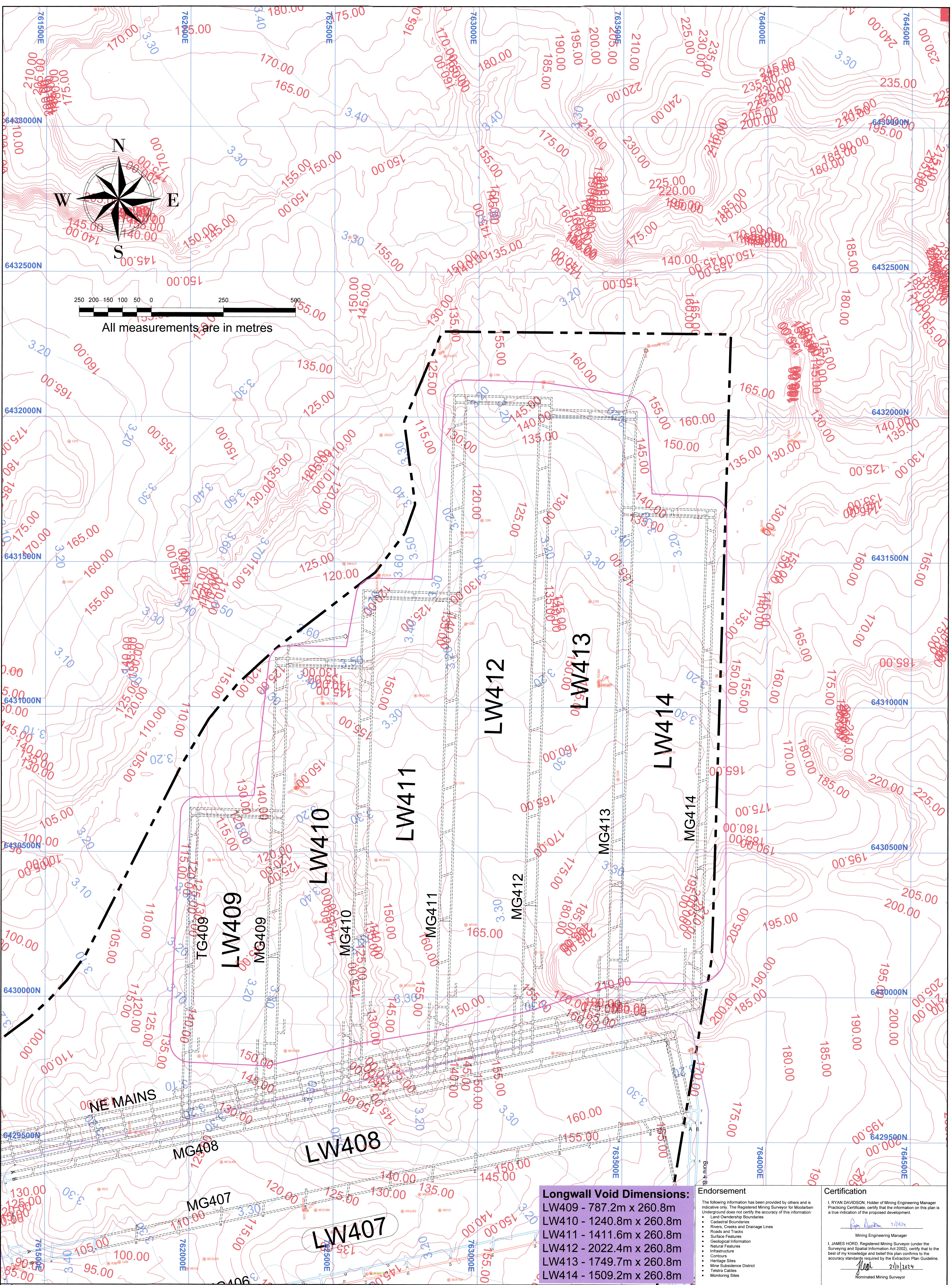
MOOLARBEN COAL OPERATIONS PTY LTD
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 Locked Bag 2003
 MUDGEES NSW 2850

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 兗煤澳大利亚有限公司
 MOOLARBEN COAL
 ABN: 59 077 939 569

Moolarben Coal Operations - Underground Mine
Extraction Plan LW409 - LW414
Figure 2 - Surface Features

Date	Scale	Drawn	Approved	Revision	Revision Date
21/11/2024	1:4000	JH	RD	0	N/A

Drawing No. MCUG04173/2
 GDA2020



Longwall Void Dimensions:

LW409	787.2m x 260.8m
LW410	1240.8m x 260.8m
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 - Cadastral Boundaries
 - Rivers, Creeks and Drainage Lines
 - Roads and Tracks
 - Surface Features
 - Geological Information
 - Natural Features
 - Contours
 - Infrastructure
 - Heritage Sites
 - Mine Subsidence District
 - Telstra Cables
 - Monitoring Sites

Certification

I, RYAN DAVIDSON, Holder of Mining Engineering Manager Practising Certificate, certify that the information on this plan is a true indication of the proposed development.

Ryan Davidson 21/11/24
Mining Engineering Manager

I, JAMES HORD, Registered Mining Surveyor (under the Surveying and Spatial Information Act 2002), certify that to the best of my knowledge and belief this plan conforms to the accuracy standards required by the Extraction Plan Guideline.

James Hord 21/11/2024
Nominated Mining Surveyor

LEGEND

	Extraction Plan Application Area LW409-414
	Extraction Plan Area LW401-408
	Mining Lease Boundary
	Working Section Thickness
	Overburden Thickness - 5m
	MCR1102 Surface to Seam Borehole (Collar Location)

NOTES

- Proposed workings are in the Ulan Seam. Development - 3.4m basal section. Longwall - up to 3.5m.
- Pillar dimensions may be modified to suit geological or safety conditions as appropriate.

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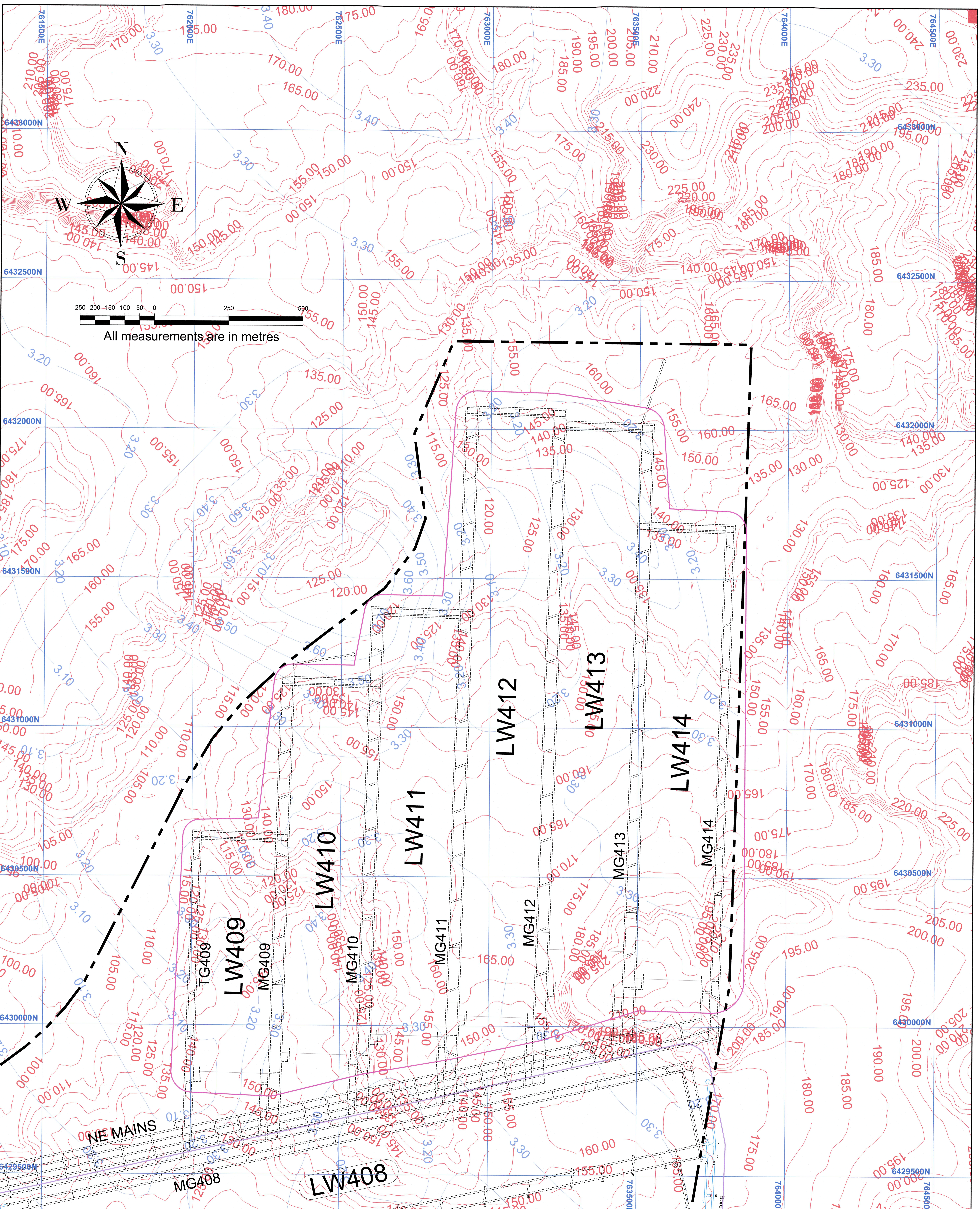
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MOOLARBEN COAL

ABN: 59 077 939 569

Moolarben Coal Operations - Underground Mine
Extraction Plan LW409 - LW414
Figure 3 - Proposed Workings: Seam and Depth of Cover

Date	Scale	Drawn	Approved	Revision	Drawing No.
21/11/2024	1:4000	JH	RD	0	MCUG04173/3
					GDA2020
					Revision Date
					N/A



250 200 150 50 0 250 500
All measurements are in metres

Longwall Void Dimensions:

LW409	787.2m x 260.8m
LW410	1240.8m x 260.8m
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 - Surface Features
 - Geological Information
 - Natural Features
 - Infrastructure
 - Contours
 - Heritage Sites
 - Mine Substance District
 - Telstra Cables
 - Monitoring Sites

Certification

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Ryan Davidson 21/11/24
Mining Engineering Manager

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James Hord 21/11/24
Notified Mining Surveyor

LEGEND

	Extraction Plan Application Area LW409-414
	Extraction Plan Area LW401-408
	Mining Lease Boundary
	Working Section Thickness
	Overburden Thickness - 5m

NOTES

- Proposed workings are in the Ulan Seam: Development - 3.4m basal section Longwall - up to 3.0m
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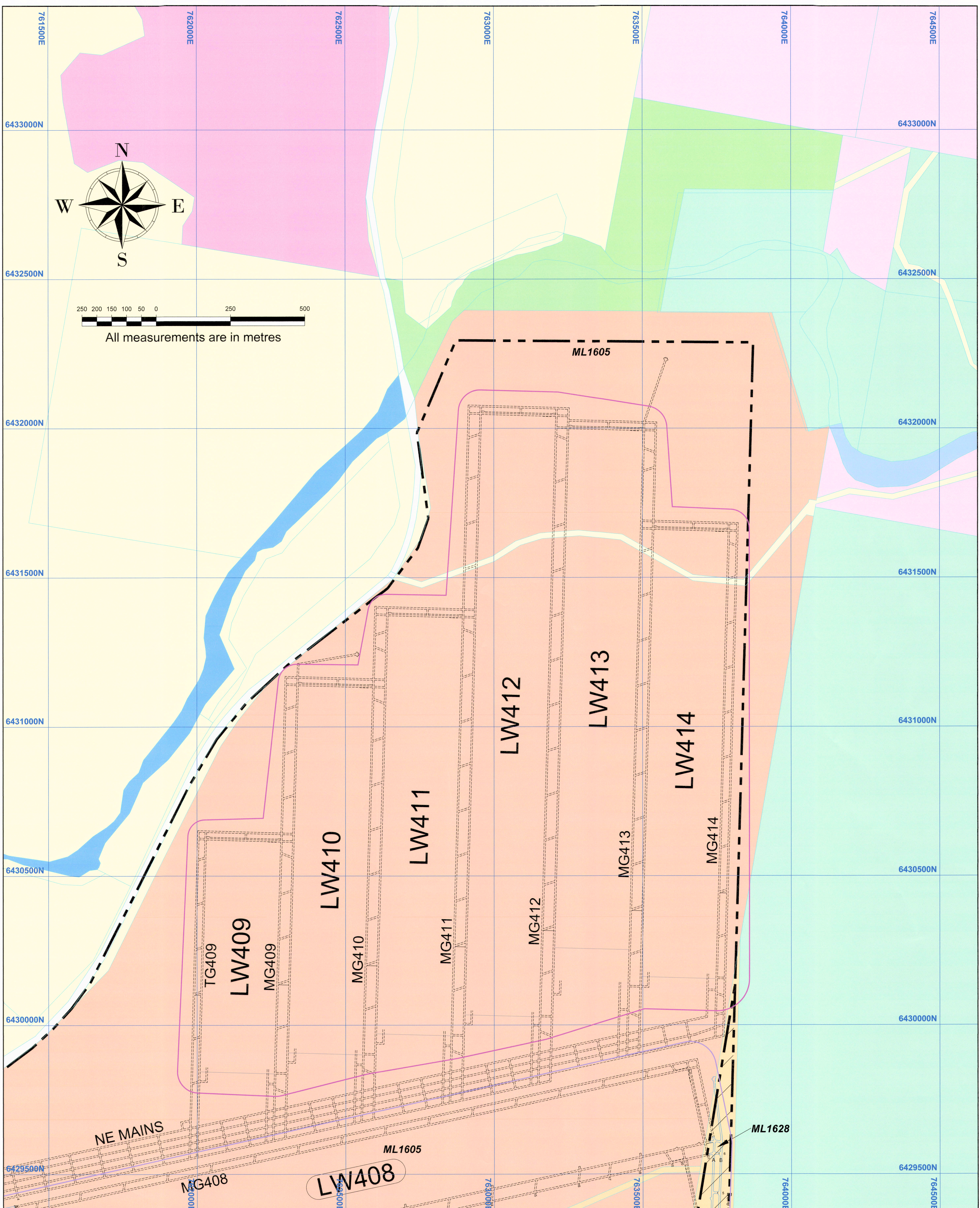
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MUDGEES NSW 2850

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MOOLARBEN COAL
ABN: 59 077 939 569

Moolarben Coal Operations - Underground Mine
Extraction Plan LW409 - LW414
Figure 4- All Workings: Seam and Depth of Cover

Date	Scale	Drawn	Approved	Revision	Drawing No.
21/11/2024	1:4000	JH	RD	0	MCUG04173/4
					Revision Date
					N/A

GDA2020



Lease No.	Area (ha)	Lease Holder	Grant Date	Expiry Date	Resource	Purpose	Parish - County	Lease Conditions (Subsidence)	Additional Notes
ML1605	1098	Moolarben Coal Mines Pty Ltd	20 December 2007	20 December 2028	Coal	Underground Mining	Lennox - Phillip	Subsidence Management Plan	Refer to original grant document. Some areas, excepts the surface and soil below to a depth of 15.24m, 20m, and 410m above MSL. Other areas embrace the surface and soil below to a depth of 900m below AHD.
ML1628	260.5	Moolarben Coal Mines Pty Ltd	24 February 2009	24 February 2030	Coal	Open Cut & Underground Mining	Lennox & Moolarben - Phillip	Subsidence Management Plan	Refer to original grant document. Some areas embrace the stratum from a depth of 20m below the surface and soil below to a depth of 900m below AHD. Other areas embrace the surface and soil below to a depth of 900m below AHD.

Longwall Void Dimensions:

- LW409 - 787.2m x 260.8m
- LW410 - 1240.8m x 260.8m
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Endorsement

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- Land Ownership Boundaries
- Cadastral Boundaries
- Rivers, Creeks and Drainage Lines
- Roads and Tracks
- Surface Features
- Geological Information
- Natural Features
- Infrastructure
- Contours
- Heritage Sites
- Mine Subsidence District
- Telstra Cables
- Monitoring Sites

Certification

I, RYAN DAVIDSON, Holder of Mining Engineering Manager Practising Certificate, certify that the information on this plan is a true indication of the proposed development.

Ryan Davidson
Mining Engineering Manager

I, JAMES HORD, Registered Mining Surveyor (under the Surveying and Spatial Information Act 2002), certify that to the best of my knowledge and belief this plan conforms to the accuracy standards required by the Extraction Plan Guideline.

James Hord
21/11/2024
Nominated Mining Surveyor

LEGEND

- Extraction Plan Application Area LW409-414
- Extraction Plan Area LW401-408
- Mining Lease Boundary
- Cadastral Boundary
- Moolarben Coal
- Crown Land - Yancoal Licence
- Crown Land
- National Park
- State Conservation Area
- Local Aboriginal Land Council
- Waterway
- Road
- Privately Owned

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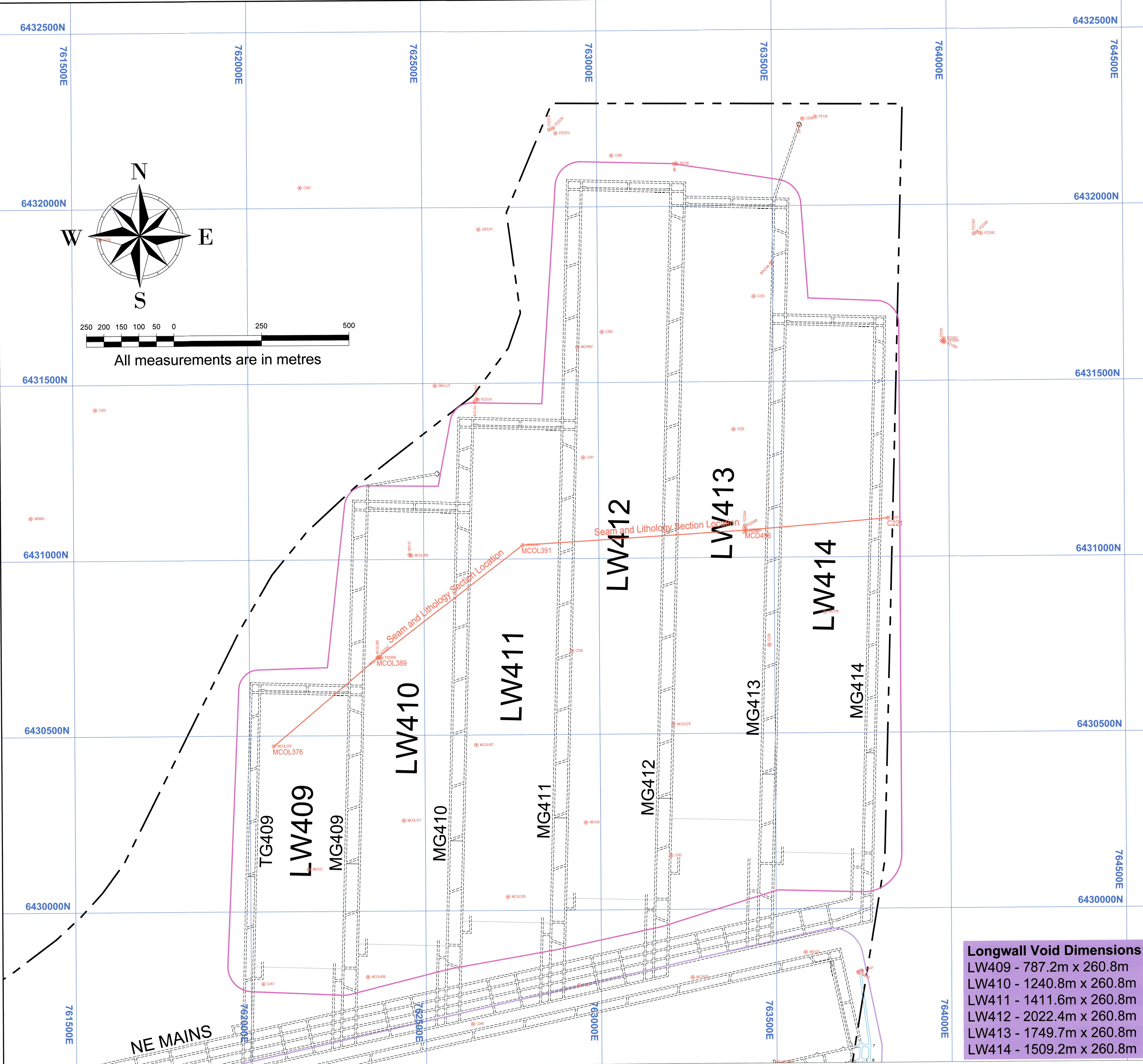
ABN: 59 077 939 569

Moolarben Coal Operations - Underground Mine Extraction Plan LW409 - LW414

Figure 5 - Mining Titles and Land Ownership

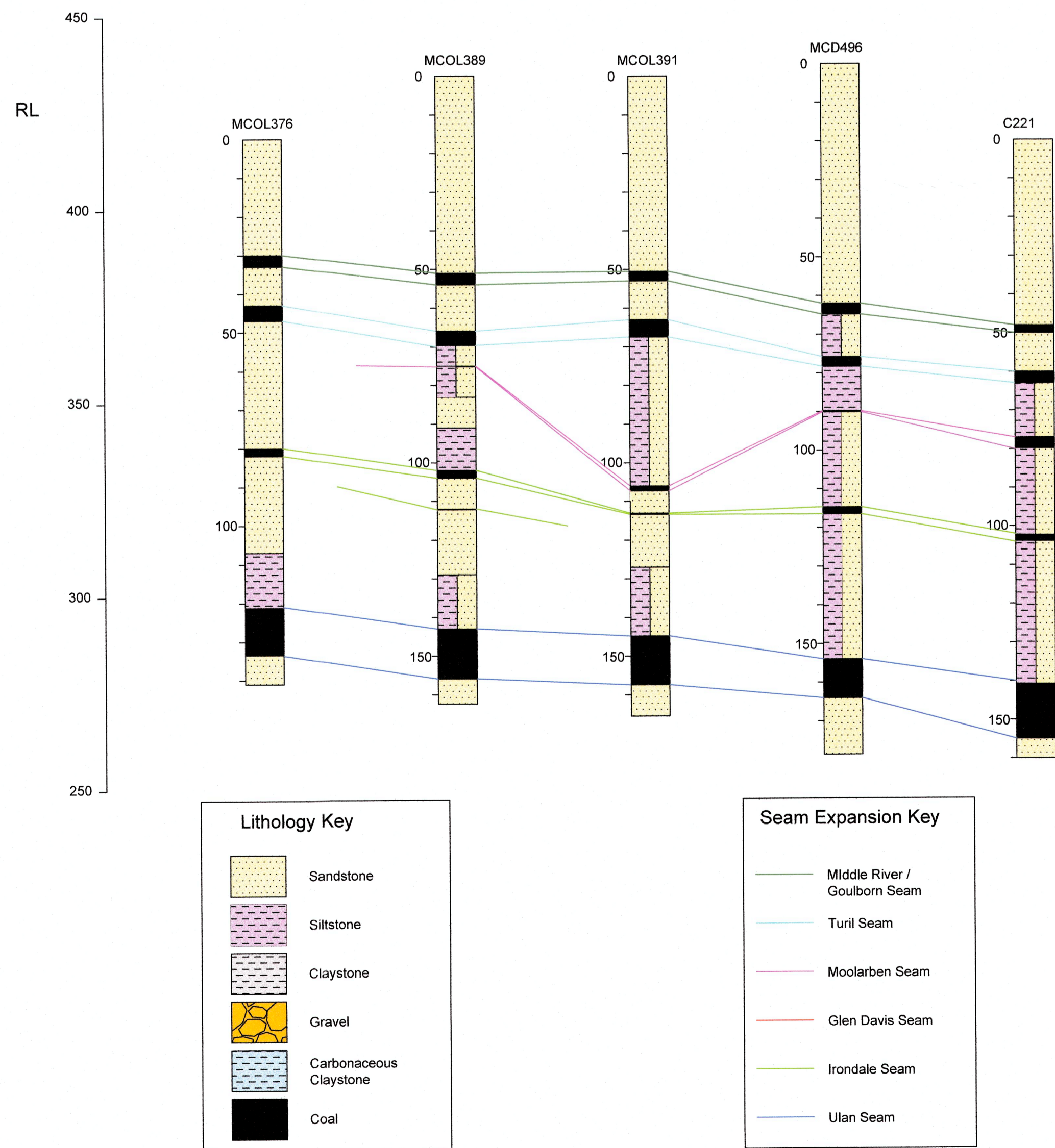
Date	Scale	Drawn	Approved	Revision	Revision Date
21/11/2024	1:4000	JH	RD	0	N/A

Drawing No. MCUG04173/5
GDA2020

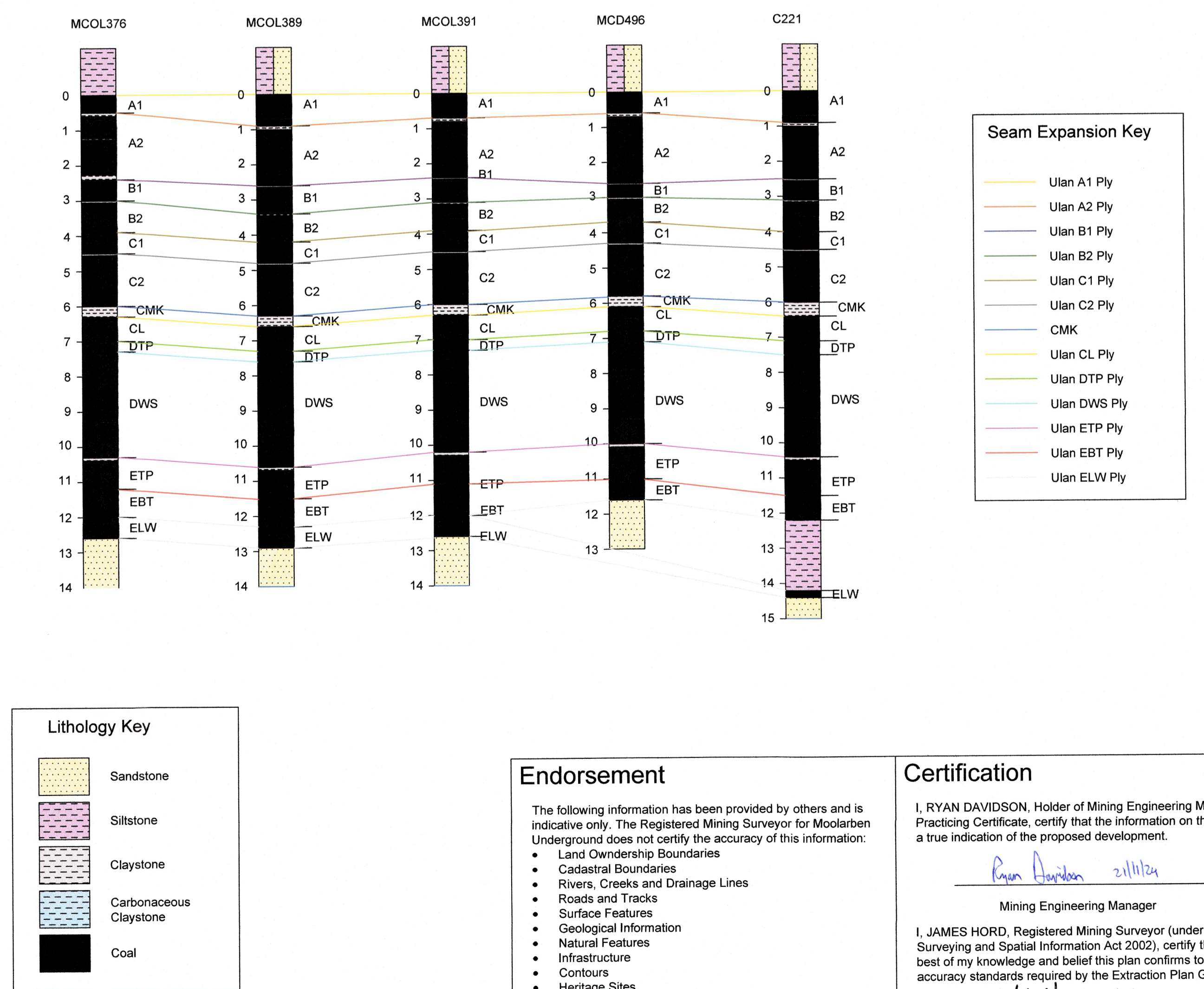


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 LW413 - 1749.7m x 260.8m
 LW414 - 1509.2m x 260.8m

Surface to Seam Lithology



Ulan Seam Section



Endorsement

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- Land Ownership Boundaries
- Cadastral Boundaries
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- Roads and Tracks
- Surface Features
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- Natural Features
- Infrastructure
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Certification

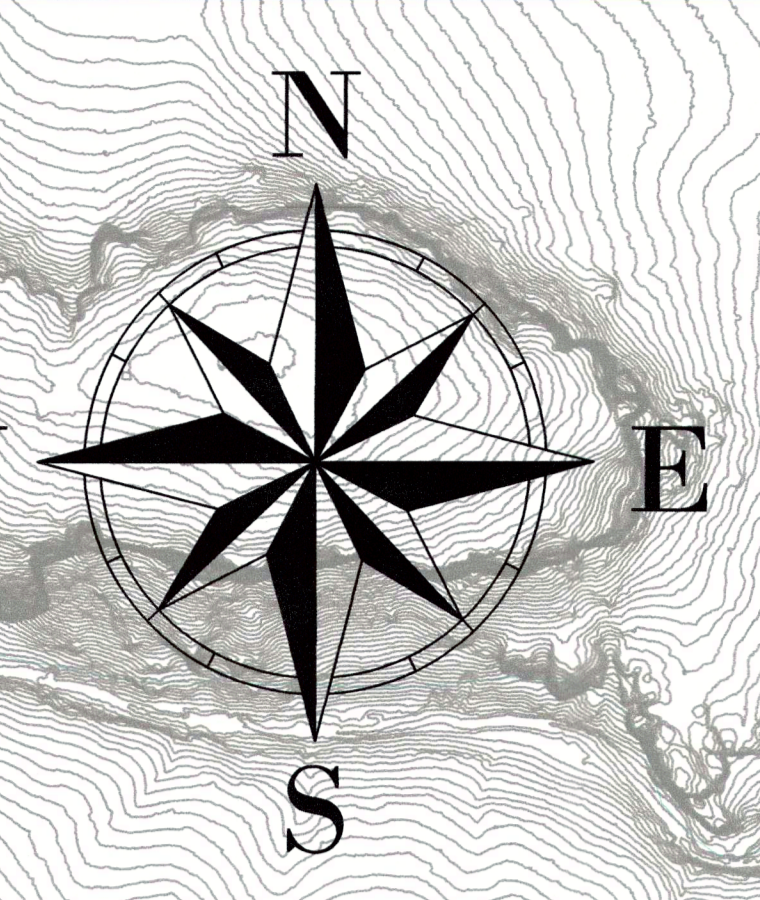
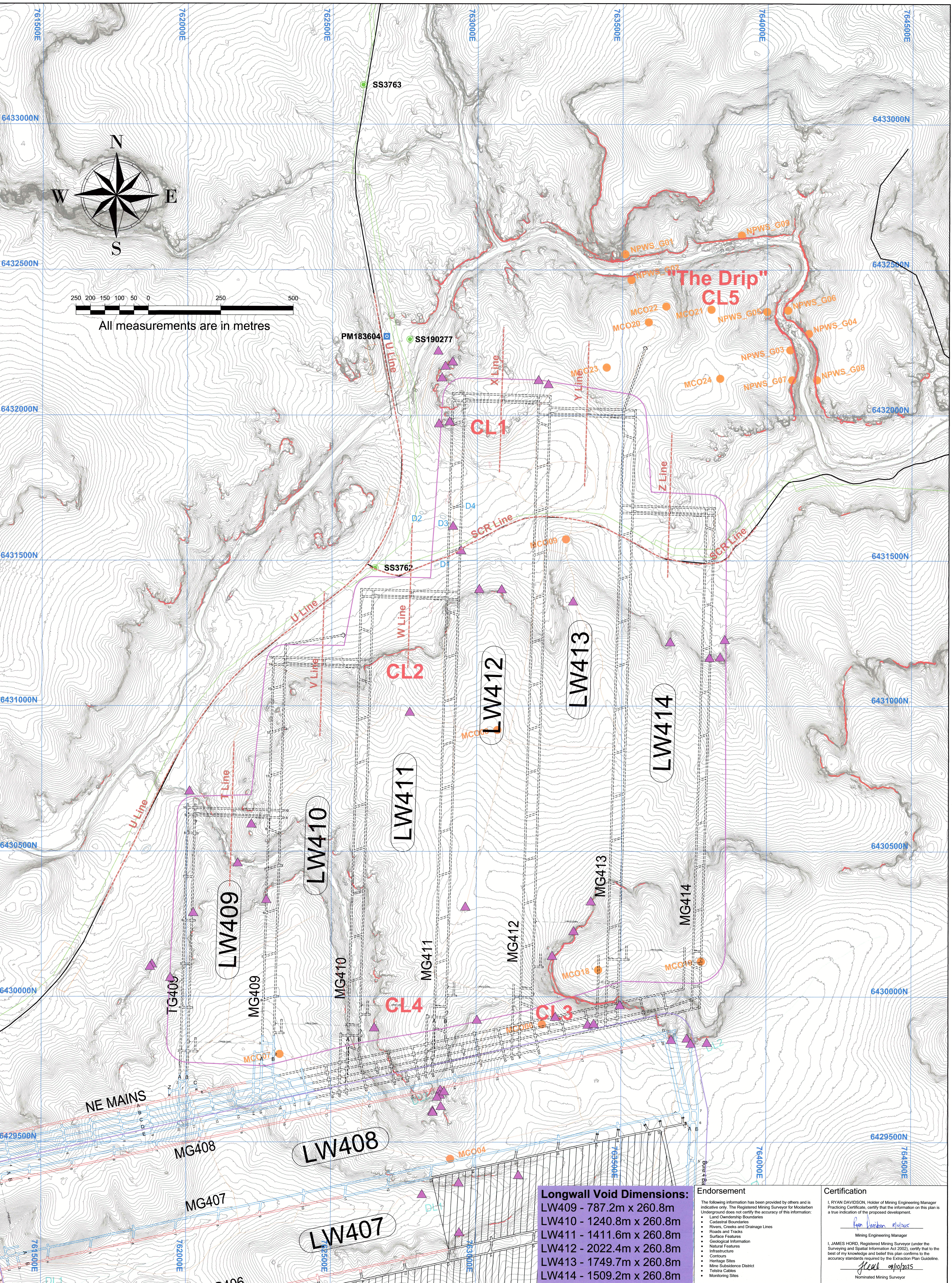
I, RYAN DAVIDSON, Holder of Mining Engineering Manager Practising Certificate, certify that the information on this plan is a true indication of the proposed development.

Ryan Davidson
 Mining Engineering Manager

I, JAMES HORD, Registered Mining Surveyor (under the Surveying and Spatial Information Act 2002), certify that to the best of my knowledge and belief this plan conforms to the accuracy standards required by the Extraction Plan Guideline.

James Hord 21/11/2024
 Nominated Mining Surveyor

LEGEND 	NOTES 1. Proposed workings are in the Ulan Seam: Development - 3.4m basal section Longwall - up to 3.0m. 2. Pillar dimensions may be modified to suit geological or safety conditions as appropriate.	 克煤澳大利亚有限公司 MOOLARBEN COAL ABN: 59 077 939 569	MOOLARBEN COAL OPERATIONS PTY LTD 12 Ulan-Wollar Road ULAN NSW 2850 Locked Bag 2003 MUDGEES NSW 2850		Moolarben Coal Operations - Underground Mine Extraction Plan LW409 - LW414 Figure 6 - Geological Strata			Drawing No. MCUG04173/6
			Date 21/11/2024	Scale 1:4000	Drawn JH	Approved RD	Revision 0	Revision Date N/A



250 200 150 100 50 0 250 500
 All measurements are in metres

Longwall Void Dimensions:
 LW409 - 787.2m x 260.8m
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 • Heritage Sites
 • Mine Subsidence District
 • Telstra Cables
 • Monitoring Sites

Certification
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 Ryan Davidson 09/10/2025
 Mining Engineering Manager
 I, JAMES HORD, Registered Mining Surveyor (under the Surveying and Spatial Information Act 2002), certify that to the best of my knowledge and belief this plan conforms to the accuracy standards required by the Extraction Plan Guideline.
 James Hord 09/10/2025
 Nominated Mining Surveyor

LEGEND

Extraction Plan Application Area LW409-414	Roads	Dams
Extraction Plan Area LW401-408	Tracks	Telstra
Mine Subsidence District - Mudgee	Surface Contours - 1m	Road Cutting
Survey Mark - PM	Watercourses	Heritage Site
Survey Mark - SS	Building	Bridge
Proposed Subsidence Line	Climflines	Installed GNSS Monitor

NOTES
 1. Proposed workings are in the Ulan Seam: Development - 3.4m basal section Longwall - up to 3.0m
 2. Pillar dimensions may be modified to suit geological or safety conditions as appropriate.

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**Moolarben Coal Operations - Underground Mine
 Extraction Plan LW409 - LW414
 Figure 7 - Subsidence Monitoring**

Date	Scale	Drawn	Approved	Revision	Drawing No.
21/11/2024	1:4000	JH	RD	1	MCUG04173/7
					Revision Date
					08/10/2025