CENTENNIAL

# Extraction Plan Main Report (MW17-18)

## MW17-18 Panel & Pillar Mining Zone Extraction Plan

**Airly Mine (SSD_5581)**

**November 2023**

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# EXECUTIVE SUMMARY

## Background

Airly Mine commenced operations in 1998. The mine currently operates under State Significant Development consent SSD_5581 pertaining to the *Airly Mine Extension Project* (the Project). The Project was approved on 15 December 2016. The consent allows mining operations at Airly Mine for a period of 20 years from the date of commencement (31 January 2017), and rehabilitation to be undertaken after this period. SSD_5581 consent will lapse on 31 January 2037.

An Extraction Plan is required to be approved prior to secondary extraction to meet Condition 7 in Schedule 3 of SSD_5581. This Extraction Plan describes the applicable regulatory framework, mine planning, management and monitoring measures to be implemented to ensure the protection of all surface/subsurface natural and built features and the protection of public safety from subsidence associated with secondary extraction within the Extraction Plan Area.

## MW17-18 Extraction Plan

Centennial Airly is proposing secondary extraction in two miniwall (MW) panels (MW17 to MW18) in the south-eastern Genowlan Mountain area of the Airly mining leases. The miniwall panels are located within the *Panel and Pillar Mining Zone* as detailed within SSD_5581.

The mine design has been specifically developed in response to the sensitive surface environment to avoid significant impact. Panel (void) and pillar widths are specifically designed using a calibrated numerical model for predictive purposes to reduce subsidence levels to be consistent with EIS predictions (i.e., maximum vertical subsidence <125mm). Centennial Airly has applied a 26.5 degree Angle of draw (AoD) around all cliffs mapped within the *Cliff Line Zone of First Workings*.

The Extraction Plan Area is comprised of two key components. The Principal Subsidence Management Area is defined by the predicted 20mm limit of vertical subsidence, this is the predicted limit of subsidence effects from the proposed miniwall extraction. The overall EP Area boundary also includes an Extended Monitoring and Management Area which is beyond the predicted extent of subsidence and primarily contains the cliffs and pagodas within the *Cliff Line Zone of First Workings* surrounding Genowlan Mountain. Negligible subsidence is predicted within the Extended Monitoring and Management Area, however monitoring and management of those sensitive features is included in this Extraction Plan as a precautionary approach.

The natural and built features identified within the EP Area include:

| Features | Principal Subsidence Management Area | Extended Monitoring and Management Area |
|---|---|---|
| Sensitive Rock Features - cliffs, minor cliffs, and pagodas as defined by development consent SSD_5581 and subject to detailed mapping | ✓ | ✓ |
| Mugii Murum-ban State Conservation Area (Mugii Murum-ban SCA) in general within the EP Area. This is taken to include steep slopes, rocky outcrops and native vegetation cover, including threatened species, that traverse the EP Area | ✓ | ✓ |
| Watercourses. There are only first and 2nd order upper tributaries of Genowlan Creek present | ✓ | ✓ |
| 4WD trails including the Trig Trail | ✓ | ✓ |
| State Survey Control Marks (The Trig) | ✓ | × |
| Deeply incised canyons/gorges in the vicinity of locations known as the Grotto, the Oasis / Jurassic Park | × | ✓ |

## Subsidence Assessment

This Extraction Plan has relied on the most recently updated predictions of subsidence effects, subsidence impacts and environmental consequences. The subsidence assessments undertaken for this Extraction Plan are documented in the following reports:

- *SCT (2023). MW17-18 Pillar and Panel Optimisation Assessment (Airly 5612 dated 8 June 2023); and*
- *MSEC (2023). Airly Mine MW17 and MW18 – Subsidence Predictions and Impact Assessments for the Natural and Built Features over and near the Proposed MWs 17 to 18 in Support of the Extraction Plan Application (MSEC1351).*

An overview of the subsidence assessments undertaken for this Extraction Plan is provided below.

***MW17-18 Pillar and Panel Optimisation Assessment***

Strata Control Technology (SCT) have developed a calibrated model for predictive purposes (within assumptions and limitations) for the Airly Mine. Recommendations for pillar sizes have been provided by SCT for MW10-12 (SCT, 2021a) and MW13-16 (SCT, 2021b).

A comparison of the measured vertical subsidence data following extraction against the SCT model predictions has been undertaken by MSEC (2023) for MW11 & MW12 and MW13, MW14 & MW15A. These comparisons confirmed that measured subsidence levels are within, or below, the range predicted by the SCT subsidence model and indicate the SCT modelling can be relied on with a reasonable confidence for predicting subsidence from miniwall mining at Airly Mine. The validation to date includes pillars of various sizes.

SCT (2023) were engaged to advise on a revision to the pillar and panel layout to limit the maximum predicted subsidence to a chosen upper design limit of 95mm (+/-20mm) aligning with a precautionary approach.

The proposed revised mining geometry includes two miniwall panels, MW17 and MW18, with panel void widths of 70.5m and 3.0m extraction height separated by a 70m wide barrier pillar.

The predicted subsidence effects for the proposed miniwalls 17 to 18 have been provided by SCT (2023). The maximum vertical subsidence for the revised mine layout is predicted to be 88 mm (+/-20mm).

***Airly Mine MW17 to MW18 – Subsidence Predictions and Impact Assessments for the Natural and Built Features over and near the Proposed MWs 17 to 18 in Support of the Extraction Plan Application***

Centennial Airly, engaged MSEC (2023) to prepare a Subsidence Prediction and Impact Assessment to support the Extraction Plan based on the subsidence prediction work provided by SCT (2023).

The primary management strategy being implemented by Airly Mine for the Extraction Plan is impact avoidance through the implementation of a conservative mine design, with panel and pillar widths specifically designed to have minimal subsidence effects and prevent subsidence impacts.

Conservative setbacks to key sensitive features within the *Cliff Line Zone of First Workings* continue to be implemented for this Extraction Plan (i.e. 26.5 degree Angle of Draw). Extensive monitoring and management measures are proposed to demonstrate the subsidence modelling and effectiveness of the revised mining and monitoring systems.

An overview of the descriptions, predictions, impact assessment and management for the key natural and built features identified within the Extraction Plan Area is provided in the following table.

| Feature | Overview of Key Findings |
|---|---|
| **Surface Water** | The upper reaches of Genowlan Creek are located above the proposed mining area. There are also other unnamed drainage lines that are located across the proposed mining area. These drainage lines are generally ephemeral.<br>The post-mining grades along Genowlan Creek and the other drainage lines are predicted to be similar to the pre-mining natural grades. It is considered unlikely that there would be adverse changes in ponding or scouring resulting from the mining-related subsidence or tilt.<br>It is expected that no fracturing of the bedrock is likely to be observed over the miniwalls and beneath the sections of the streams that are located directly above and adjacent to the proposed miniwalls. Surface water flow diversions are unlikely to occur along the sections of the streams that are located directly above and adjacent to the proposed miniwalls.<br>The Airly Mine Water Management Plan (WMP) (GHD, 2023) details the monitoring and management measures to be implemented for surface and groundwater values (including creek geomorphic stability, aquatic ecology and stygofauna) within the Airly Mine Development Consent Area, including the EP Area. Any monitoring results that indicate impacts beyond predictions will be managed in accordance with the WMP Trigger Action Response Plans (WMP Appendix E). |
| **Groundwater** | The Airly Mine WMP was developed in consultation with relevant stakeholders and was originally finalised during 2017. The most recent revision of the WMP was developed in consultation with relevant stakeholders and in consideration of the mine design for the EP Area. Aquifers and groundwater systems are outlined in the WMP.<br>No Groundwater Dependent Ecosystems (GDE's) have been identified within the EP Area. Facultative ecosystems do occur, however these are primarily in the Extended Monitoring and Management Area. Regardless, no significant impact to the surface or sub-surface in these areas (including no expected cracking) results in no predicted impacts for these features. |
| **Landforms**, including cliffs, pagodas, minor cliffs, steep slopes, the general Surface of the Mugii Murum-ban State Conservation Area, walking and four-wheel drive roads / management trails | Detailed identification and mapping of potentially sensitive land features, including cliffs, pagodas and minor cliffs has been undertaken within the Extraction Plan Area. The mine design protects the major external cliffs that surround the south-eastern area of Genowlan Mountain by ensuring that no secondary extraction will occur within the 26.5 degree angle of draw of cliffs within the *Cliff Line Zone of First Workings*.<br>The impact assessment for landform features within a 26.5 degree angle of draw of the Airly Mine underground workings concluded that (considering the very low levels of subsidence being predicted over the identified internal cliffs and rock features), there was only an extremely low probability that cliff instabilities would occur at the identified and listed cliffs over and near the proposed miniwalls, which are mostly relatively short, isolated cliffs that were located over solid unmined coal areas beyond the edges of the miniwall panels.<br>The predicted levels of subsidence over MWs 17 to 18 are similar to those provided in the 2014 EIS. The assessed levels of potential impact for the cliffs, are similar to those based on the EIS Layout. That is, at these predicted low subsidence levels, it is unlikely that the cliffs, pagodas and rock formations will be adversely impacted by the proposed miniwall extraction.<br>The monitoring program to be implemented for the management of potential subsidence impacts on landscape features that will be potentially affected by the secondary extraction of MW17-18 is detailed in the Land Management Plan for MW17-18 (MW17-18 LMP). The purpose is to monitor for the presence/absence of mine-induced damage or change to features (i.e. rock falls and surface cracking). This includes high resolution remote aerial monitoring undertaken at approximately six-month intervals. Detailed baseline surveys have already been completed. |

| Feature | Overview of Key Findings |
|---|---|
| **Biodiversity**, including threatened species, threatened populations, EECs and Groundwater Dependent Ecosystems (GDEs), with the exception of those listed below | Given the predicted low levels of subsidence over the area of mesa that is affected by the proposed extraction, the proposed extraction should not cause physical impacts (such as surface cracking) that could potentially change the environment or habitat for this natural vegetation.<br>The Biodiversity Management Plan for MW17-18 (MW17-18 BMP) outlines the management strategies, controls and monitoring programs to be implemented for the management of potential subsidence impacts on aquatic and terrestrial flora and fauna affected by the secondary extraction of MW17-18. The MW17-18 BMP was informed by a Baseline Ecology Assessment developed by RPS for the EP Area with the purpose of reviewing the relevant biodiversity information within the region.<br>It is noted , the *Pultenaea* sp. Genowlan Point population and Genowlan Point *Allocasurina nana* Heathland community is located beyond this EP Area. |
| **Public Safety** | The performance measure for public safety requires negligible additional risk, in consultation with the Resources Regulator and BCD. The Public Safety Management Plan for MW17-18 (MW17-18 PSMP) has been prepared generally in accordance with the relevant WHS requirements and guidelines, and is intended to manage potential risks from subsidence, particularly in the context of protection of the "safety of others" (public safety).<br>In addition to the MW17-18 PSMP, the landscape features which were identified as directly related to potential risk to public safety (including cliffs and pagodas) are also managed under other supporting plans.<br>Given the low levels of subsidence predicted it is not expected that there would be any adverse impacts on natural and built surface features within the EP Area which have relevance to public safety. |
| **State Survey Control Marks (The Trig)** | A State Survey Trig Station exists at Genowlan Mountain. The Trig Station is located near the proposed miniwalls, and it could experience the full range of predicted subsidence effects. This site was identified as having potential to be subsided and moved in the SCIMS search for the Pt Hatteras Panel & Pillar Mining Zone (MW13-16) Extraction Plan (2021).<br>Consultation with the Department of Lands (Land and Property Information Division) has been undertaken (under the previous Extraction Plan). It may be necessary on the completion of the proposed miniwalls, when the ground has stabilised, to re-establish the positions of this state survey control mark. |

## Consultation

The development of this Extraction Plan and its sub-management plans has built upon the substantial consultation that has been undertaken with key stakeholders over an extended period. This includes (but is not limited to) detailed consultation during the:

- Airly Mine Extension Project EIS and approval process (2014-2016); and
- Previously approved Extraction Plans, including:
    - Cliff Line Zone of First Workings Extraction Plan (2017);
    - Splitting and Quartering Extraction Plan (2018);
    - Mt Airly Panel & Pillar Mining Zone Extraction Plan (2019); and
    - Pt Hatteras Panel & Pillar Mining Zone (MW13-16) Extraction Plan (2021).

Condition 7 in Schedule 3 of SSD_5581 requires the preparation of this Extraction Plan and the supporting sub-plans in consultation with key relevant stakeholders. The outcomes of consultation undertaken specifically for this Extraction Plan is provided in *Attachment D – Stakeholder Consultation*, including copies of relevant correspondence such as project presentations delivered by the mine to key stakeholders and relevant formal correspondence received from key stakeholders.

Stakeholder feedback provided has been reviewed and addressed as necessary as part of the development and review of this Extraction Plan and sub-plans.

## Conclusion

Centennial Airly is proposing secondary extraction in two miniwall panels (MW17 to MW18) in the south-eastern area of Genowlan Mountain.

The predicted subsidence effects for the proposed MWs 17 to 18 have been provided by SCT (2023) after detailed modelling using a FLAC model that was initially calibrated for the local conditions against the measured subsidence data over MWs 02 to 07. The subsidence predictions by SCT from this FLAC model has now been supported by the monitored incremental subsidence results over MWs 11 to 12 and the monitored results over MWs 13 to 15A.

Compared to the mine layout design detailed in the 2014 Environmental Impact Statement (EIS), the mine layout design recommended by SCT (2023) based on numerical modelling specific to the available resource in the EP Area has resulted in chain pillar widths between MWs 17 to 18 increasing from 29.5 m to 70 m and the panel void widths increasing from 61 m to 70.5 m. The predicted maximum vertical subsidence over the proposed of MWs 17 to 18 with the wider pillars and panels would be 88 mm (+/-20mm).

This Extraction Plan has been developed using a risk-based approach to address the management of potential subsidence-related impacts within the EP Area. Centennial Airly have undertaken a dedicated subsidence and environmental risk assessment for the EP Area including reference to related risk assessments and supporting studies and has consulted with key stakeholders to assess the adequacy of the supporting technical assessments and determine the content of relevant sub-plans.

The predicted levels of subsidence over MWs 17 to 18 are similar to those provided in the 2014 EIS. The assessed levels of potential impact are similar to those based on the EIS Layout. The performance measures for subsidence for the Airly Mine are outlined in Condition 2 in Schedule 3 of Development Consent SSD_5581. **At these predicted low subsidence levels, it is unlikely that performance measures of SSD_5581 will be exceeded by the proposed miniwall extraction.**

This Extraction Plan includes appropriate Trigger Action Response Plans in the unlikely event of an exceedance of a subsidence impact performance measure or if an unexpected impact is detected, including consideration of potential adaptive management or contingency measures.

# 1 INTRODUCTION

## 1.1 Background

Airly Mine is an existing underground coal mine located approximately 40 kilometres (km) northwest of Lithgow in New South Wales, 170km northwest of Sydney and 4 km to the northeast of Capertee, as illustrated on **Figure 1.1**. The mine is partly located within the Mugii Murum-ban State Conservation Area (SCA). Centennial Airly Pty Limited (Centennial Airly) is the operator of the mine and is a wholly owned subsidiary of Centennial Coal Company Pty Limited.

Development Consent for the Airly Mine Extension Project (MEP) was approved on 15 December 2016 subject to the Conditions in Schedules 2 to 6 of State Significant Development 5581 (SSD_5581). The consent allows extraction of 1.8 million tonnes of run-of-mine (ROM) coal per calendar year for a period of 20 years, which is supplied to both domestic and international markets. As per commitments within the Environmental Impact Statement (EIS) for SSD_5581, Airly Mine is implementing a conservative and staged approach to mining[1].

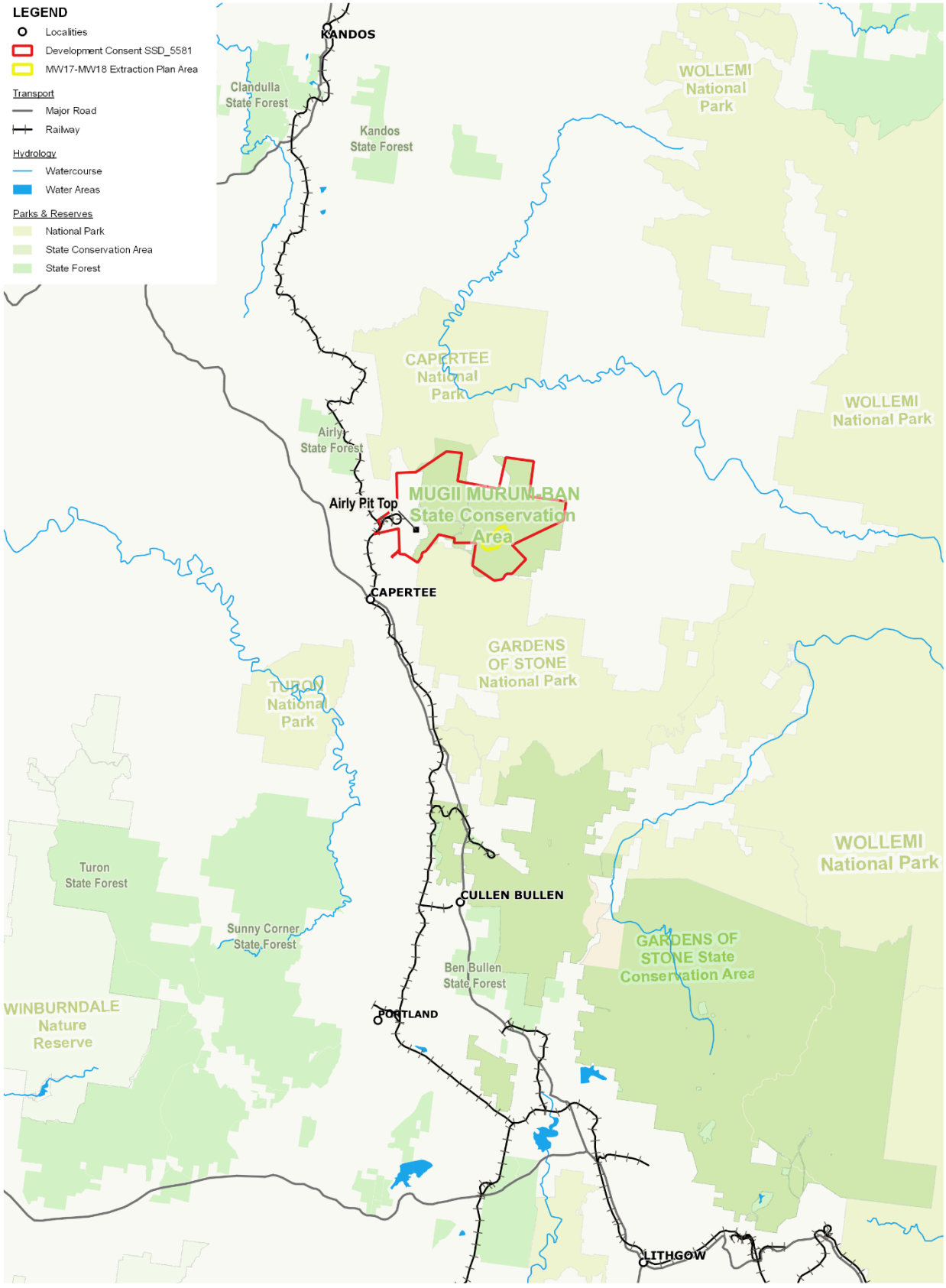
The *MW17-18 Panel and Pillar Mining Zone Extraction Plan* as detailed in this *Extraction Plan Main Report (the EP Main Report)* and the supporting sub-management plans, continues the conservative and staged approach to mining being implemented by Airly Mine, with secondary extraction proposed in two miniwall panels (MW17 to MW18). The miniwall panels are located within the *Panel and Pillar Mining Zone* as detailed within SSD_5581.

Airly Mine have undertaken extensive modelling and mine design revisions, with panel (void) and pillar widths specifically designed to reduce subsidence levels to be consistent with EIS predictions (i.e., maximum vertical subsidence <125mm). Conservative setbacks to key sensitive features located within the *Cliff Line Zone of First Workings* will continue to be implemented for the MW17-18 PPMZ Extraction Plan, and extensive monitoring and management measures are proposed to demonstrate the subsidence modelling and effectiveness of the mining. The *Extraction Plan Area (EP Area)* is further defined in **Section 1.3**.

An Extraction Plan is required to be approved prior to secondary extraction to meet Condition 7 in Schedule 3 of SSD_5581. This Extraction Plan will describe the applicable regulatory framework, mine planning, management and monitoring measures to be implemented to ensure the protection of all surface/subsurface natural and built features and the protection of public safety from subsidence associated with secondary extraction within the Extraction Plan Area.

[1] Airly Mine has five (5) mining zones approved under development consent SSD_5581 as shown in Figure 2 in Appendix 3 of SSD_5581. These zones provide design criteria for different mining methods based on the differing levels of environmental sensitivity of surface features and depth of cover across the Airly mining leases. Section 8 of the Airly Mine EIS (2014) provides further details on the definitions of each of these approved mining zones if required.

**Figure 1.1: Locality Plan**




Regional Context

MW17-MW18 PPMZ Extratcion Plan

*The data displayed on this figure has been collected from various sources. The source data may contain inconsistencies or omissions, may not be to scale, may not be current and may present indicative information only. Catalyst Environmental Management does not warrant the accuracy or completeness of the contents of this figure.*

## 1.2 Purpose and Scope

The purpose of this *EP Main Report* and the supporting sub-management plans is to:

- Provide detailed plans of the project;
- Address all regulatory and related requirements[2] using a risk based and consultative approach;
- Detail the mine planning and design associated with panel and pillar extraction mining activities, located within the Extraction Plan Area
- Outline potential subsidence effects, subsidence impacts and environmental consequences due to the project;
- Address the key performance measures and objectives for mine design, environmental management and regulatory, with associated indicators;
- Describe the measures that will be implemented to ensure compliance with the subsidence impact performance measures and investigate, mitigate, manage and remediate potential subsidence impacts and environmental consequences; and
- Detail a monitoring and contingency plan for potential subsidence impacts and environmental consequences outside of predictions, including detailed performance indicators for subsidence impact performance measures.

This *EP Main Report* and the supporting sub-management plans have been developed using a risk-based approach and in accordance with:

- Relevant requirements listed under *Condition 7 in Schedule 3* of SSD_5581, which requires an Extraction Plan to be approved prior to carrying out any second workings.
- *Extraction Plan Guideline,* NSW Department of Planning and Environment 2022; and
- *Managing Risks of Subsidence Guideline*, NSW Department of Industry, Resources Regulator (NSWRR), 2017; and
- *Consultation with all relevant key stakeholders* (potentially affected by subsidence) and the Independent Expert Panel (IEP) established by NSW Department of Planning and Environment (DPE) for the project.

[2] Further details regarding all requirements addressed by this report are provided in Section 2.1 and Attachment B – Relevant Legal and Other Requirements

## 1.3 Extraction Plan Area

Two miniwalls are proposed for extraction in the south-eastern area of Genowlan Mountain within the Airly mining leases being miniwalls (MW) 17 and 18. The miniwall panels are located within the *Panel and Pillar Mining Zone* as detailed within SSD_5581. Centennial Airly has applied a 26.5 degree Angle of draw (AoD) around all cliffs mapped within the *Cliff Line Zone of First Workings*. No secondary extraction will occur within the 26.5 degree angle of draw of cliffs within the *Cliff Line Zone of First Workings*.

The Extraction Plan Area (EP Area) is comprised of two key components as defined below and illustrated on **Figure 1.2**. The proposed overall EP Area boundary includes an Extended / Far Field Monitoring and Management Area which is beyond the predicted extent of subsidence and involves monitoring and management of sensitive features, primarily the cliffs and pagodas contained within the *Cliff Line Zone of First Workings* surrounding Genowlan Mountain as a precautionary approach to demonstrate the mining methods.

**Table 1.1: MW17-18 Panel & Pillar Mining Zone Extraction Plan Area**

| EP Area Components | Defining Comments |
|---|---|
| **Near-Field / Principal Subsidence Management Area** *(Secondary Extraction Area)* | • Approved area of secondary extraction in accordance with the development consent SSD_5581<br>• The proposed miniwall extraction (second workings) within the **Panel and Pillar Mining Zone** associated with **miniwall panels MW17-MW18**<br>• **No second workings within 26.5 degree setback from the tops of cliffs** located within the Cliff Line Zone of First Workings to **all miniwall panels i.e. MW17-MW18**<br>• **Predicted 20mm limit of vertical subsidence**<br>• Located within parts of both Mining Lease ML1331 and ML1814 |
| **Extended / Far Field Monitoring and Management Area** | • **Monitoring and management area only** for this Extraction Plan, no proposed secondary extraction within this Extraction Plan[3]<br>• This area lies entirely **beyond** the 26.5 degree setback from the tops of cliffs located within the Cliff Line Zone of First Workings to all panels MW17-MW18<br>• Conservatively monitors sensitive features located **beyond** the *Near-field / Principal Subsidence Management Area* for potential subsidence effects further afield<br>• Primarily comprises cliffs and pagodas contained within the Cliff Line Zone of First Workings |

[3] Parts of the Extended / Far-field Monitoring and Management Area overlap with the *Cliff Line Zone of First Workings*. First workings within the *Cliff Line Zone of First Workings* requires a separate Extraction Plan and any mining undertaken in the *Cliff Line Zone of First Workings* will be managed in accordance with an approved Extraction Plan.

## 1.4 Relevant Features and Sub-management Plans

The natural and built features relevant to the MW17-18 PPMZ Extraction Plan are identified in the checklist provided in *Attachment A – Identification of Natural and Built Features Checklist.*

**Table 1.2** provides a summary of the natural and built features within the EP Area along with the related Sub-management Plan that the respective features are managed through. The relevant features within the EP Area are illustrated on **Figure 1.2**.

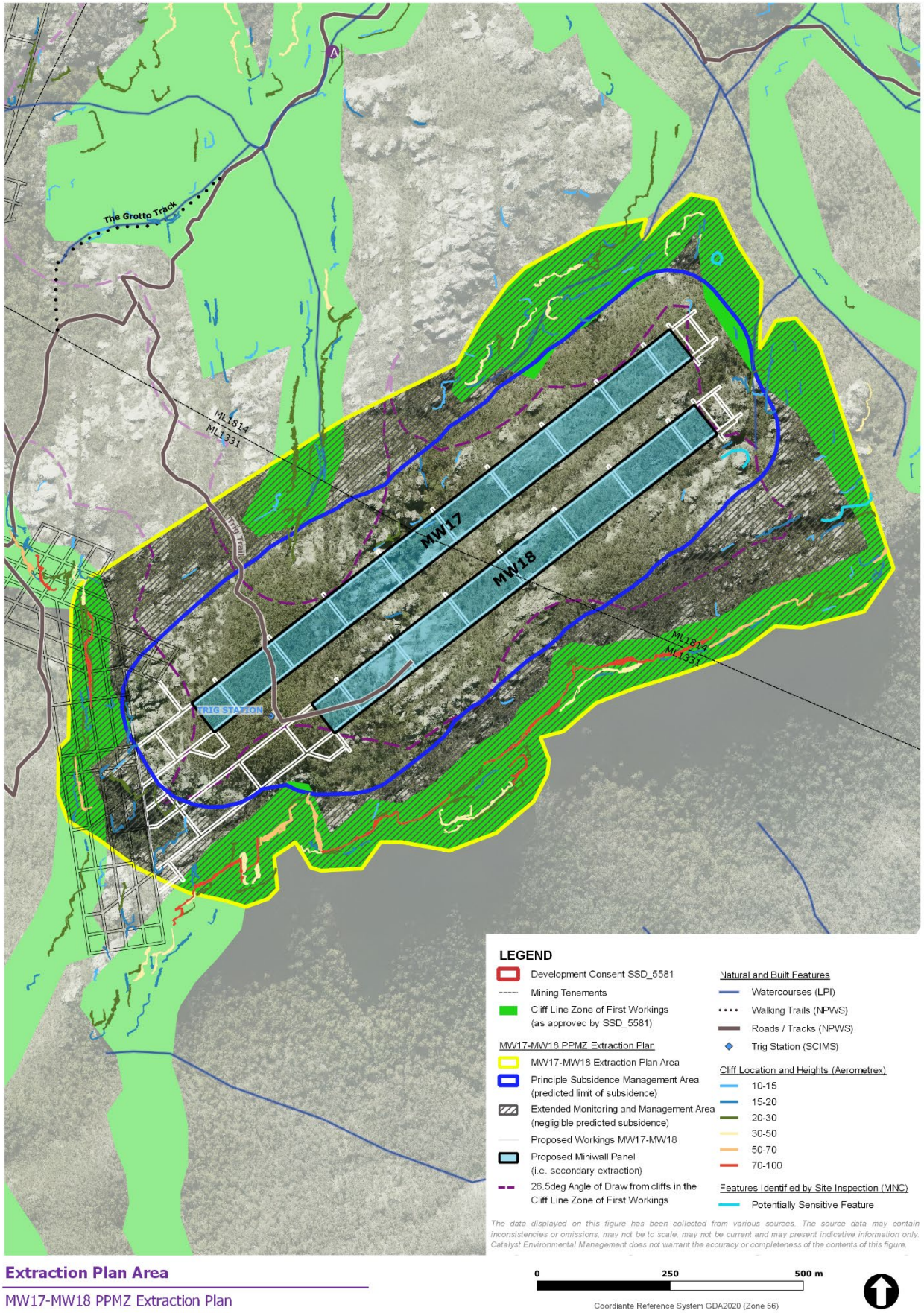
**Table 1.2: Relevant Features within the EP Area and Related Management Plans**

| Key Features Managed and Monitored | Section | Sub-management Plan |
|---|---|---|
| Surface Water (quality, flow and stream stability, erosion & sediment control)<br>Groundwater (including downstream alluvial and facultative ecosystems)<br>Monitoring of aquatic ecology<br>*Note: no privately owned bores within (or potentially affected by) the EP Area.* | 4.2.1 and 4.2.2 | Airly Mine Water Management Plan (WMP)<br>*(whole of site/consent area) – refer Appendix 1* |
| Cliffs, Minor Cliffs and Pagodas<br>Mugii Murum-ban SCA General Surface Area, including steep slopes and rock outcrops<br>The deeply incised canyons/gorge including an area known as the Grotto<br>Tracks and Trails, Fences & Gates | 4.2.3 | Land Management Plan for MW17-18 (MW17-18 LMP) – *refer Appendix 2* |
| Habitat<br>Threatened flora and fauna<br>Endangered Ecological Communities (EEC)<br>Groundwater Dependent Ecosystems (GDE)<br>Aquatic ecosystems | 4.2.4 | Biodiversity Management Plan for MW17-18 (MW17-18 BMP) – *refer Appendix 3* |
| Public Safety / Safety of 'others' associated with *potential* for subsidence.<br>Publicly accessible sections of the EP Area within Mugii Murum-ban State Conservation Area including tracks and trails and general SCA surface area. | 4.2.6 | Public Safety Management Plan for MW17-18 (MW17-18 PSMP) – *refer Appendix 4* |
| Details the monitoring program for the EP Area for all Key Features<br>Includes baseline monitoring, as well as during and post mining requirements | 4.1 | Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) – *refer Appendix 5* |

The scope of management plans for the Extraction Plan was developed in consultation with DPE.[4]

[4] See *Attachment D – Stakeholder Consultation*

**Figure 1.2: Extraction Plan Area (EP Area) and Relevant Features within the EP Area**



## 1.5 Document Structure

An overview of the Extraction Plan and its supporting sub-management plans and studies is provided below.

**Extraction Plan Main Report (this document)**

**Section 2** Includes details on the development of the Extraction Plan, including details of the legal requirements which apply and have been addressed, review of relevant risk assessments and consultation with relevant agencies and other stakeholders within the EP Area

**Section 3** Includes an overview of the mine planning and design, overall subsidence predictions related to that mine design, potential impacts from the predicted subsidence, and demonstration of the subsidence predictions meeting the performance objectives

**Section 4** Provides an overview and details of subsidence management measures including plans prepared to address impacts to relevant environmental and/or built features. The individual management plans are contained in Appendices to the Extraction Plan

**Section 5** Addresses the key elements of how the Extraction Plan is implemented, including trigger action response plans and the adaptive management approach and reporting

**Section 6** Provides the details regarding review and key responsibilities for this Extraction Plan

**Section 7** Lists the reference documents referred to in this Extraction Plan

**Appendix 1** to **Appendix 7** contains the key sub-management management plans and graphical plans which have been provided as part of the Extraction Plan.

Appendix 1 Airly Mine Water Management Plan

Appendix 2 Land Management Plan for MW17-18 (MW17-18 LMP)

Appendix 3 Biodiversity Management Plan for MW17-18 (MW17-18 BMP)

Appendix 4 Public Safety Management Plan for MW17-18 (MW17-18 PSMP)

Appendix 5 Subsidence Monitoring Program for MW17-18 (MW17-18 SMP)

Appendix 6 Master Trigger Action Response Plan for MW17-18 (MW17-18 Master TARP)

Appendix 7 Graphical Plans for MW17-18

**Attachment A** to **Attachment I** provides copies of the detailed technical assessments and other supporting information to support this Extraction Plan.

Attachment A Identification of Natural and Built Features Checklist

Attachment B Relevant Legal and Other Requirements

Attachment C Subsidence and Environmental Risk Assessment

Attachment D Stakeholder Consultation

Attachment E Technical Report: Pillar Width Modelling (SCT, 2023)

Attachment F Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023)

Attachment G Technical Report: Baseline Biodiversity Assessment (RPS, 2023)

Attachment H Technical Report: Baseline Historic Heritage Assessment (RPS, 2022a)

Attachment I Technical Report: Baseline Aboriginal Heritage Assessment (RPS, 2022b)

# 2 PLAN DEVELOPMENT AND CONSULTATION

## 2.1 Statutory Requirements

This Extraction Plan and the supporting management plans have considered all relevant regulatory approvals, leases, licences and guidelines, including the key requirements of Condition 7 in Schedule 3 of SSD_5581, the *Extraction Plan Guideline* (DPE, 2022) and the *Managing Risks of Subsidence Guideline* (NSW RR, 2017).

Airly Mine operates under a number of legislative and regulatory requirements and approvals, the relevant requirements to this Extraction Plan include:

- The conditions of the Development Consent (SSD_5581)
- Mining Leases (i.e. ML 1331 and ML 1814)
- WHS requirements[5] in relation to subsidence
- Other relevant licences and permits, including conditions attached to the Environment Protection Licence (EPL No. 12374) and EPBC Approval (referral 2013/7076), and
- Other relevant State and Commonwealth environmental, planning, mining, safety, and natural resource legislation and guidelines.

Centennial Airly maintains a register of all legislative and regulatory requirements in a compliance database. Applicable requirements of development consent, EIS/Statement of Commitments, and other related approvals, leases, licences and guidelines are presented in *Attachment B – Relevant Legal and Other Requirements*.

The following sections provide an overview of the key related regulatory conditions to the development of this Extraction Plan and supporting sub-plans under Development Consent SSD_5581 and NSW Work Health and Safety legislation as relevant to Mines and Petroleum sites.

### 2.1.1 Development Consent (SSD_5581)

The consent provides the conditional planning approval framework for mining activities to be addressed within an Extraction Plan and supporting management plans under Condition 7 in Schedule 3, as detailed in **Table 2.1**[6].

**Table 2.1: Development Consent Extraction Plan Requirements**

| Condition | Condition Requirement | Section | Detail |
|---|---|---|---|
| **Schedule 3, Condition 7** *(Extraction Plan)* | | | |
| 7. | Prior to carrying out any first workings within the Cliff Line Zone and Zone of First Workings (refer Figure 2 in Appendix 3), or second workings, the Applicant must prepare an Extraction Plan for the relevant workings to the satisfaction of the Secretary. Each Extraction Plan must: | - | MW17-18 Panel & Pillar Mining Zone Extraction Plan |
| 7.(a) | Be prepared by suitably qualified and experienced persons whose appointment has been endorsed by the secretary | - | *Attachment D – Stakeholder Consultation* |

5 WHS requirements include the Work Health and Safety Act 2011 (WHS Act), Work Health and Safety Regulation 2017 (WHS Regulation), Work Health and Safety (Mines and Petroleum Sites) Act 2013 (WHSMP Act), and the Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 (WHSMP Regulation)

6 Development Consent condition requirements relevant to Performance Measures (as described in Schedule 3 of SSD_5581) are detailed separately in Section 5.1.

| Condition | Condition Requirement | Section | Detail |
|---|---|---|---|
| 7.(b) | Provide a detailed justification for any proposed divergence from the advice of the IEP or DRE; | 2.6 | Attachment D – *Stakeholder Consultation* |
| 7.(c) | Include detailed plans of existing and proposed first and second workings and overlying surface features, including the identification of appropriate setback distances between cliffs, steep slopes, and pagodas and second workings and any applicable adaptive management measures | This document | Appendix 7 – Graphical Plans for MW17-18 |
| 7.(d) | Include adequate consideration of mine roof and floor conditions, pillar width to height ratio, final pillar design dimensions and the long-term stability of pillars, following consultation with the IEP; | 3 | Attachment F – Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) |
| 7.(e) | Give express consideration to the design parameters underpinning the advice in the IPRP's report, and if the proposed mine layout diverges from these parameters, provide a detailed justification for the proposed divergence, following consultation with the IEP; | 3 | Attachment E – Technical Report: Pillar Width Modelling (SCT, 2023) |
| 7.(f) | Provide an assessment of the likely stability of cliff lines, pagodas, and steep slopes, in consultation with the IEP; | 3.2 and 4.2.3 | Attachment F – Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023)<br>Appendix 2 – Land Management Plan for MW17-18 (MW17-18 LMP) |
| 7.(g) | Provide revised predictions of the potential subsidence effects, subsidence impacts and environmental consequences of the proposed mining covered by the Extraction Plan, incorporating any relevant information obtained since this consent, in consultation with the IEP | 3.2 | Attachment E – Technical Report: Pillar Width Modelling (SCT, 2023)<br>Attachment F – Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) |
| 7.(h) | Describe in detail the performance indicators and measures that would be implemented to ensure compliance with the performance measures in Tables 1 and 2, and manage or remediate any impacts and/or environmental consequences to meet the rehabilitation objectives in condition 27 of Schedule 4, following consultation with the IEP. | 5.1 | Appendix 6 – MW17-18 Master TARP |
| 7.(i)<br>7.(i) (i) | Include a:<br>**Subsidence Monitoring Program** which has been prepared in consultation with the IEP, Resources Regulator, and BCD to:<br>• Monitor the subsidence effects and subsidence impacts of the development<br>• Develop effective remote monitoring techniques for the development<br>• Monitor pillar loads underground to develop an understanding of the loading conditions on pillars in the vicinity of cliff lines, pagodas, and steep slopes<br>• Provide data to assist with the management of risks associated with subsidence | 4.1 | Appendix 5 – MW17-18 SMP |

| Condition | Condition Requirement | Section | Detail |
|---|---|---|---|
| | • Validate the subsidence predictions<br>• Analyse the relationship between the predicted and resulting subsidence effects and predicted and resulting impacts under the plan and ensuing environmental consequences; and<br>• Inform the contingency plan and adaptive management processes. | | |
| 7.(i) (ii) | **Built Features Management Plan**, which has been developed in consultation with Resources Regulator, to manage the potential subsidence impacts of the proposed underground workings on built features, and which:<br>• Has been prepared in consultation with the owners of potentially affected features;<br>• Addresses in appropriate detail all items of key public infrastructure and other public infrastructure and all classes of other built features;<br>• Recommends appropriate pre-mining mitigation measures to reduce subsidence impacts; and<br>• Recommends appropriate remedial measures and includes commitments to mitigate, repair, replace or compensate predicted impacts on potentially affected built features in a timely manner. | - | *Not relevant to this Extraction Plan* |
| 7.(i) (iii) | **Water Management Plan** which has been developed in consultation with BCD and the Water Division , which provides for the management of potential subsidence impacts and/or environmental consequences of the proposed underground workings on watercourses and aquifers, including:<br>• Detailed baseline data on:<br>- surface water flows and quality in Gap and Genowlan Creeks;<br>- Airly Village Spring and the Grotto;<br>- Groundwater levels, yields and quality in the region.<br>• Surface and groundwater impact assessment criteria, including trigger levels for investigating any potentially adverse impacts on water resources or quality;<br>• A surface water monitoring program to monitor and report on:<br>- stream flows and quality;<br>- stream and riparian vegetation health;<br>- channel and bank stability<br>• A groundwater monitoring program to monitor and report on:<br>- springs, their discharge quantity and quality, as well as any associated Groundwater Dependent Ecosystems;<br>- groundwater inflows to the underground mine operations;<br>- the height of groundwater depressurisation;<br>- background changes in groundwater yield/quality against mine-induced changes, in particular on groundwater bore users;<br>- permeability, hydraulic gradient, flow direction and connectivity of the deep and shallow groundwater aquifers;<br>• A description of any adaptive management implemented to guide future mining activities in the event of greater than predicted impacts on aquatic habitat;<br>• A program to validate the surface water and groundwater models for the development, and compare the monitoring results with modelled predictions; and<br>• A plan to respond to exceedance of any of the surface and groundwater assessment criteria. | 4.2.1 | Appendix 1 - *Airly Mine WMP* |
| 7.(i) (iv) | **Biodiversity Management Plan** which has been developed in consultation with DoEE and BCD , which provides for the management of potential impacts and/or environmental consequences of proposed first and second workings on aquatic and terrestrial flora and fauna, with a specific focus on threatened species populations and their habitats, Endangered Ecological Communities (EEC) and Groundwater Dependent Ecosystems (DGE's), including but not limited to: | 4.2.4 | Appendix 3 – MW17-18 BMP |

| Condition | Condition Requirement | Section | Detail |
|---|---|---|---|
| | • *Pultenaea* sp. Genowlan Point<br>• Genowlan Point *Allocasuarina nana* Heathland<br>• *Prostanthera stricta* (Mount Vincent Mint-bush) and<br>• *Eucalyptus cannonii* (Capertee Stringybark) | | |
| 7.(i) (v) | **Land Management Plan** which has been prepared in consultation with the IEP, Resources Regulator, BCD and any affected public authorities, to manage the potential Impacts and/or environmental consequences of the proposed underground workings on land in general, with a specific focus on cliffs, pagoda formations, steep slopes and gorges | 4.2.3 | Appendix 2 – MW17-18 LMP |
| 7.(i) (vi) | **Heritage Management Plan** which has been prepared in consultation with Heritage Division and relevant Aboriginal stakeholders, to manage the potential environmental consequences of the proposed workings on Aboriginal and Historic Heritage and includes all requirements under Condition 18 of Schedule 4. | - | *Not relevant to this Extraction Plan* |
| 7.(i) (vii) | **Public Safety Management Plan** which has been prepared in consultation with the IEP, Resources Regulator and BCD to ensure public safety and manage access on the site | 4.2.6 | Appendix 4 – MW17-18 PSMP |
| 7.(i) (viii) | include Trigger Action Response Plans, or equivalent, to prevent greater than predicted subsidence impacts and environmental consequences that may result from mine subsidence | 5.4 | Appendix 6 – MW17-18 Master TARP |
| 7.(i) (ix) | include a contingency plan that expressly proves for adaptive management where monitoring indicates that there has been an exceedance of any performance measure in Tables 1 and 2, or where such exceedances appear likely; | 5.5 | Appendix 6 – MW17-18 Master TARP |
| 7.i) (x) | Proposes appropriate revisions to the Rehabilitation Management Plan required under Condition 27 in Schedule 4; | 5.3 | Appendix 5 – MW17-18 SMP *(if triggered)* |
| 7.i) (xi) | include a program to collect sufficient baseline data for future Extraction Plans | 4.3 | Appendix 5 – MW17-18 SMP |
| | The Applicant must implement the approved Extraction Plan for the development | 6.3 | - |
| | *Notes:*<br>• *This condition does not apply to first or second workings which are covered by an Extraction Plan or SMP approved, or under assessment, as at the date of this development consent.*<br>• *In accordance with Condition 4 in Schedule 6, the preparation and implementation of Extraction Plans may be staged, with each plan covering a defined area of underground workings. In addition, these plans are only required to contain management plans that are relevant to the specific underground workings that are being carried out.*<br>• *Due to the sensitive and rugged terrain of the Mugii Murum-ban State Conservation Area, the Applicant may propose remote subsidence monitoring techniques.* | -<br><br>1.3<br><br>4.1 | -<br><br>*Extraction Plan Main Report (this document)*<br><br>Appendix 5 – MW17-18 SMP |

The development consent also contains conditions to be addressed for the preparation of any management plans which are required under SSD_5581, as such all management plans including this EP Main Report have been prepared in accordance with Condition 2 in Schedule 6, as detailed in **Table 2.2**.

**Table 2.2: Development Consent Management Plan Requirements**

| Condition | Condition Requirement | Section | Detail |
|---|---|---|---|
| **Schedule 6** | | | |
| **Condition 2** *(Management Plan Requirements)* | | | |
| 2. | The Applicant must ensure that the management plans required under this consent are prepared in accordance with any relevant guidelines, and include: | - | *Extraction Plan Main Report (this document), and* Appendix 1 to Appendix 5 (sub-management plans) |
| 2.(a) | Detailed baseline data; | 4.3 | |
| 2.(b) | A description of:<br>• The relevant statutory requirements (including any relevant approval, licence or lease conditions);<br>• Any relevant limits or performance measures/criteria;<br>• The specific performance indicators or triggers that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures. | 2.1<br>5.1<br>5.1 | |
| 2.(c) | A description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria. | 5.2 | |
| 2.(d) | A program to monitor and report on the:<br>• Impacts an environmental performance of the development;<br>• Effectiveness of any management measures (see c) above); | 4 | |
| 2.(e) | A contingency plan to manage any unpredicted impacts and consequences | 5.5 | |
| 2.(f) | A program to investigate and implement ways to improve the environmental performance of the development over time | 5.7 | |
| 2.(g) | A protocol for managing and reporting any:<br>• Incidents;<br>• Complaints;<br>• Non-compliance with statutory requirements; and<br>• Exceedances of the impact assessment criteria and/or performance criteria; and | 5.6 | |
| 2.(h) | A protocol for periodic review of the plan. | 6.2 | |

### 2.1.2 Work, Health and Safety Laws (subsidence related)

Airly Mine operates in accordance with its Safety Management System which integrates plans, policies and procedures that enables a systematic approach to establishing and maintaining effective systems to manage health and safety consistent with WHS laws and relevant standards.

WHS laws have been considered for the Extraction Plan principally within the context of subsidence related risks to public safety, including to public infrastructure and in reference to *Managing Risks of Subsidence Guideline* (NSW RR, 2017).

An outline of key relevant WHS requirements is provided in the sections below:

***Management of Risks to Health and Safety***

Under section 14(1) of the WHSMP Regulation, a PCBU at a mine, including the mine operator, *must manage risks to health and safety associated with mining operations* at the mine in accordance with Part 3.1 of the Work Health and Safety Regulation 2011 (WHS Regulation). Specifically, under section 70(1) of the WHSMP Regulation, the mine operator of an underground coal mine *must, in complying with section 14 , manage risks to health and safety associated with subsidence*[7] *at the mine*.

7 The WHSMP Regulation defines subsidence as meaning "the deformation or displacement of any part of the ground surface or subsurface strata caused by the extraction of minerals". Such deformation or displacement has potential to cause hazardous conditions, which must be controlled to ensure, so far as is reasonably practicable, that the health and safety of workers and other persons is not put at risk from subsidence.

Section 70(2) sets out specific requirements in relation to subsidence as:

*"..the mine operator must ensure that--*

*a) so far as is reasonably practicable, the rate, method, layout, schedule and sequence of mining operations do not put the health and safety of any person at risk from subsidence, and*

*b) monitoring of subsidence is conducted, including monitoring of its effects on relevant surface and subsurface features, and*

*c) any investigation of subsidence and any interpretation of subsidence information is carried out only by a competent person, and*

*d) all subsidence monitoring data is provided to the regulator in the approved manner and form and at the times required by the regulator, and*

*e) so far as is reasonably practicable, procedures are implemented for the effective consultation, co-operation and co-ordination of action with respect to subsidence between the mine operator and relevant persons conducting any business or undertaking that is, or is likely to be, affected by subsidence.*

These requirements have been considered and are addressed throughout this MW17-18 Panel & Pillar Mining Zone Extraction Plan.

***Potential Risks to the Safety of Others***

Section 19 of the Work Health and Safety Act 2011 (WHS Act) requires that all persons conducting a business or undertaking (PCBUs), including mine operators under the Work Health and Safety (Mines and Petroleum Sites) Act 2013, *must ensure, so far as is reasonably practicable,.. that the health and safety of other persons is not put at risk from work carried out as part of the conduct of the business or undertaking.*

In particular, the following is noted for public safety and the "safety of others":

| | |
|---|---|
| *Public Safety:* | Feedback from detailed stakeholder consultation since the MEP EIS (pre 2014) and the dedicated *Subsidence and Environmental Risk Assessment* undertaken for this Extraction Plan, provide key supporting information in the management of public safety which informed development the MW17-18 PSMP. Appropriate monitoring to support the MW17-18 PSMP and the MW17-18 Master TARP for the identified potential risks has been considered during development of the MW17-18 SMP. |
| *Centennial Personnel and Contractor Safety:* | The safety of Centennial personnel and contractors engaged by the mine working in the EP Area are managed under the Airly Mine Safety Management System. This includes (but is not limited to) detailed safety communication, training and induction processes for all personnel and contractors, a dedicated *Contractor Management Plan* and supporting *Contractor Work Authorisation Permit* process. |

***High Risk Activity***

The proposed workings are defined as a High Risk Activity in relation to subsidence in Schedule 3 of the WHSMP Regulation. As such, Airly Mine must give notice of a High Risk Activity to the regulator and ensure that the requirements of Section 35 and Schedule 3 of the WHSMP Regulation are complied with. Airly Mine is preparing a High Risk Activity Notification for the EP Area for submission to the NSW Resource Regulator (Mines Safety) concurrently with the Extraction Plan.

Key documents from this Extraction Plan, including the MW17-18 PSMP, MW17-18 SMP and MW17-18 Master TARP and supporting specialist subsidence reports, will also be included as part of a High Risk Activity notification submitted to the NSW Resource Regulator for the EP Area.

***Subsidence as a Principal Hazard***

The mine operator must prepare a Principal Hazard Management Plan (PHMP) for each principal hazard associated with mining operations at the mine in accordance with Section 28 and Schedule 1 of the WHSMP Regulation.

Section 4 of the WHSMP Regulation provides the definition of a principal hazard as:

*"..a principal hazard is an activity, process, procedure, plant, structure, substance, situation or other circumstance relating to the carrying out of mining operations or petroleum operations that has a reasonable potential to result in multiple deaths in a single incident or a series of recurring incidents in relation to--*

*(a) for mining operations--one or more of the following--:*

*…… (vi) subsidence,…. "*

The primary design criteria used by Centennial Airly to achieve the performance outcomes, from a surface subsidence perspective, are limiting long-term subsidence nominally to not more than 125mm with minimal associated tilts and strains. The mine design factors are discussed in **Section 3.1** and assessed in the specialist *Airly Mine MW17 to MW18 – Subsidence Predictions and Impact Assessments for the Natural and Built Features over and near the Proposed MWs 17 to 18 in Support of the Extraction Plan Application MSEC1351* (MSEC, 2023). The report also specifically considered key factors noted in the *Managing Risks of Subsidence Guideline* (NSW RR, 2017) including factors for potential greater than predicted subsidence movements.

Given these design factors and detailed investigations assessing relevant risks, it is considered that there is no reasonable potential to cause multiple deaths from such a system. Accordingly, panel and pillar mining within the EP Area is not considered a principal hazard under the above WHS requirements. Notwithstanding, the Public Safety Management Plan for MW17-18 has been prepared generally in accordance with the relevant WHS requirements and guidelines, and is intended to manage potential risks from subsidence, particularly in the context of protection of the "safety of others" (public safety).

***Managing Risks of Subsidence Guideline***

This Extraction Plan has been prepared in accordance with the *Managing Risks of Subsidence Guideline* (NSW RR, 2017) which provides practical guidance to assist the mine operator of an underground coal mine in:

- Complying with their obligations under the WHS requirements in relation to subsidence; and
- Identifying and controlling hazards that may cause harm to people from subsidence through the development and implementation of a principal hazard management plan (PHMP) or risk management in accordance with a High Risk Activity (HRA) notification.

*Attachment B – Relevant Legal and Other Requirements* lists key recommended factors to be considered in the management of subsidence risks to 'other persons' (including for Principal Hazard Management Plans) in accordance with the NSWRR guidelines. This includes HRA components of the guidelines considered for the MW17-18 PSMP. These have been specifically included in Subsidence and Environmental Risk Assessment undertaken for the Extraction Plan[8], supported by specific technical assessments of these aspects in supporting specialist reports such as those in *Attachment F – Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023)*.

8 See Section 2.4 Risk Assessment and Attachment C – Subsidence and Environmental Risk Assessment

## 2.2 Specialist Assessments

### 2.2.1 Cliff Identification (Aerometrex, 2021; MNC, 2022)

The key objective of the mine design approach is to minimise risk of surface impacts through appropriate mine layout design to reduce subsidence at sensitive high cliffs and escarpments located on the external parts of the Mount Airly and Genowlan Mountain mesas. The results of the major cliff identification and mapping studies are used as the basis for determining set back distances to the proposed secondary extraction (within the PPMZ) can occur to the cliffs (within the CLZ). Therefore, it is important for Centennial to ensure that the cliffs have been suitably and accurately mapped.

Aerometrex (2021) was engaged by Centennial to identify the cliffs and other sensitive surface features over Genowlan Mountain that satisfied the rock feature definitions in the development consent. The following provides a brief overview of the methodology of cliff identification work undertaken by Aerometrex:

- A Digital Terrain Model (DTM) is generated from classified LiDAR ground point-clouds
- Potential cliff areas are extracted from the DTM and filtered using a semi-automatic approach to meet the major cliff definition (minimum length of 20m, 10m height and minimum slope of 63.4 degree).
- Each identified cliff is then analytically and visually checked against the 3D mesh model.
- A vector file (Shapefile and KML format) is provided with the following attributes:
    - ID: Major Cliff identification ID
    - AVG_H: Average height of the cliff
    - AVG_L: Average length of the cliff
    - MAX_H: Maximum height of small outlying sections of a cliff
- The dataset is split in several areas (Cliffs ID are CB_xx (area1), CC_xx (area2), etc)

Michael Nicholson Consulting Pty Ltd (MNC) (2022) was then engaged to undertake site inspections ("ground truthing") of the cliffs that were identified as being located within the CLZ or the PPMZ on Genowlan Mountain to supplement the extensive aerial photogrammetry and cliff identification work that was undertaken previously by Aerometrex (2021). The objectives of this report were to primarily provide ground truthing verification of the cliff mapping and cliff identification completed in desktop studies by Aerometrex. The site inspection was also undertaken to inspect for any cliffs or other features not previously identified/mapped, as well as inspecting the area to check there were no rock features (i.e. pinch points, overhangs, etc.) that would be particularly sensitive to subsidence ground movements. The key findings of the report are:

- Good positional correlation was noted with cliff segments digitised by MNC and those identified by the Aerometrex process – the site inspection supports using the cliff mapping provided by Aerometrex for developing setbacks to secondary extraction.
- There were no particularly vulnerable features identified in the EP Area that would need to be avoided through mine design.
- A few sensitive features were highlighted within the report, with recommendations for these features to be specifically assessed within the subsidence predictions and impact assessment report. This was completed by MSEC (2023).[9]

The relevant features within the EP Area, including the key cliffs and features identified by these reports, are illustrated on **Figure 1.2**.

[9] See Section 2.2.3, Section 3.2 and Attachment F – Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) for further detail on the subsidence predictions and impact assessment for key cliffs and features in the EP Area

### 2.2.2 Pillar Width Modelling (SCT, 2022; SCT, 2023)

Strata Control Technology (SCT) have developed a detailed numerical model, from previous Airly Mine subsidence assessments, calibrated for predictive purposes at Airly Mine. The subsidence predictions by SCT from this FLAC model has now been supported by the monitored incremental subsidence results over MWs 11 to 12 (i.e. Mt Airly) and the monitored results over MWs 13 to 15A (i.e. Point Hatteras).[10]

Following the development of the 26.5 degree setback from the tops of cliffs located within the Cliff Line Zone of First Workings, SCT (2022) were engaged to undertake a detailed modelling assessment using the existing numerical model to advise on a modification of the miniwall design within the available resource to **limit the maximum predicted subsidence to less than 125mm**. The initial mine layout proposed three miniwall panels (MW17 to MW19) including:

- Panel void widths of 56m, a reduction from 61m compared with the EIS design and as mined elsewhere at Airly; and
- Pillar widths of 50m, an increase from 29.5m compared with the EIS design.

SCT (2022) predicted that the maximum vertical subsidence over the proposed MWs 17 to 19 would be 118 mm with a subsidence tolerance of +/-20mm. This was a conservative estimate of subsidence for the MW17-19 mining area given the modelled depth of cover was 280m, and actual depth of cover ranges from 215m to 290m but is mostly less than 260m. It is also noted that the current subsidence levels observed over MWs 13 to 15A are below the predicted subsidence levels modelled by SCT.

During external consultation it was noted that the initial mine layout proposed had the potential to create maximum vertical subsidence levels of up to 138mm, and it was suggested that the extraction plan and mine design should be revised according to a precautionary approach so that subsidence thresholds do not have the potential to be exceeded.

SCT (2023) were then engaged to advise on a revision to the pillar and panel layout to **limit the maximum predicted subsidence to a chosen upper design limit of 95mm (+/-20mm)** aligning with a more precautionary approach.

The proposed revised mining geometry includes two miniwall panels, MW17 and MW18, with panel void widths of 70.5m and 3.0m extraction height separated by a 70m wide barrier pillar.

The predicted subsidence effects for the proposed miniwalls 17 to 18 have been provided by SCT (2023). **The maximum vertical subsidence for the revised mine layout is predicted to be 88 mm (+/-20mm).**[11]

### 2.2.3 Subsidence Predictions and Impact Assessment (MSEC, 2023)

MSEC (2023) was engaged to prepare and provide a subsidence prediction and impact assessment report, on the likely impacts of these predicted levels of subsidence on the natural and built features that exist over and near MWs 17 to 18, based on the subsidence modelling work provided by SCT (2023).

This subsidence predictions and impact assessment report provides:

- Predicted subsidence contours for the Extraction Plan covering parts of the Genowlan Mountain due to the proposed extraction of MWs 17 to 18, based on the subsidence modelling by SCT (2023); and
- A subsidence assessment for the natural and built features that are located over or near MWs 17 to 18.

This report is discussed in further detail in **Section 2.3** and **Section 3.2**.

[10] See Section 2.3 for further detail on the review of previous subsidence predictions.

11 See Attachment E – Technical Report: Pillar Width Modelling (SCT, 2023) for further detail on the Pillar Width Modelling Assessment.

### 2.2.4 Biodiversity (RPS, 2023)

A Baseline Ecology Assessment was developed by RPS (2023) for the EP Area with the purpose of reviewing the relevant biodiversity information within the region and informing the development of the Biodiversity Management Plan for the Extraction Plan.

### 2.2.5 Heritage (RPS, 2022a; RPS, 2022b)

A Baseline Historic Heritage Assessment (RPS, 2022a) and Baseline Aboriginal Cultural Heritage Assessment (RPS, 2022b) has been developed for the EP Area with the purpose of reviewing the relevant heritage information to identify heritage items within the region and informing the development of the Heritage Management Plan for the Extraction Plan.

## 2.3 Review of Previous Subsidence Predictions

The Airly Mine EIS in 2014, presented an approach to mining throughout the lease which employed different mining methods in different areas, each targeted to suit each specific area, referred to as 'mining zones'. A key objective of the approach was to minimise risk of surface impacts by limiting subsidence through appropriate mine design. Sensitive high cliffs and escarpments located on the external parts of the Mount Airly, and Genowlan Mountain mesas were protected by a Cliff Line Zone (CLZ) of First Workings (i.e. no secondary extraction).

The Panel and Pillar Mining Zone (PPMZ), located in the centres of the mesas, were designed with miniwall extraction of narrow panels (around four times narrower than conventional longwalls) and large chain pillars that were designed to limit subsidence. The 2014 EIS report, which was prepared by Golder Associates, predicted the maximum subsidence over the PPMZ areas of the mine, after the extraction of 61 m wide miniwall panel widths and 29.5 m chain pillars, would be less than 125 mm, tilts would be less than 2.5 mm/m and strains would be less than 2 mm/m. It was assessed that, at these low subsidence values, no surface cracking, rock falls or cliff impacts were expected (MSEC, 2021).

An updated subsidence prediction report was provided by Strata$^2$ (March 2019) for the introduction of miniwall mining on the Airly leases (within the Mt Airly PPMZ Extraction Plan), which advised that the maximum short-term subsidence over the whole Airly mine was likely to be 70 mm and the long-term maximum subsidence was predicted to be 110 mm. This Strata$^2$ report confirmed the 2014 EIS advice that, at these low subsidence values, no surface cracking, rock falls or cliff impacts were expected (MSEC, 2021).

Whilst the mine design built on successful experience in other locations, especially Clarence Colliery, the miniwall mine design was considered unique in a mesa environment and high confidence/accuracy subsidence monitoring was undertaken over the initial panel and pillar mining areas (MSEC, 2021).

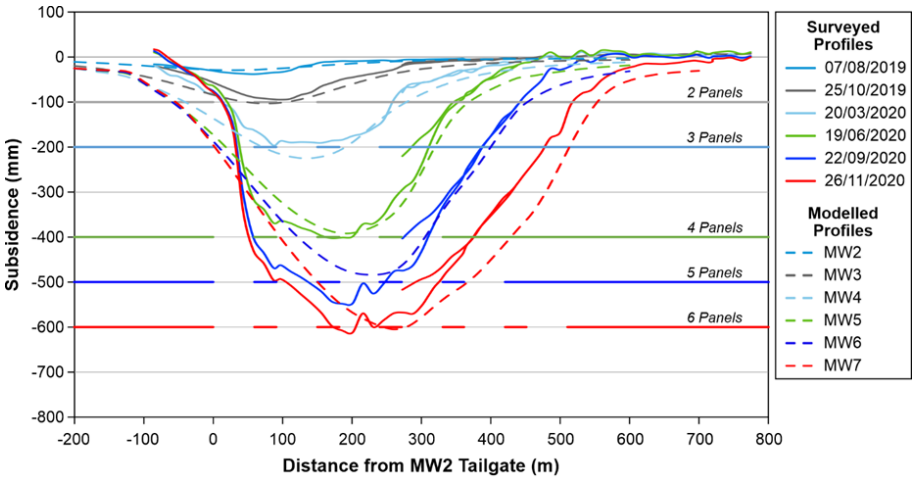
During the extraction of miniwall panels under Mt Airly observed subsidence surpassed the predicted maximum subsidence of 125 mm and some associated surface cracks were identified. Accordingly, in consultation with regulators and the IEP, Airly Mine have undertaken extensive modelling and mine design revisions aimed to reduce subsidence levels to be consistent with EIS predictions (i.e., maximum vertical subsidence <125mm), including:

- Subsidence numerical modelling (UDEC) calibrated against observed subsidence to date (MSEC, 2020a)
- Review of geotechnical issues related to the update of the Extraction Plan for Mini Walls 7 to 9 (Strata$^2$, 2020)
- IEP technical review of subsidence analysis (e.g., horizontal movements) and preliminary recommendations (adopted by Airly)
- Updated UDEC numerical modelling to include faulting and revised subsidence predictions and cliff stability assessment for MW8-9 modification (MSEC & UNSW, 2020b)
- Modelling Investigation of Subsidence Mechanism (FLAC numerical modelling) and Pillar Size Assessment (to limit the vertical subsidence above MW11-12, in the Mt Airly PPMZ EP Area, to 125mm) (SCT, 2021a), and

- Updated FLAC numerical modelling and revised subsidence predictions for the Point Hatteras region of Genowlan Mountain (i.e., MW13-16) (SCT, 2021b).

SCT (2021a) investigated the mechanism producing subsidence from miniwall mining in the Mt Airly PPMZ EP Area. After calibrating against the Mount Airly observed subsidence ground movements, SCT were able to simulate the caving and subsidence observed over Mt Airly using a numerical modelling approach in FLAC 2D for Centennial Airly to match the available strata responses that were observed over MWs 2 to 9 (SCT, 2021a), as shown in **Figure 2.1**.

**Figure 2.1: Surveyed and Modelled Subsidence Comparison (for previous Mt Airly EP Area)**




(source: SCT, 2021b)

The SCT (2021a) modelling indicated that the mechanism for increased subsidence at Airly Mine is the fracturing and compression of strata above the chain pillars. This fracturing of strata is primarily a function of weak strata, abutment load, reduced confinement due to the adjacent goaf voids and pillar width. Fracturing of the strata reduces the stiffness of the strata and results in increased compression from the abutment load. This increased compression of the strata manifests as increased surface subsidence (SCT, 2021a). The modelling indicated that surface subsidence can be controlled by increasing pillar width which reduces the fracturing of the strata above the chain pillars (SCT, 2021a). The surface subsidence is also sensitive to extraction height. This earlier work provided an understanding of the mechanisms for subsidence, a method to control subsidence (pillar size and extraction height) and a calibrated model for predictive purposes (within assumptions and limitations) (SCT, 2021b).

The calibrated model has been used by SCT to provide modelling assessments for recommendations for pillar size for MW10-12 (SCT, 2021a). SCT were then asked to use this FLAC 2D model to recommend a revised mine design that would restrict the maximum subsidence over MWs 13 to 16 to less than the EIS prediction of 125 mm. Various pillar sizes of 40-120m were modelled, including pillar size combinations (e.g. 40m, 80m, 40m, 80m, 40m). This modelling assessment indicated that a consistent pillar width of 70m and extraction height of 2.8m, for 4-5 miniwalls, was the most appropriate mining geometry for the 61m wide panels for the depth range at Point Hatteras (approximately 200-300m) (SCT, 2021b).

A comparison of the measured vertical subsidence data following extraction against the SCT model predictions has been undertaken by MSEC (2023) for MW11 & MW12 and MW13, MW14 & MW15A. These comparisons confirmed that measured subsidence levels are within, or below, the range predicted by the SCT subsidence model and indicate the SCT modelling can be relied on with a reasonable confidence for predicting subsidence from miniwall mining at Airly Mine. The validation to date includes pillars of various sizes.[12]

[12] See Section 4 of Attachment F – Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) for further details about the review of previous subsidence predictions.

## 2.4 Risk Assessment

Centennial Airly has undertaken a dedicated ***Subsidence and Environmental Risk Assessment*** *(Stature RA Number: 1001308023*[13]*)* directly in support of this Extraction Plan which provide a risk framework basis for development of the sub-management plans.

The risk assessment for this *Extraction Plan* was completed on the 13 July 2022 with key staff from the Airly Mine including the Technical Services Manager, Statutory Mine Surveyor, Mining Engineer / Compliance Manager and Environment and Community Officer, as well as the General Manager of Technical Services for Centennial and the Lead Consultant for the EP Project Team from Catalyst Environmental Management. The *Subsidence and Environmental Risk Assessment* was facilitated by the Mining Engineer / Compliance Manager and has been reviewed by key EP Project Team members for Heritage, Ecology and Subsidence.

Risks were identified and assessed through the review of known surface and sub-surface features within the EP Area. The risk assessment also specifically assessed key heads of consideration required by the Managing Risks of Subsidence Guideline (NSW RR, 2017).

A risk ranking (low, moderate, significant, high or extreme) was assigned to each risk/hazard in consideration of the Maximum Reasonable Consequence (MRC) for the given controls. There were 49 potential risks scenarios assessed during the Risk Assessment; 8 moderate, 41 low and two were assessed as not applicable.

The risk assessment determined that the risk of impact for landscape features (noting the extensive controls identified) was **Low to Moderate** including aspects associated with cliffs and pagodas within the EP Area.

A copy of the risk assessment is included in *Attachment C – Subsidence and Environmental Risk Assessment*. Additional details regarding the management and monitoring of subsidence related impacts to land within the EP Area have been detailed in **Section 4.**

## 2.5 Avoidance and Minimisation Strategies

Potential environmental consequences during the mining of MW17-18 will be managed in accordance with the relevant requirements of Project Approval (SSD_5581) and other approvals, through:

- **Avoidance/Mine Design** –extensive modelling has informed the layout of MW17-18 with panel (void) and pillar widths specifically designed to reduce subsidence levels to be consistent with EIS predictions (i.e., maximum vertical subsidence <125mm) and meet the subsidence impact performance measures (**Section 3.1 and 5.1**).
- **Subsidence Monitoring** – visual and survey monitoring and reporting will be conducted to confirm predictions of subsidence effects and potential subsidence impacts and environmental consequences (**Section 4**).
- **Management Measures and Remediation** – implementation of management measures and/or remediation, as required, to address subsidence impacts and/or environmental consequences (in consideration of the potential impacts of the unmitigated impact, including the potential for self-healing or long-term degradation, and the potential impacts of the remediation) (**Section 5**).
- **Trigger Action Response Plan** – implementation of Trigger Action Response Plans in the event an exceedance of a subsidence impact performance measure or if an unexpected impact is detected (**Section 5.4**), including consideration of identified potential contingency measures.

13 Centennial Airly has adopted the Stature Risk Assessment Program which was developed to ensure consistency in all risk assessments across the Centennial operations. The Stature Risk Assessment Program sets out a consequences table and risk ranking matrix for managing identified risks consistent with AS/NZS ISO 31000:2009.

- **Adaptive Management and Contingency Planning** – adaptive management will be implemented where appropriate by reviewing and evaluating the effectiveness of management strategies, and adjusting management strategies to improve performance, particularly following an exceedance of a subsidence (**Section 5.5**).
- **Reporting and Review** – procedures for investigations of incidents (including all exceedances of performance measures) and appropriate response, as well as procedures for quality assurance and review of the management system (**Sections 5.7.1 and 5.6**).

## 2.6 Consultation

### 2.6.1 Identification of Key Stakeholders

During development of this Extraction Plan and its sub-management plans, substantial consultation has been undertaken with key stakeholders. Stakeholder analysis undertaken during preparation of this Extraction Plan included:

- Risk-based consideration of key environmental and built features within the proposed EP Area;
- Stakeholders prescribed for consultation for this Extraction Plan within the Development Consent;
- Stakeholders identified within previous Environmental Assessments;
- Existing and known stakeholders to Airly Mine, including the Community Consultative Committee; and
- Identified landowners/users relevant to the EP Area.

Key Stakeholders identified for consultation are outlined in **Table 2.3**.

**Table 2.3: Key Stakeholders**

| Group | Stakeholder |
|---|---|
| NSW Government Agency | • Department of Planning and Environment (DPE)<br>• Independent Expert Panel (IEP) as required by SSD_5581<br>• National Parks and Wildlife Services (NPWS)<br>• BCD<br>• NSW Resource Regulator<br>• Water Division |
| Local Government Authority | • Lithgow City Council |
| Community | • Airly Mine Consultative Committee (CCC) |

*It is noted that following review of updated/current land ownership for the EP Area (including SCA / crown lands under lease), the following additional stakeholders were confirmed not applicable to the current EP Area:*

- *NSW Department of Industry – Division of Lands and Forestry ('Crown Lands') – no crown lands within EP Area (now gazetted into the SCA where applicable);*
- *Telstra (Network Integrity Services) - (buried cable is outside the EP Area)*
- *Private land owners (none within EP Area)*

### 2.6.2 Consultation Required by Consent Conditions

Condition 7 in Schedule 3 of SSD_5581 requires the preparation of this Extraction Plan in consultation with key relevant stakeholders as detailed in **Table 2.4**.

**Table 2.4: Development Consent Required Consultation**

| Condition | Consultation Requirement |
|---|---|
| 7.(i) (i) | **Subsidence Monitoring Program** which has been prepared in consultation with the IEP, DRE, and BCD |
| 7.(i) (ii) | **Built Features Management Plan**, which has been developed in consultation with Resources Regulator. |
| 7.(i) (iii) | **Water Management Plan** which has been developed in consultation with BCD and the Water Division |
| 7.(i) (iv) | **Biodiversity Management Plan** which has been developed in consultation with DoEE and BCD |
| 7.(i) (v) | **Land Management Plan** which has been prepared in consultation with the IEP, Resources Regulator, BCD and any affected public authorities |
| 7.(i) (vi) | **Heritage Management Plan** which has been prepared in consultation with Heritage Division and relevant Aboriginal stakeholders |
| 7.(i) (vii) | **Public Safety Management Plan** which has been prepared in consultation with the IEP, Resources Regulator and BCD |

Copies of sub-management plans have been provided for consultation with the various stakeholders in accordance with SSD_5581 and identified during the preparation of this Extraction Plan. Any further stakeholder feedback will be reviewed and addressed as necessary.

### 2.6.3 Consultation Required by Mining Lease and Work, Health and Safety Legislation

A summary of consultation requirements required under both the mining leases and Work, Health and Safety Legislation is included in the various Key Sub-management Plans to outline how each matter has been addressed.

### 2.6.4 Results and Outcomes of Consultation

The outcomes of consultation undertaken for the project is provided in *Attachment D – Stakeholder Consultation*, including copies of relevant correspondence such as project presentations delivered by the mine to key stakeholders and relevant formal correspondence received from key stakeholders.

Stakeholder feedback provided has been reviewed and addressed as necessary as part of the development and review of this Extraction Plan and key sub-plans.

# 3 SUBSIDENCE ASSESSMENT

## 3.1 Mine Planning and Design

### 3.1.1 Proposed Mining Geometry and Parameters

The mine design has been specifically developed in response to the sensitive surface environment to avoid significant impact. As a result, Airly Mine operates in specific mining zones using low-impact underground mining methods that limit void widths and leaves sufficiently large pillars to support the overburden and prevent subsidence impacts. Comparisons of measured subsidence and the SCT subsidence model indicate the SCT modelling can be relied on with a reasonable confidence for predicting subsidence from miniwall mining at Airly Mine.[14]

Miniwall panels 17 and 18 are consistent with the modelled design by SCT (2023) and have been designed based on the following:

- Each panel will have panel void widths of 70.5m
- The barrier pillar width between the panels will be 70m (maximum of 2 adjacent panels)
- The cover depths over the miniwalls range from approximately 215m to 290m, with areas of higher depth of cover (i.e. greater than 280) located to the western (finishing) end of MW17, and the majority of the cover depths over the miniwalls less than 260m
- The Lithgow seam thickness ranges from 3.5 m to 3.8 m
- The panel extraction height will be 3.0m
- The first workings roadways will be nominally 5.4m wide and 3.0m high

**Figure 1.2** illustrates the proposed panels in the landscape. The typical layout for the EP Area is shown on **Figure 3.1**. A summary of the dimensions for the proposed miniwall panels is provided in **Table 3.1**.

**Table 3.1: Geometry of the proposed Miniwall Panels MW17-MW18**

| Miniwall Panel | Overall void length including installation heading (m) | Overall void width including first workings (m) | Overall tailgate chain pillar width (m) |
|---|---|---|---|
| MW17 | 1140 | 70.5 | - |
| MW18 | 912 | 70.5 | 70 |

### 3.1.2 Mining Method and Sequence

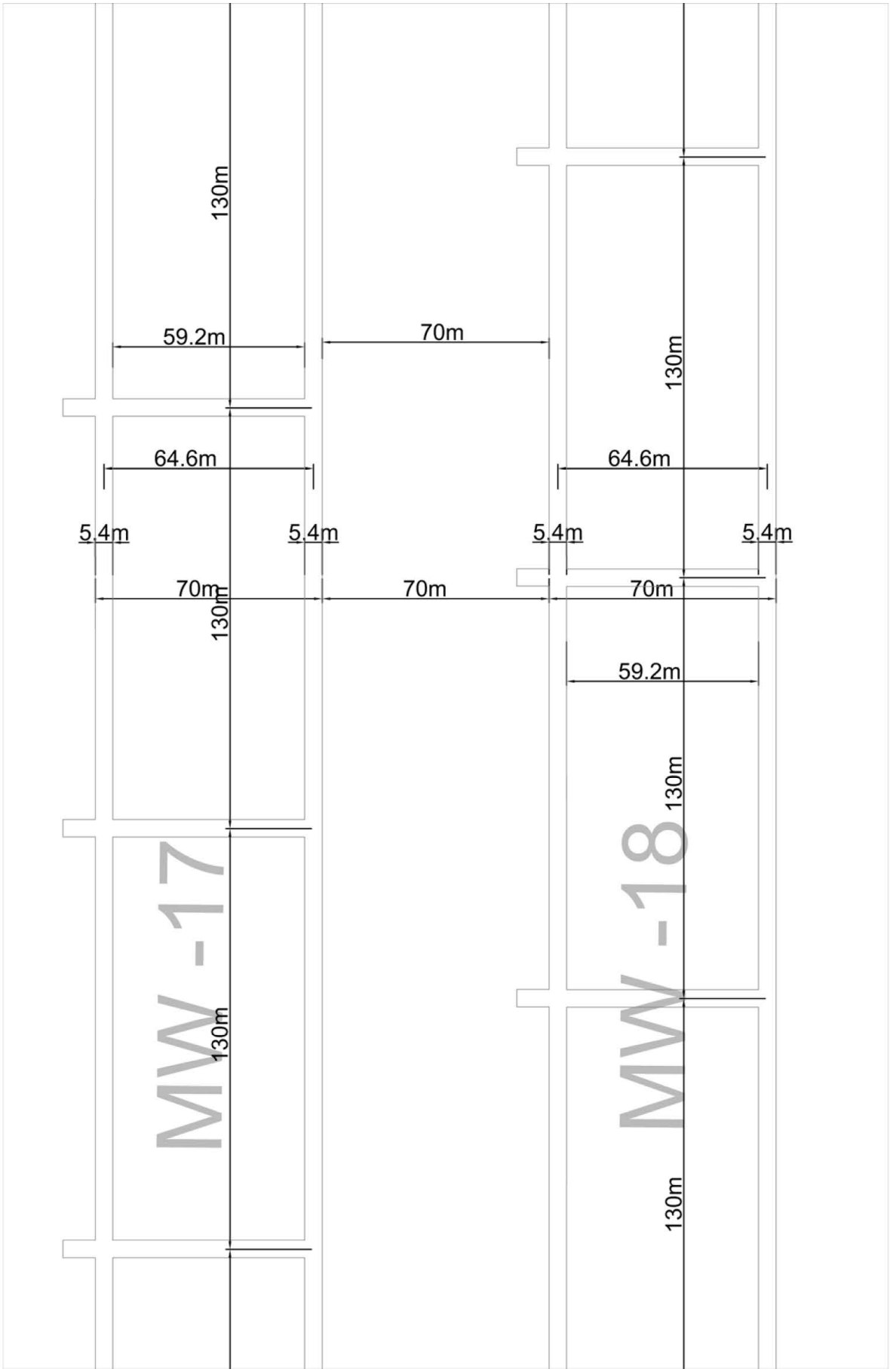
The proposed workings within the EP Area will be developed using panel and pillar (miniwall) mining methods employing continuous miners to develop narrow width panels, supported by interpanel pillars of sufficient size to be long term stable after extraction is complete.

Extraction is done using longwall type cutting equipment but with a very small number of shields due to the very narrow nature of the extraction block. The intent of the system design to provide support the surface that results in minimal subsidence movement, whilst providing a safe and productive mining system.

Miniwall extraction will commence from the eastern end of the miniwall panel and move to the west beneath the surface features. The sequence of miniwall extraction will move from north to south with MW17 being mined first and completing extraction under this Extraction Plan in MW18.

[14] See Section 2.3 Review of Previous Subsidence Predictions

**Figure 3.1: Typical Panel and Pillar Layout for the EP Area**




(source: supplied by Centennial Airly)

### 3.1.3 Mine Schedule and Resource Recovery

Miniwall mining within the EP Area will commence following the completion of mining in the Pt Hatteras (MW13-16) PPMZ EP Area, which is expected to be completed in 2023.

The EP Area includes two miniwall panels which are currently scheduled to be extracted in approximately 12 months. Secondary extraction is currently scheduled to commence in MW17 in April 2024 and complete MW18 in October 2024. The proposed panels comprising the EP Area will be developed and extracted according to the schedule in **Table 3.2**[15].

Overall expected resource recovery from the EP Area (including development and secondary extraction) is **737,992 tonnes**. The tonnages listed have been based on a design working height of 3.0m during miniwall extraction. The specific gravity of the coal (relative coal density) is 1.48. All recovery percentages are approximate only and may vary depending on final panel layout and geological restrictions.

Panels proposed to mined within the EP Area are illustrated on **Plan 1 - Existing and Future Workings.**

**Table 3.2: Indicative Mining Schedule proposed for Miniwall Panels MW17-MW18**

| Miniwall | Mine Plan | Stage | Recovery (tonnes) | Target Start (month) | Target Finish (month) |
|---|---|---|---|---|---|
| **MW17** | MG17 Development | Development | 105,990 | September 2023 | March 2024 |
| | MW17 Extraction | Secondary Extraction | 297,657 | April 2024 | July 2024 |
| **MW18** | MG18 Development | Development | 96,305 | November 2023 | June 2024 |
| | MW18 Extraction | Secondary Extraction | 238,040 | August 2024 | October 2024 |
| ***Total Expected Recovery in EP Area (MW17-MW18)*** | | Development | 202,295 | | |
| | | Secondary Extraction | 535,697 | | |
| | | **Total** | **737,992** | | |
| ***Total Available Resource in EP Area (MW17-MW18)*** | | **Total** | **1,882,700** | | |

15 The target start and finish dates are provided as an indication only, are pending approval and subject to change based on potential future operational requirements

## 3.2 Subsidence Predictions

### 3.2.1 Predicted Subsidence Effects and Subsidence Impacts

This Extraction Plan has relied on the most recently updated predictions of subsidence effects, subsidence impacts and environmental consequences. Centennial Airly, engaged MSEC to prepare a *Subsidence Predictions and Impact Assessment* to support the Extraction Plan, which included a *Cliff Impacts Assessment* for all cliffs within proximity to the extraction areas (including cliffs within the Cliff Line Zone of First Workings) based on the subsidence prediction work provided by SCT (SCT, 2023).

The subsidence prediction and impact assessment is documented in the following report:

- *MSEC (2023). Airly Mine MW17 to MW18 – Subsidence Predictions and Impact Assessments for the Natural and Built Features over and near the Proposed MWs 17 to 18 in Support of the Extraction Plan Application (MSEC1351).*

The primary management strategy being implemented by Airly Mine for the Extraction Plan is impact avoidance through the implementation of a conservative mine design, with specifically designed panel and pillar widths, to have minimal subsidence effects and prevent subsidence impacts.

Conservative setbacks to key sensitive features within the *Cliff Line Zone of First Workings* continue to be implemented for this Extraction Plan (i.e. 26.5 degree Angle of Draw). Extensive monitoring and management measures are proposed to demonstrate the subsidence modelling and effectiveness of the mining and monitoring systems.

The following sections provide brief overviews of conventional and non-conventional mine subsidence movements. [16]

***Subsidence Prediction Method***

SCT (2023) were asked to use the calibrated FLAC 2D numerical model to recommend a revised mine design that would restrict the maximum subsidence over the EP Area of MWs 17 to 18 to **a chosen upper design limit of 95mm (+/-20mm)** aligning with a more precautionary approach so that subsidence thresholds do not have the potential to be exceeded (i.e. less than the EIS prediction of 125 mm). The mine layout for MW17-18 has been designed according to the geometry and parameters modelled by SCT (2023).[17]

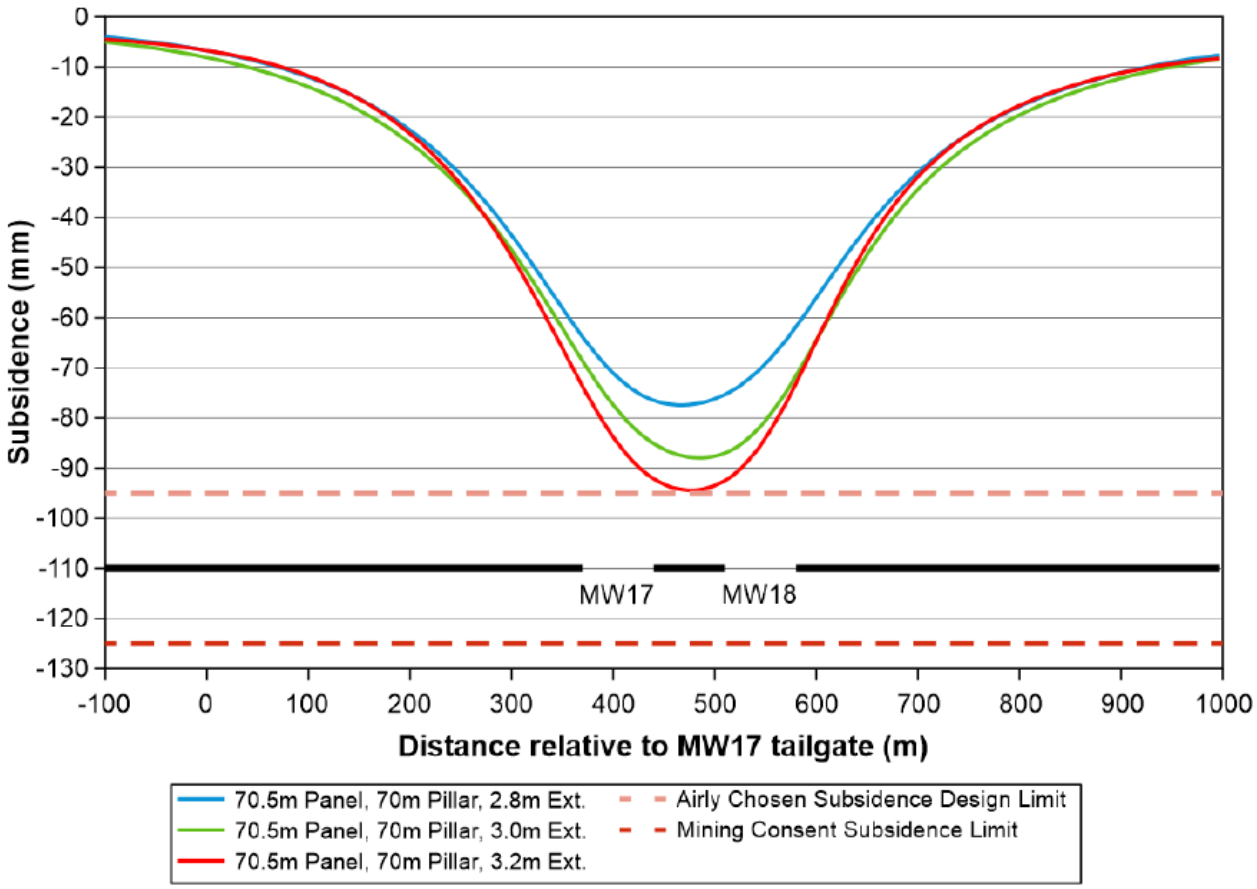
**Figure 3.2** shows the modelled subsidence profiles for the MW17 to MW18 mine design, various extraction heights were modelled for subsidence sensitivity, the proposed extraction height is 3.0m. **Figure 3.3** shows the rock failure model output for the MW17 to MW18 mine design. The model output shows little to no rock failure of strata above the pillars for the proposed 3.0m extraction height (SCT, 2023).

The FLAC 2D modelling indicated that the maximum subsidence, after MWs 17 to 18 are extracted, will be 88 mm. SCT note that a subsidence tolerance of +/-20mm should be applied to the modelled subsidence, based on subsidence tolerance / natural variability. The modelling suggests the 88mm plus 20mm tolerance may produce a maximum subsidence of 108mm. The caving and subsidence model had a depth of 260m which was determined to be representative for most of the barrier pillar.

16 See *Attachment F – Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023)* for further discussions and details, including the methods that have been used to predict these movements

17 See *Attachment E – Technical Report: Pillar Width Modelling (SCT, 2023)* for further detail on the Pillar Width Modelling Assessment

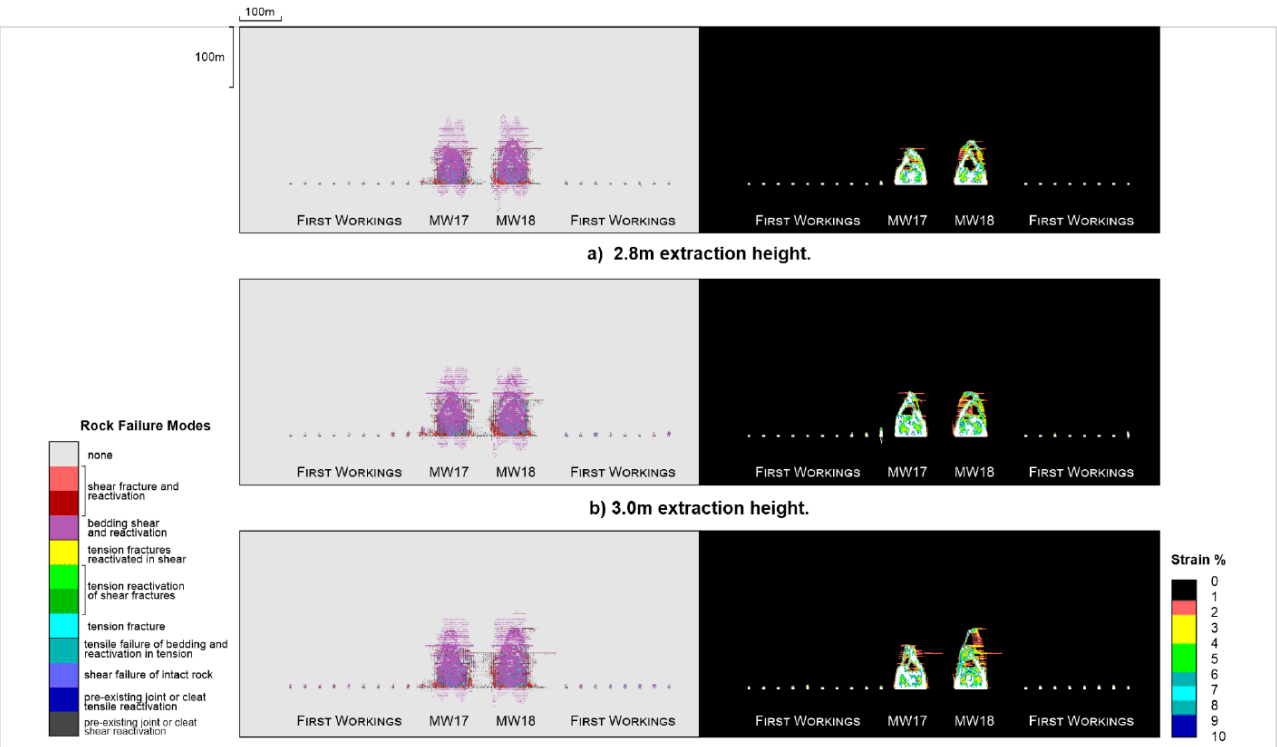
**Figure 3.2: Modelled surface subsidence profiles following MW17 and MW18 extraction**




*Note: A subsidence tolerance/natural variability of +/-20mm should be applied to the modelled subsidence*

(source: SCT, 2023)

**Figure 3.3: Mode of rock failure mode and shear strain for 70.5m panel and 70m wide pillar design**




(source: SCT, 2023)

The profiles of vertical subsidence for MW17 to MW18 have been determined by SCT (2023) based on a FLAC numerical model. MSEC has not developed a separate prediction model for the proposed miniwalls. The predicted subsidence contours have been developed by MSEC based on the 2D profiles of vertical subsidence provided by SCT using the method outlined below.

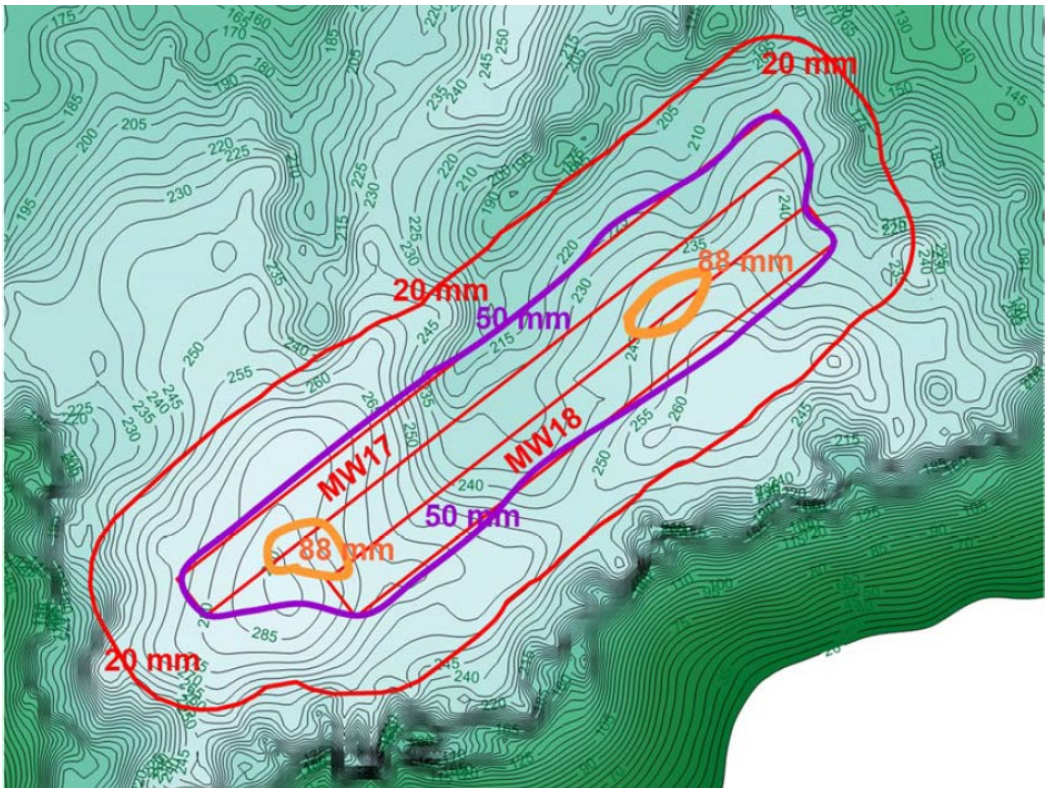
MSEC were supplied with results of modelling undertaken by SCT (2023), using the FLAC 2D programme including the predicted subsidence profiles for MW17 to MW18, along with the mine layout which was developed in accordance with the recommendations from SCT and located the edges of MWs 17 to 18 to be further than a 26.5 degrees AoD from the edge of the top of the major external cliffs.

After determining where the miniwall panel edges were to be, preliminary 20 mm, 50mm and 88 mm (maximum) predicted subsidence contour lines were prepared by MSEC. The 50mm and 88 mm predicted subsidence contours lines have been located based on the SCT modelling profiles[18], depending on the changing depth of cover where miniwall panels are to be extracted.

In their report SCT (2021b) advised that the modelled subsidence profiles present the maximum vertical subsidence for inside the extent of the mined miniwalls and the modelled subsidence profiles outside the panels overestimates the vertical subsidence due to model boundary effects. SCT recommended that empirical datasets from comparable subsidence levels should be used for setting the AoD estimates and subsidence predictions outside the panel edges. Therefore, the 20mm predicted subsidence contour line has been located based on 26.5 degrees from the edges of the mined panels. This AoD is larger than observed angles of draw from the early Mount Airly panels and is therefore considered to be a conservative estimate of the maximum extent of subsidence within the EP Area.

**Figure 3.4** shows the resulting predicted 20 mm, (the red-coloured line), 50mm and 88 mm subsidence contours lines over MWs 17 to 18.

**Figure 3.4: Predicted subsidence contour levels (using 26.5 degrees AoD as 20mm)**




(source: MSEC, 2023)

18 See **Figure 3.2**

***Predicted Conventional Subsidence Movements***

The maximum predicted vertical surface subsidence following the extraction of MWs 17 to 18 is 88mm (+/-20mm). **Table 3.3** shows the incremental subsidence effects. The predicted total subsidence effects represent the cumulative movements including the mining of adjacent and nearby completed miniwalls and workings. Airly Mine will monitor the incremental subsidence for each panel extracted to validate the model and to ensure the subsidence is within the progressive modelled subsidence.

**Table 3.3: Maximum predicted conventional subsidence effects**

| After Miniwall | Maximum predicted total vertical subsidence (mm) | Maximum predicted total tilt (mm/m) | Maximum predicted total strain (mm/m) |
|---|---|---|---|
| **MW17** | -39mm (+/-20mm) | <2.5 | <2 |
| **MW18** | -88mm (+/-20mm) | <2.5 | <2 |

***Predicted Far-Field Movements and Non-conventional Ground Movements***

The predicted far-field horizontal movements and non-conventional ground movements due the proposed MW17 to MW18 are expected to be small and could only be detected by precise surveys. Potential impacts of far-field horizontal movements and non-conventional ground movements on the natural and built features within the vicinity of the proposed miniwalls are not expected to be significant (MSEC, 2023).[19]

### 3.2.2 Potential Environmental Consequences and Impacts

The predictions and subsequent environmental consequences for the Extraction Plan are detailed in MSEC (2023), in the following key sections:

- Section 7 Descriptions, Subsidence Predictions & Impact Assessments for the Natural Features, and
- Section 8 Descriptions, Subsidence Predictions & Impact Assessments for the Built Features

The Key Sub-management Plans have been developed in consideration of the subsidence effects on the built and natural environment and with respect to the approved performance criteria under SSD_5581.

The main findings from this report are as follows:

- **Cliffs:** MSEC prepared the cliff impact assessment report for the identified cliffs over and near MWs 17 to 18. The results of this mining induced cliff impact assessment are based on knowledge gained from developing a data base of known mining induced cliff falls and a data base of the mining conditions and the monitored ground movements at many of these mining induced cliff fall sites in the Western and Southern Coalfields of NSW.

  The MSEC cliff impact assessment review was undertaken regarding the very low levels of subsidence being predicted over the identified internal cliffs and rock features that were identified and located near and over MWs 17 to 18. This review concluded that there was only an extremely low probability that cliff instabilities would occur at these identified and listed cliffs over and near the proposed MWs 17 to 18, which were mostly relatively short, isolated cliffs located over solid unmined coal areas beyond the edges of the mini wall panels.

  This cliff impact review also advised that because natural rock falls have been reported to occur regularly over time with ongoing weathering and erosion, it is not possible to guarantee that there

19 See Section 6.3 and Section 6.4 of Attachment F – Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) for discussion on far-field movements and non-conventional subsidence effects

would be no rock falls reported during the period of mining. However, there should only be occasional falls of small slabs of rock and, because of the very low levels of subsidence being predicted at the identified internal cliffs and rock features, there should be little chance of exceedance of these development approval conditions for cliffs.

Hence, as the predicted levels of subsidence over MWs 17 to 18 are similar to those provided in the 2014 EIS, i.e., the maximum predicted subsidence is less than 125 mm with no predicted surface cracking, the assessed levels of potential impact for the cliffs, are similar to those based on the EIS Layout. That is, at these predicted low subsidence levels, it is unlikely that the cliffs, pagodas and rock formations will be adversely impacted by the proposed mini wall extraction

- **Steep slopes:** The steep slopes and rock outcrops within the Study Area are throughout the Genowlan Mountain mesa. Potential impacts on these features generally occur from increased horizontal movements in the downslope direction, potentially resulting in tension cracks appearing at the tops and on the sides of the steep slopes and outcrops, compression ridges forming at the bottoms of the steep slopes, and buckling of the bedrock at the bottoms of the rock outcrops. However, given that the predicted levels of subsidence over these steep slopes and rock outcrops are very low and not greater than 88 mm, it is unlikely that the steep slopes and rock outcrops will be adversely impacted by the proposed mini wall extraction.
- **Drainage lines:** The upper reaches of Genowlan Creek are located above the proposed mining area. There are also other unnamed drainage lines that are located across the proposed mining area. These drainage lines are generally ephemeral. Since the maximum predicted subsidence is only 88 mm over these mini walls, the predicted post-mining grades along Genowlan Creek and the other drainage lines are similar to the pre-mining natural grades. It is unlikely, therefore, that there would be adverse changes in ponding or scouring resulting from the mining-related subsidence or tilt.

  It is expected that no fracturing of the bedrock is likely to be observed over the mini walls and beneath the sections of the streams that are located directly above and adjacent to the proposed mini walls. Surface water flow diversions are unlikely to occur along the sections of the streams that are located directly above and adjacent to the proposed mini walls.
- **Conservation Areas:** Most of the surface areas over Genowlan Mountain are located within the Mugii Murum-ban SCA that has significant natural and cultural heritage values and contains significant mineral resources. Two threatened ecological communities have been identified on Genowlan Point which is nearby, but beyond, the Study Area. Given the predicted low levels of subsidence over the area of mesa that is affected by the proposed extraction, the proposed extraction should not cause physical impacts (such as surface cracking) that could potentially change the environment or habitat for this natural vegetation. [20]
- **Built features:** There are **unsealed roads and tracks** located directly above the proposed mining area. It is expected that the potential effects of the low predicted subsidence levels would be negligible and unnoticeable on these roads, and these roads could be maintained in safe and serviceable condition throughout the mining period using normal road maintenance techniques.

  A **survey control mark (Trig Station)** is located near the proposed mini walls and it could experience the full range of predicted subsidence effects. It may be necessary on the completion of the proposed mini walls, when the ground has stabilised, to re-establish the positions of this state survey control marks.

[20] See Attachment G – Technical Report: Baseline Biodiversity Assessment (RPS, 2023) and MW17-18 BMP (Appendix 3) for further discussion on the natural vegetation and potential for subsidence related impacts

# 4 MONITORING PROGRAM

An integrated Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) has been developed as a component of the Extraction Plan in accordance with Condition 7.(i)(i) in Schedule 3 of SSD_5581.

The purpose of the Subsidence Monitoring Program is to set out the program for monitoring the subsidence movements and effects associated with second workings within the EP Area and to provide consolidated summaries of monitoring for natural and built features.

An overview of the Subsidence Monitoring Program is provided in the sections below.

## 4.1 Subsidence Effects Monitoring Program

**Table 4.1** provides a summary of the subsidence monitoring program that will be undertaken to monitor and manage the effects of subsidence within the EP Area. All forms of subsidence monitoring will be undertaken by appropriately qualified and experienced personnel. The results from the subsidence monitoring program will be evaluated by appropriately qualified and experienced personnel against the performance measures and subsidence predictions.

The primary objective of the mine design is to prevent any significant mine induced risk to surface features by providing low levels of subsidence. This minimises potential for environmental impacts and allows built features to remain safe, serviceable and repairable. Accordingly, adherence to the final mine design during implementation (mining) will be monitored as part of Underground Mining Controls.

**Table 4.1: Subsidence Monitoring Program Summary**

| **Monitoring Component / Feature** (Management Plan) | **Purpose/Parameter** | **Monitoring Method** | **Frequency & Duration** |
|---|---|---|---|
| **Underground Mine Control** | Confirm that formation of underground workings for development and extraction is implemented as per approved designs | Underground survey of chain pillar / workings as completed in the active panel<br>Visual inspections<br>Overlay of 'as built' pillars (as surveyed) against designs | During mining: Up to weekly in active working areas during mining<br>Post Mining: Final inspection of pillars at completion of active panel, additional post mining inspections for accessible pillars in the Extended Monitoring and Management Area (Cliff Line Zone of First Workings) |

| Monitoring Component / Feature (Management Plan) | Purpose/Parameter | Monitoring Method | Frequency & Duration |
|---|---|---|---|
| **Airly Mine GNSS Monitoring Stations** | Continuous occupation monitoring, including for baseline, at key locations / surface features (e.g. large cliffs, valley closure measurements, built features, public access areas, pseudo 'transverse' and 'longitudinal' lines) | Continuous near real time point data (raw data set at 10 second intervals) using the Global Navigation Satellite System (GNSS) | Baseline: Installed prior to secondary extraction commencement, continuous data from installation through to commencement of secondary extraction of nearest panel (i.e. some stations far from MW17 will continue to provide baseline until mining comes nearer)<br>During mining: Continuous throughout extraction MW17-MW18<br>Post Mining: GNSS stations will remain in-situ until consistent results are obtained demonstrating completion of major subsidence movement (i.e. within survey error) following completion of panels MW17-MW18 |
| **LiDAR** | Differential subsidence measure between each monitoring event ('epochs') across large areas. Vertical subsidence movements monitoring of 'broad-area' (typically >50mm at high confidence levels) relative to previous monitoring events ('epochs') | High resolution (40 points per square meter) LiDAR survey georeferenced to GNSS monitoring stations | Baseline: At least two surveys undertaken prior to miniwall extraction.<br>During Mining: At least one survey throughout extraction MW17-MW18<br>Post Mining: At least one survey will be undertaken following completion of panels MW17-MW18. No further detailed analysis after post mining survey has indicated negligible impacts (in the undermined area). |
| **Targeted visual surface inspection** | Complementary supportive monitoring | Visual inspection of relevant area/location where safely accessible | Only if triggered as per MW17-18 Master TARP triggers |

## 4.2 Environmental Monitoring Program

### 4.2.1 Surface Water Monitoring

The Airly Mine Water Management Plan (WMP) (GHD, 2023) has been developed to meet broader relevant approvals and licensing requirements for the mine beyond the EP Areas. In consultation with DPE, Airly Mine has submitted the WMP to also meet the requirements for the Water Management Plan required for the Extraction Plan in accordance with Condition 7 (i) iii in Schedule 3 of SSD_5581. A summary of the details relevant to this Extraction Plan is provided below.[21]

Surface water features are confined to the small ephemeral upper drainage lines located within the EP Area (primarily first order and one second order), which are illustrated on **Figure 1.2**.

***Baseline***

The extent of baseline data considered for surface water quality data relevant to the EP Area includes:

- **Gap Creek**. Period from 11/07/2012 to 23/05/2018
- **The Grotto**. Period from 11/07/2012 to 22/05/2018
- **Genowlan Creek 2**. Period from 18/01/2018 to 23/05/2018

Baseline surface water flow date have been collected at the Gap Creek monitoring site, from February 2013 to July 2018 and at the Genowlan Creek monitoring site, from February 2013 to June 2018. Flows at Gap Creek and Genowlan Creek are primarily rainfall-dependent.

A baseline assessment of geomorphology at Airly Mine was undertaken for the Airly Mine Extension Project (GHD, 2014). Due to the relatively undisturbed nature of the area, the geomorphic condition of the assessed streamlines are generally in good condition. Baseline aquatic ecology monitoring at Airly Mine has been undertaken within Gap Creek, Genowlan Creek, Airly Creek, Torbane Creek and Dog Trap Creek on ten (10) occasions between 2013 and 2018. Overall, the aquatic habitat in Genowlan Creek was determined to be in the best condition (GHD, 2017).

Baseline surface water monitoring data is detailed in Section 5.1 and Section 5.4 of the WMP.

***Monitoring Summary***

The WMP provides information on (but not limited to) the following surface water monitoring:

- Surface water quality;
- flow monitoring and stream health monitoring, including geomorphic condition; and
- watercourse stability as well as aquatic ecology monitoring.

**Table 4.2** provides a summary of the monitoring program for surface water within the EP Area. Monitoring results are compared with the detailed performance criteria which have been developed from baseline information and the water management performance measures specified by Table 6 of development consent SSD-5581.

21 See Appendix 1 – Airly Mine Water Management Plan for further details

**Table 4.2: Surface Water Monitoring Program Summary**

| Monitoring Component / Feature (Management Plan) | Purpose/Parameter | Monitoring Method | Frequency & Duration |
|---|---|---|---|
| **Surface water flow and quality** | Evidence of subsidence impacts compared to baseline records | Undertake surface water quality monitoring in accordance with section 4.2 of the WMP | Undertake surface water quality monitoring in accordance with section 4.2 of the WMP |
| **Stream Health** | Evidence of subsidence impacts compared to baseline records | Undertake stream health monitoring in accordance with section 4.5 of WMP | Undertake stream health monitoring in accordance with section 4.5 of WMP |

### 4.2.2 Groundwater Monitoring

The site WMP was developed in consultation with relevant stakeholders and was originally finalised during 2017. The most recent revision of the WMP was developed in consultation with relevant stakeholders and in consideration of the mine design for the EP Area. Aquifers and groundwater systems are outlined in the WMP.

The purpose of the WMP is to detail monitoring and management measures to be implemented for groundwater values (including groundwater levels and quality, groundwater seepage, underground water transfers and stygofauna) within the Airly Mine Development Consent Area, including the EP Area.

No Groundwater Dependent Ecosystems (GDE's) have been identified within the EP Area. Facultative[22] ecosystems do occur, however these are primarily in the Extended Monitoring and Management Area. Regardless, no significant impact to the surface or sub-surface in these areas (including no expected cracking) results in no predicted impacts for these features.

***Baseline***

The extent of baseline data considered for groundwater levels and quality data is provided in **Table 4.3**.

**Table 4.3: Details of the extent of baseline groundwater quality data**

| Location | Period from | Period to | Number of points |
|---|---|---|---|
| **AM2B-1 (production bore)** | 11/07/2012 | 04/06/2018 | 6–68 |
| **ARP05** | 11/07/2012 | 06/09/2017 | 5–43 |
| **APR09** | 19/09/2013 | 22/12/2014 | 1–5 |
| **Nioka** | 18/12/2013 | 18/04/2018 | 2–4 |
| **Village Spring** | 09/08/2010 | 18/04/2018 | 4–79 |
| **ARP11** | 18/05/2017 | 20/06/2018 | 2–11 |
| **ARP13SP** | 18/05/2017 | 19/06/2018 | 2–9 |
| **ARP14** | 17/05/2017 | 19/06/2018 | 2–13 |
| **ARP15SP** | 17/05/2017 | 19/06/2018 | 2–11 |

Note that ARP07 and ARP12 have been consistently dry since installation and therefore no baseline groundwater data are presented for these sites. Water in ARP08 is assumed to be residual water from drilling and therefore no baseline data are presented for ARP08.

22 These vegetation communities occur within shallow aquifer zones, and whilst not strictly considered GDE's there is potential to have some reliance on groundwater on a seasonal basis or only during extended drought periods.

The seepage of groundwater into the existing underground workings has been reported by Centennial Airly to be negligible. Limited dewatering of the underground has occurred to date.

Baseline groundwater monitoring data is detailed in Section 5.3 of the WMP.

***Monitoring Summary***

The WMP presents a broader environmental monitoring program within the Development Consent Area including the current EP Area, rather than monitoring specifically required or proposed for the EP Area. Groundwater features and monitoring locations under the WMP and related *MW17-18 SMP* are illustrated in the WMP.

The WMP provides information on (but not limited to) the following groundwater monitoring:

- water quality and levels in the established groundwater piezometer network;
- underground water transfers; and
- stygofauna monitoring.

**Table 4.4** provides a summary of the monitoring program for groundwater within the EP Area.

**Table 4.4: Groundwater Monitoring Program Summary**

| **Monitoring Component / Feature** (Management Plan) | **Purpose/Parameter** | **Monitoring Method** | **Frequency & Duration** |
|---|---|---|---|
| **Groundwater extraction, levels, quality** | Confirm impacts of mining are consistent with hydrogeological model predictions | Undertake groundwater quality monitoring in accordance with section 4.4.1 of the WMP | Undertake groundwater quality monitoring in accordance with section 4.4.1 of the WMP |

### 4.2.3 Landform Monitoring

The Land Management Plan for MW17-18 (MW17-18 LMP) has been developed as a key component of the Extraction Plan in accordance with Condition 7.(i)(v) in Schedule 3 of Development Consent SSD_5581, and is contained in Appendix 2.

The purpose of the Land Management Plan is to provide the management strategies, controls and monitoring programs to be implemented for the management of potential subsidence impacts on landscape features that will be potentially affected by the secondary extraction of MW17-18.

The landscape features managed by the Land Management Plan are cliffs, minor cliffs and pagodas, the general surface area of the Mugii Murum-ban SCA (which includes steep slopes and rock outcrops) and the deeply incised canyons/gorges, including the area known as the Grotto.

***Baseline***

Baseline monitoring of natural features as they relate to land within the EP Area has commenced and will be obtained by using a combination of the following methods:

- The installation of the GNSS network will be completed following receipt of necessary approvals with baseline continuous data from installation through to commencement of secondary extraction of nearest panel.
- High resolution stereo vertical photogrammetry baseline flown in May 2020, November 2020, May 2021, May 2022 and December 2022.
- High resolution 3D oblique photogrammetry baseline flown in May 2020, November 2020, May 2021, May 2022 and December 2022.

***Monitoring Summary***

The land features managed by the MW17-18 LMP for the EP Area are detailed in **Table 4.5** along with their relevant monitoring programs.

**Table 4.5: Landform Monitoring Program Summary**

| Monitoring Component / Feature (Management Plan) | Purpose/Parameter | Monitoring Method | Frequency & Duration |
|---|---|---|---|
| **Cliffs, Minor Cliffs & Pagodas** | Presence/absence of mine-induced damage or change to features (significant rock falls and surface cracking)<br>Various Parameters relevant to each method | LiDAR | Remote aerial monitoring is undertaken at approximately six-month intervals. At least 2 surveys will have been undertaken prior to miniwall extraction. At least one survey throughout extraction MW17-MW18 and at least one survey will be undertaken following completion of panels MW17-MW18. No further detailed analysis after post mining survey has indicated negligible impacts (in the undermined area). |
| | | Targeted GNSS Monitoring Stations | Installed prior to commencement, continuous data from installation, throughout extraction of MW17-MW18 and will remain in-situ until consistent results are obtained demonstrating completion of major subsidence movement (i.e. within survey error) following completion of panels MW17-MW18 |
| | | Targeted visual surface inspections | Only if triggered as per MW17-18 Master TARP triggers |
| **General Land Surface (excl. cliffs and pagodas)** | Evidence of subsidence impacts compared to baseline records | LiDAR | Remote aerial monitoring is undertaken at approximately six-month intervals. At least 2 surveys will have been undertaken prior to miniwall extraction. At least one survey throughout extraction MW17-MW18 and at least one survey will be undertaken following completion of panels MW17-MW18. No further detailed analysis after post mining survey has indicated negligible impacts (in the undermined area). |
| | | Targeted GNSS Monitoring Stations | Installed prior to commencement, continuous data from installation, throughout extraction of MW17-MW18 and will remain in-situ until consistent results are obtained demonstrating completion of major subsidence movement (i.e. within survey error) following completion of panels MW17-MW18 |
| | | Targeted visual surface inspections | Only if triggered as per MW17-18 Master TARP triggers |

| Monitoring Component / Feature (Management Plan) | Purpose/Parameter | Monitoring Method | Frequency & Duration |
|---|---|---|---|
| **The Grotto** | Evidence of subsidence impacts compared to baseline records | LiDAR | Remote aerial monitoring is undertaken at approximately six-month intervals. At least 2 surveys will have been undertaken prior to miniwall extraction. At least one survey throughout extraction MW17-MW18 and at least one survey will be undertaken following completion of panels MW17-MW18. No further detailed analysis after post mining survey has indicated negligible impacts (in the undermined area). |
| | | Targeted GNSS Monitoring Stations | Installed prior to commencement, continuous data from installation, throughout extraction of MW17-MW18 and will remain in-situ until consistent results are obtained demonstrating completion of major subsidence movement (i.e. within survey error) following completion of panels MW17-MW18 |
| | | Undertake surface water flow and quality monitoring in accordance with section 4.2 of the WMP | Undertake surface water flow and quality monitoring in accordance with section 4.2 of the WMP |
| **Walking and 4WD tracks** | Evidence of subsidence impacts compared to baseline records | LiDAR | Remote aerial monitoring is undertaken at approximately six-month intervals. At least 2 surveys will have been undertaken prior to miniwall extraction. At least one survey throughout extraction MW17-MW18 and at least one survey will be undertaken following completion of panels MW17-MW18. No further detailed analysis after post mining survey has indicated negligible impacts (in the undermined area). |
| | | Targeted visual surface inspections | Only if triggered as per MW17-18 Master TARP triggers |

### 4.2.4 Biodiversity Monitoring

The Biodiversity Management Plan for MW17-18 (MW17-18 BMP) has been developed as a key component of the Extraction Plan in accordance with Condition 7.(i)(iv) in Schedule 3 of SSD_5581, and is contained in Appendix 3.

The purpose of the Biodiversity Management Plan is to provide the management strategies, controls and monitoring programs to be implemented for the management of potential subsidence impacts on aquatic and terrestrial flora and fauna[23] affected by the secondary extraction of MW17-18.

23 With a specific focus on threatened species populations and their habitats, Endangered Ecological Communities (EEC) and Groundwater Dependent Ecosystems (DGE's)

***Baseline***

The Biodiversity Management Plan was informed by a Baseline Ecology Assessment developed by RPS for the EP Area with the purpose of reviewing the relevant biodiversity information within the region.[24]

***Monitoring Summary***

The biodiversity features managed by the MW17-18 BMP for the EP Area are detailed in **Table 4.6** along with their relevant and monitoring programs.

**Table 4.6: Biodiversity Monitoring Program Summary**

| Monitoring Component / Feature (Management Plan) | Purpose/Parameter | Monitoring Method | Frequency & Duration |
|---|---|---|---|
| **Terrestrial Ecology** | Evidence of subsidence impacts compared to baseline records | Terrestrial Ecology monitoring is undertaken in accordance with the Section 5 of the MW17-18 BMP | Terrestrial Ecology monitoring is undertaken in accordance with the Section 5 of the MW17-18 BMP |
| **Aquatic Ecology** | Evidence of subsidence impacts compared to baseline records | Aquatic Ecology monitoring is undertaken in accordance with Section 4.5.2 of the WMP | Aquatic Ecology monitoring is undertaken in accordance with Section 4.5.2 of the WMP |

### 4.2.5 Heritage Monitoring

**There are no known Aboriginal and cultural heritage sites in the MW17-18 PPMZ Extraction Plan Area.**

As agreed with stakeholders, Centennial Airly will operate under the existing Western Region Aboriginal Cultural Heritage Management Plan (ACHMP) and the Western Region Historic Heritage Management Plan (HHMP) which were developed in consultation with OEH and key stakeholders in accordance with Condition 19 in Schedule 4 of SSD_5581.

The Western Region ACHMP and Western Region HHMP outline the mitigation measures and management protocols relevant to the operation, including protocols for unexpected finds. The Western Region ACHMP and Western Region HHMP are available on the Airly website. [25]

***Baseline***

This Extraction Plan was informed by a Baseline Historic Heritage Assessment (RPS, 2022a) and Baseline Aboriginal Heritage Assessment (RPS, 2022b) with the purpose of reviewing the relevant biodiversity information within the region.[26]

***Monitoring Summary***

Not relevant to the Extraction Plan.

24 See Attachment G – Technical Report: Baseline Biodiversity Assessment (RPS, 2023)

25 See https://www.centennialcoal.com.au/operations/airly/

26 See Section 2.2.5, Attachment H - Technical Report: Baseline Historic Heritage Assessment (RPS, 2022a) and Attachment I – Technical Report: Baseline Aboriginal Heritage Assessment (RPS, 2022b) for further details

### 4.2.6 Public Safety Management Plan / Principal Hazard Management Plan

The Public Safety Management Plan for MW17-18 (MW17-18 PSMP) has been developed as a key component of the Extraction Plan in accordance with Condition 7.(i)(vii) in Schedule 3 of SSD_5581, and is contained in Appendix 4.

The purpose of the Public Safety Management Plan is to provide the management strategies, controls and monitoring programs to be implemented for the management of potential subsidence impacts that may affect public safety, specifically from the secondary extraction of MW17-18.

Panel and pillar mining within the EP Area is not considered a principal hazard.[27] Notwithstanding, the Public Safety Management Plan has also been prepared with consideration of the requirements of the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2022* (Section 28) to manage subsidence as principal mining hazard. Regulatory requirements applicable to the development of the Public Safety Management Plan to manage subsidence related risks to public safety, including to private property and public infrastructure are outlined in the Public Safety Management Plan.

The performance measure for public safety requires negligible additional risk, in consultation with the Resources Regulator and BCD. It is not expected that there would be any adverse impacts on natural and built surface features within the EP Area which have relevance to public safety. In addition to the Public Safety Management Plan, the features identified within the EP Area relevant to public safety are also managed under other supporting plans as noted in **Table 4.7**.

**Table 4.7: Public Safety Features within the EP Area and Relevant Management Plans**

| Feature | Identification and Assessment | Management and Monitoring [a] |
|---|---|---|
| **Cliffs, minor cliffs and pagodas** | Section 2.4, Section 3.2 and Section 4.2.3 | Land Management Plan for MW17-18<br>Subsidence Monitoring Program for MW17-18<br>Trigger Action Response Plan for MW17-18 |
| **Mugii Murum-ban SCA, including Steep Slopes and Rock Outcrops** | Section 2.4, Section 3.2 and Section 4.2.3 | Land Management Plan for MW17-18<br>Subsidence Monitoring Program for MW17-18<br>Trigger Action Response Plan for MW17-18 |
| **Walking and 4WD tracks** | Section 2.4, Section 3.2 and Section 4.2.3 | Subsidence Monitoring Program for MW17-18<br>Trigger Action Response Plan for MW17-18 |

a) in addition to the Public Safety Management Plan for MW17-18 (MW17-18 PSMP)

27 See Section 2.1.2, sub-heading Subsidence as a Principal Hazard

## 4.3 Ongoing Baseline Data Collection Program

Complementary environmental monitoring associated with ongoing existing programs required separately to the Extraction Plan (e.g. for site-wide management plans requires separately by Development Consent) provide useful baseline and monitoring information for the EP Area. This includes downstream surface waters, groundwater, biodiversity and aquatic ecology and stream health monitoring.

An outline and overview of environmental monitoring programs to monitor potential subsidence impacts and environmental consequences within the EP Area and over the site as a whole includes:

- **Airly Mine Water Management Plan**:
    - The Airly Mine Water Management Plan (WMP) (GHD, 2023) has been developed to meet broader relevant approvals and licensing requirements for the mine beyond the EP Areas. Monitoring described within the WMP includes:
        - Surface water monitoring
        - Groundwater monitoring
        - Aquatic ecology and stream health
- **Biodiversity Management Plan:**
    - A broadscale Biodiversity Monitoring Program is currently being undertaken at Airly within the Development Consent Area (SSD_5581) as per the Western Region Biodiversity Management Plan – Appendix B Airly (Centennial 2019a) required by consent condition 15, Schedule 4, including;
        - Threatened vegetation communities monitoring
        - Threatened flora monitoring
        - Threatened fauna monitoring
- **Remote monitoring of the Surface Environment**:
    - Remote monitoring is undertaken in areas ahead of proposed secondary extraction to be conducted concurrently with monitoring detailed in the MW17-18 Extraction Plan, including future extraction areas, and includes;
        - LiDAR (High Resolution 40 points per square meter)
        - Cliff mapping and ground truthing assessments.
- **Monitoring ground movement:**
    - The Global Navigation Satellite System (GNSS) Monitoring Stations / Continually Operating Reference Station (CORS) which provide long occupation real time point data will be installed prior to secondary extraction commencement and provide continuous data from installation through to commencement of secondary extraction of nearest panel (i.e. some stations far from MW17 will continue to provide baseline until mining comes nearer)

# 5 MANAGEMENT, MITIGATION, REMEDIATION AND REPORTING MEASURES

## 5.1 Performance Measures and Indicators

Performance measures for subsidence for the Airly Mine are outlined in Condition 2 in Schedule 3 of Development Consent SSD_5581[28]. **Table 5.1** presents the performance measures and indicators that have been used when developing the management strategies incorporated in this Extraction Plan and supporting sub-plans.

**Table 5.1: Subsidence Impact Performance Measures and Indicators – Key Relevant Features**

| Feature | Performance Measure (Approved Impact) | Performance Indicator |
|---|---|---|
| **Gap and Genowlan Creeks** | Negligible environmental consequences to water quality and to bed and bank stability | Watercourse quality within or below trigger values developed with reference to historical monitoring data |
| | No greater environmental consequences than predicted in the EIS to water flows (including baseflow) | Watercourse flow volumes within or above historical monitoring data |
| **Groundwater** | Consistent with hydrogeological model predictions | Groundwater level above trigger values (i.e. drawdown less than predicted) |
| | | Groundwater quality within or below trigger values |
| | | Groundwater inflows consistent with predictions |
| | | No complaints regarding groundwater access or quality |
| **Stream Health** | Negligible environmental consequences to bed and bank stability for Gap and Genowlan Creeks. | Bed and bank stability maintained or improved |
| | | Erosional processes do not occur as a result of subsidence |
| | | Change in stream gradient does not vary beyond predictions of subsidence modelling |
| | | No connective cracking between the surface and underground workings |
| | | Riparian, channel and environmental scores relating to riparian and instream vegetation within historical range and/or consistent with reference sites |
| **The Grotto** | Negligible subsidence impacts or environmental consequences | Presence/absence of mine-induced damage or change to features (no significant rock falls or surface cracking)<br>Watercourse flow volumes within or above historical monitoring data |

28 Measures relating to natural and heritage features are presented in Table 1 and measures relating to built features and public safety are presented in Table 2

**Table 5.1: Subsidence Impact Performance Measures and Indicators – Key Relevant Features (continued)**

| Feature | Performance Measure (Approved Impact) | Performance Indicator |
|---|---|---|
| **Cliffs** within a 26.5 degree angle of draw of the Airly underground mine workings | No greater subsidence impacts or environmental consequences than predicted in the EIS *(i.e. occasional falls, displacement or dislodgment of boulders or slabs of less than 30m$^3$, or fracturing, that do not impact Aboriginal heritage, EECs or public safety*), that in total do not impact more than 2% of the total area of such cliffs. | Presence/absence of mine-induced damage or change to features (significant rock falls and surface cracking)<br>Various Parameters relevant to each monitoring method |
| **Pagodas** within a 26.5 degree angle of draw of the Airly underground mine workings (other than pagodas affected by the New Hartley interaction zone) | | |
| **Minor Cliffs** | No greater subsidence impacts or environmental consequences than predicted in the EIS | |
| **Steep slopes** | | |
| **All other land** not covered by a performance measure above | | |
| Walking and 4WD tracks | Use should be maintained wherever practicable in consultation with BCD<br>Damage must be fully repairable and must be fully repaired | Presence/absence of mine-induced damage or change to features (significant rock falls and surface cracking)<br>Various Parameters relevant to each method |
| Threatened species, threatened populations, EECs and Groundwater Dependent Ecosystems (GDEs), with the exception of those listed below | Negligible environmental consequences | Evidence of subsidence impacts compared to baseline records |
| Public Safety | Negligible additional risk, in consultation with the Resources Regulator and BCD | Presence/absence of mine-induced damage or change to features (significant rock falls and surface cracking)<br>Various Parameters relevant to each method |

### 5.1.1 Performance Measures for Mine Design and Underground Mining Control

The primary objective of the mine design is to prevent any significant mine induced risk to surface features by providing low levels of subsidence. This minimises potential for environmental impacts and allows built features to remain safe, serviceable and repairable. Accordingly, adherence to the final mine design during implementation (mining) will be monitored as part of Underground Mining Controls[29]. The minimum performance measures for mine design parameters have been used as Condition Red trigger levels within the MW17-18 Master TARP.

The minimum performance measures for mine design parameters for the current EP Area are based on the commitments in the Consent, EIS or most recent subsidence assessments. The mine design parameters which will be monitored as underground mining control are detailed below in **Table 5.2**.

29 See Section 4.1 for a summary of underground mining control monitoring and MW17-18 SMP (Appendix 5) for details

**Table 5.2: Underground Mine Design Requirements – Panel and Pillar Mining Zone**

| Design/Control Aspect | Minimum Performance Measure for the current EP |
|---|---|
| Mining System Type(s) | Miniwall panels<br>*(sub-critical, partial extraction)* |
| Final Pillar Stability | Long Term Stable |
| Design Cover Depth Range | 160-310m |
| Nominal Mining Height (m)[a] | <3.0m |
| Nominal Maximum Roadway Width (m)[a] | 5.5m |
| Nominal Maximum Void Width for narrow panel extraction (m)[a] | 70.5m |
| Formation of Pillars (Centres) | Final pillars 70m solid interpanel pillars |
| Nominal Chain Pillar Width to Height Ratio (average across panel)[a] | >9 |
| Minimum Pillar System Factor Of Safety (FOS) | ≥1.6 |
| Predicted Maximum Panel Subsidence (mm) | Maximum ≤125mm |
| Setbacks[b] from cliffs identified in the Cliff Line Zone of First Workings | No second workings within an angle of draw of 26.5 degrees of the crest of any cliffs[c]<br>*EIS assessments undertaken for 8 degrees AOD.* |

a) on average across panel system as mined

b) in accordance with Condition 1 in Schedule 3 of SSD_5581

c) cliffs as defined by Aerometrex (2021) and inspected by MNC (2022) based on definitions of consent SSD_5581

## 5.2 Management and Mitigation Measures

Centennial has developed an integrated, holistic approach to subsidence management for key risks within its operations at a regional, site and EP Area level to provide an appropriate and systematic management approach.

- Regional management plans provide a framework for strategic management under which site plans and EP Area plans are established in accordance with consent conditions.
- Site management plans typically cover all aspects of mining operations (including surface operations and non-subsidence related aspects) as required by other conditions of the development consent.
- Management Plans for individual EP Areas (key sub-plans) are developed specifically to address Condition 7 (Extraction Plan) in Schedule 3 of SSD_5581 which has a specific focus in terms of both location and context as well as environmental management of subsidence and underground mining operations specifically related to the EP Area.

The key sub-management plans submitted as part of this Extraction Plan include:

- Airly Mine Water Management Plan;
- Land Management Plan for MW17-18;
- Biodiversity Management Plan for MW17-18;
- Public Safety Management Plan for MW17-18; and.
- Subsidence Monitoring Program for MW17-18.

The plans have been developed using a risk-based approach to address the management of potential subsidence-related impacts within the EP Area. Consultation with government agencies and has been undertaken as required under Development Consent SSD_5581 as summarised in **Table 5.3**.

A copy of each sub-management plan is supplied in Appendix 1 to Appendix 5 of this Extraction Plan. Centennial Airly have undertaken a dedicated subsidence and environmental risk assessment for the EP Area including reference to related risk assessments and supporting studies[30] and has consulted with key stakeholders to determine the content of relevant sub-plans.[31]

**Table 5.3: Sub-management Plans, Consultation and Status at time of EP Submission**

| Management Plan | Summary of Consultation | | | | Status at EP Submission |
|---|---|---|---|---|---|
| | *Consultation Required* [a] | *Comments Invited from* [b] | *Comments Received by* | *Comments / Issues Raised* [c] | |
| Airly Mine Water Management Plan | BCD and the Water Division | Existing Airly Mine WMP prepared originally in 2017 (consulted EPA, OEH, Water NSW and DPI Water). [d] | N/A | As detailed in Appendix A and Appendix B in the Airly Mine WMP | **Final** |
| Land Management Plan for MW17-18 | IEP, Resources Regulator and BCD | DPE / IEP Resources Regulator<br>BCD<br>NPWS | IEP – 28 July 2023<br>Resources Regulator – 14 March 2023<br>BCD – 27 March 2023, 31 July 2023 & 5 Oct 2023<br>NPWS – 31 July 2023 & 28 Sep 2023 | Nil (to date) | **Final** |
| Biodiversity Management Plan for MW17-18 | DoEE and BCD | DoEE<br>BCD<br>NPWS | BCD – 27 March 2023, 31 July 2023 & 5 Oct 2023<br>NPWS – 31 July 2023 & 28 Sep 2023 | Nil (to date) | **Final** |
| Public Safety Management Plan for MW17-18 | IEP, Resources Regulator and BCD | DPE / IEP Resources Regulator<br>BCD<br>NPWS | IEP – 28 July 2023<br>Resources Regulator – 14 March 2023<br>BCD – 27 March 2023, 31 July 2023 & 5 Oct 2023<br>NPWS – 31 July 2023 & 28 Sep 2023 | IEP recommended considering further controls for public safety including controlling access to extraction areas if triggered. MW17-18 PSMP and MW17-18 Master TARP updated accordingly | **Final** |
| Subsidence Monitoring Program for MW17-18 | IEP, Resources Regulator and BCD | DPE / IEP Resources Regulator<br>BCD<br>NPWS | IEP – 28 July 2023<br>Resources Regulator – 14 March 2023<br>BCD – 27 March 2023, 31 July 2023 & 5 Oct 2023<br>NPWS – 31 July 2023 & 28 Sep 2023 | NPWS requested GNSS subsidence monitoring data is provided quarterly and recommended two additional GNSS units. MW17-18 SMP updated accordingly | **Final** |

*a) in accordance with Condition 7 in Schedule 3 of development consent SSD_5581*

*b) Management Plans to be distributed to relevant agencies concurrently with submission to DPE*

*c) Note, other recommendations to Airly, which are non-specific to the sub-management plans, have been addressed within this version of the Extraction Plan and sub-management plans, as detailed in Attachment D – Stakeholder Consultation.*

*d) The site WMP was developed in consultation with relevant stakeholders and was originally finalised during 2017. The most recent revision of the WMP has been developed in consultation with relevant stakeholders and in consideration of the mine design for the EP Area. Consultation and approval of the Airly Mine Water Management Plan is separate to the Extraction Plan approval process.*

30 See Section 2.4, Attachment C – Subsidence and Environmental Risk Assessment and Attachment E to Attachment I
31 See Section 2.6 and Attachment D – Stakeholder Consultation

## 5.3 Remediation and Rehabilitation Measures

Due to the minimal subsidence expected the need to implement remediation/rehabilitation measures for potential impacts are considered unlikely. However, in the event that remediation is required, Airly Mine will undertake remediation in accordance with:

- Conditions 7a)-7c) in Schedule 6 of SSD_5581, noting in particular the requirement to submit a report to DPE describing remediation options and any preferred remediation measures or other course of action;
- Any relevant actions prescribed in the *MW17-18 Master TARP* developed for this Extraction Plan (or other relevant plans of management);
- The current Mining Operations Plan and Rehabilitation Management Plan; and
- In consultation with key stakeholders including any affected land holders and relevant government agencies.

A Response Strategy will be adopted if a significant impact is detected as a result of mining activities within the Extraction Plan area.

## 5.4 Master Trigger Action Response Plan

A detailed Master Trigger Action Response Plan for MW17-18 (MW17-18 Master TARP) has been developed for the Extraction Plan to reflect the commitments of this Extraction Plan and supporting sub-management plans[32]. Whilst impacts are not predicted nor expected, the MW17-18 Master TARP provides a process of tiered and escalating trigger levels for contingency measures should subsidence and impacts be greater than predicted/approved. The MW17-18 Master TARP applies only to the EP Area (separate TARPs apply to other established EP Areas in various approved mining zones).

Given the mine design specifically to avoid impacts, the MW17-18 Master TARP includes detailed measures for **Underground Mining Controls** to ensure that the mining geometry is formed as per the approved design specifications that determine the predicted subsidence movements and impacts.

Detailed performance indicators to meet Performance Measures set by development consent SSD_5581 are outlined in the Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) and incorporated into relevant aspects of the MW17-18 Master TARP. The contingency plan where a performance indictor has been exceeded is outlined in the MW17-18 Master TARP. A trigger will result in additional investigations to determine if the exceedance is related to non-mining-factors or is a consequence of mining activity. The response to these exceedances will follow the MW17-18 Master TARP. Management/ corrective actions can be implemented where required to remedy these non-conformities and report accordingly.

To establish compliance with the performance measures outlined in **Sections 5.1 and 5.1.1**, Airly Mine has established performance indicators for each feature, via escalating triggers and levels of investigation in accordance with the performance indicator levels described in **Table 5.4**.

The MW17-18 Master TARP details the parameters and associated trigger levels developed for the Extraction Plan, and the MW17-18 SMP established the appropriate monitoring to demonstrate that subsidence performance satisfies the performance measures for the Airly Mine.

32 See Appendix 6

**Table 5.4: Performance Indicators & TARP Risk Management Scenarios**

| Performance Indicator | General Description | Action / Response |
|---|---|---|
| **Level 1: Condition Green** | **Operations within predictions, and within approved impacts**. | Continued operations and monitoring as normal. |
| **Level 2: Condition Amber** | **Operations within approved impacts but potentially exceed / exceed predictions**. | Review and investigation processes are engaged, with adaptive management as required. |
| **Level 3: Condition Red** | **Operations exceed approved impact.**<br>*The approved Performance Measures (criteria thresholds) of Development Consent (and any other relevant approvals) are listed in Condition Red.* | Adaptive Management measures are fully engaged as per the MW17-18 Master TARP and relevant sections of the Extraction Plan and the MW17-18 SMP. |

## 5.5 Adaptive Management and Contingency Planning

### 5.5.1 Centennial Coal Adaptive Management Framework

An Adaptive Management Framework provides for flexible decision making, adjusted to consider uncertainties as management outcomes are understood.

Through feedback to the management process, the management procedures are changed in steps until monitoring shows that the desired outcome is obtained. The monitoring program has been developed so that there is statistical confidence in the outcome.

In adaptive management the goal to be achieved is set, so there is no uncertainty as to the outcome, and conditions requiring adaptive management do not lack certainty, but rather they establish a regime which would permit changes, within defined parameters, to the way the outcome is achieved.

The Centennial Coal Adaptive Management Framework is a process of ongoing testing, learning, monitoring and managing and relies on:

- Description of the environmental value and its role in the landscape, including aspects of an operation that may result in a significant impact to the environmental value (not all aspects of a project will generate impacts);
- A model of the environmental response to certain management actions/decisions, supported by the description of the environment;
- Mechanisms to test the model;
- Engagement with relevant stakeholders in the description of the environment and development of models, model outcomes and management actions/decisions;
- Identification of clear management objectives for each environmental value;
- Monitoring the system using best available technologies and multiple lines of evidence to:
  - Evaluate progress against objectives;
  - Determine the status of the system;
  - Increase our understanding of the system; and
  - Refine the modelling where applicable.

### 5.5.2 Adaptive Management Strategy for Airly Mine

Airly Mine has sought to eliminate risks and avoid potential impacts to surface features, as the most effective form of management on the risk hierarchy, through an extensive mine design process. Progressive implementation and monitoring of mining within the approved mining zones during the mine schedule affords further opportunity and flexibility for adaptive management if required.

The adaptive management approach at Airly Mine involves monitoring and evaluation against performance measures and associated indicators in the *Master Trigger Action Response Plans for MW17-18 (MW17-18 Master TARP)* established for the extraction plan and supporting management plans.

Where performance indicators indicate increasing levels of risk (i.e., where relevant thresholds of conditions green, amber or red are being exceeded), escalating adaptive management measures are engaged in accordance with the MW17-18 TARP. The process has been successfully implemented in existing Extraction Plan areas at Airly Mine and has been updated to reflect EIS commitments and consent requirements for the Airly Mine Extension Project, including specific performance measures.

In accordance with Condition 7 (Adaptive Management) in Schedule 6 of SSD_5581, where any exceedance of applicable maximum criteria and/or performance measures has occurred (Condition Red), Centennial will at the earliest opportunity:

a) Take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur

b) Consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action; and

c) Implement remediation measures as directed by the Secretary, to the satisfaction of the Secretary.

Adaptive management measures would follow failure/root cause analysis where appropriate (including review of any observed impacts in EP Areas for potential mining induced causes, acknowledging the dynamic natural environment such as cliffs), and would be undertaken in consultation with relevant stakeholders, and involve review of this management plan.

Centennial Airly's approach to adaptive management allows for modifications to be made to the mine design in the event that performance measures are not met. The mine design is conservative enough in terms of subsidence that changes can be made to the underground operations should impacts be outside the predicted levels before any significantly adverse impact actually occurs. If required, the following actions could be used in isolation or in various combinations to adapt the mine workings to avoid adverse impacts:

- Avoid mining under sensitive surface features by increasing horizontal offsets from major features or relocating the underground mining equipment.
- Changing the dimension of pillars or void widths / adjust roadway widths to ensure total extracted span and pillar sizes are within appropriate limits.
- Review and upgrade operational control and communication systems (including Development and Extraction Control Procedures).
- Review and undertake appropriate monitoring.

Each of these actions has the potential to have a significant impact on the feasibility of the operation, and would only be undertaken as a considered response to impacts outside predicted values. It is noted that the mine design has been modified from that proposed in the EIS and already includes an increase in the size of protection zones by commencing or stopping extraction further away from sensitive features than planned and significantly larger pillar sizes.

## 5.6 Incidents, Complaints, Exceedances and Non-compliances

Incidents, exceedances and non-compliances may become evident as a result of inspections, monitoring, through audit findings or complaints. Where any exceedance or non-compliance has been identified it will be investigated and the and the steps undertaken in accordance with Condition 7 in Schedule 6 of SSD 5581.[33]

The implementation of corrective actions will be monitored and documented using the Environment & Community Database and reported in the monthly environmental performance report.

A non-compliance will be reported internally and externally to the relevant authorities as per the *Centennial Coal Management Standard 012 External Environmental Reporting* and in accordance with the *Pollution Incident Response Management Plan*. A record of all non-compliance reporting is to be maintained in the Environment and Community Database as well as reported in the Annual Review.

A non-compliance will be investigated as per the Accident / Incident Investigation procedure in the *Airly Mines Health and Safety Management System* (HSMS). A record of all non-compliance investigations will be maintained in the Environment & Community Database.

## 5.7 Reporting and Auditing

### 5.7.1 Reporting and Notifications

Reporting is undertaken in accordance with the requirements of specific requirements of relevant approvals and licences including SSD_5581, EPL12374 and EPBC 2013/7076, and generally in accordance with the *Extraction Plan Guideline* (DPE, 2022). Additionally, high potential incident notifications for unexpected subsidence events in relation to the safety of other persons under WHS legislation has also been included.

Airly will submit the following reports as summarised in **Table 5.5** during the secondary extraction as relevant. The frequency of reporting is proposed to be proportionate and reflective of the nature of the current EP Area and no predicted surface impacts with negligible ground movements.

**Table 5.5: Reporting and Notification Requirements**

| Report | Triggers | Relevant Statutory Conditions | Requirements |
|---|---|---|---|
| Notification of Controlled Action Commencement | Commencement of Controlled Action EPBC 2013/7076 | Condition 2 of EPBC 2013/7076 | ▪ DoEE to be notified in writing of date of commencement of controlled action (including first workings), required within fourteen (14) days after commencement.<br>***Note**: This condition has been satisfied by Centennial Airly as per details below in footnote 2).* |
| Website Publication | Approval of the management plan by the Minister (DPE);<br>Advice /reports received from the IEP (relevant to this management plan);<br>Completion of the Annual Review<br>Receipt of complaint relating to aspects covered by this Extraction Plan | Condition 7 of EPBC 2013 / 7076 (1 month)<br>Schedule 6, Condition 14(a) of SSD_5581<br>Schedule 6, Condition 10 of SSD_5581<br>Schedule 6, Condition 2(g) of SSD_5581 | ▪ Copy of this management plan to be published on Centennial Airly website within one (1) month of approval by the Minister (DoEE) and kept up to date (DPE).<br>▪ Any advice/reports (relevant to this management plan) issued by the IEP are to be published on the Centennial Airly website.<br>▪ Comprehensive summary of monitoring results of the development.<br>▪ The last five (5) Annual Reviews to be published on Centennial Airly website.<br>▪ Protocol for managing complaints (register updated monthly).<br>▪ Complaints register published on website. |

[33] See Section 5.5.2, steps a) to c).

| Report | Triggers | Relevant Statutory Conditions | Requirements |
|---|---|---|---|
| Incident[1], Reporting | Any set of circumstances that causes or threatens material harm to the environment; and/or breaches or exceeds the limits or performance measures/criteria in development consent SSD_5581[1]. | Consent condition 9 (Schedule 6) of SSD_5581. | ▪ Detailed report to be provided to DPE on the incident within seven (7) days of the incident<br>▪ Secretary of DPE and any other relevant agencies to be notified immediately (including DPE, EPA and DoEE) if material harm to the environment is threatened or caused.<br>▪ Includes non-compliance with any statutory requirements or exceedance of performance measures. |
| | Any incident[1] relating to land in accordance with consent condition 9 (Schedule 6), EPL12374 condition R2, EPBC 2013/7076 Condition 1, or as triggered by the TARP (reporting incidents under Management Plans as per Schedule 6, Condition 2 of SSD_5581). | EPBC 2013/7076 Condition 1, or as triggered by the TARP (reporting incidents under Management Plans as per Schedule 6, Condition 2 of SSD_5581).<br><br>EPL12374 condition R2 | ▪ Any additional notifications and reporting as per relevant approved TARP, including actions being undertaken to prevent recurrence.<br>▪ The licensee or its employees must notify all relevant authorities of **incidents causing or threatening material harm to the environment** **immediately after the person becomes aware of the incident** in accordance with the requirements of Part 5.7 of the POEO Act. As per R2.1 of the EPL, notifications to EPA must be made by phoning the Environment Line service on **131 555**.<br>▪ The licensee must provide written details of the above notification to the EPA within 7 days of the date on which the incident occurred, as per R2.2 of EPL. |
| Duty to notify Resource Regulator of certain incidents - High Potential Incident' Reporting (WHS legislation) | High Potential Incidents[3] that relate to this Extraction Plan | WHS Regulation (Mines and Petroleum Sites, 2022) Section 124 - *Duty to notify regulator of certain incidents*<br><br>Section 6 of the Guidelines for Managing Risks of Subsidence (WHS (Mines and Petroleum Sites), February 2017 | Respond in accordance with Section 124:<br>▪ all reasonable steps must be undertaken to ensure that the regulator is notified after becoming aware of an incident (other than a notifiable incident defined by the Regulations -refer the Safety Management System for details):<br>▪ Notifications in accordance with the WHS Guide "Notification of Incident and Injury" (April 2018) as per 'Other Incident' category, including:<br>○ Notification must be as soon as possible and:<br>▪ in the case of a high potential incident that resulted in an injury or illness, no later than 48 hours after becoming aware the incident resulted in an injury or illness, or<br>▪ no later than 7 days after becoming aware of the incident (whichever is earlier).<br>○ Notification must be in writing using the Notification of incident and injury form.<br>▪ Notify key stakeholders including DPE, NPWS as soon as practicable of the above.<br>***Note:*** *Whilst unexpected, should an incident actually occur which causes injury (as defined by Schedule 9, Section 12) separate priority notifications apply in accordance with WHS requirements and the mine SMS.* |
| Subsidence Impacts and Environmental Monitoring Report | Reporting of all impacts and environmental monitoring results annually in a combined report with previous EP reporting for which the same survey is performed (i.e. reporting following completion of aerial surveys). | Condition 10, Schedule 6 of SSD_5581<br><br>Section 3.6.7 of *Extraction Plan Guideline* (DPE, 2022) | This report will include:<br>▪ a comprehensive summary of all impacts, including:<br>○ A summary of integrated subsidence monitoring program results (conventional, remote[4] and underground monitoring);<br>○ Results of related environmental monitoring where applicable;<br>○ An assessment of impact compliance (if impacts remained within predictions, any which exceed predictions but remained with performance measures and/or performance indicators, and if any impacts exceeded performance measures of consent).<br>○ Details of any observed impacts (including full description, location identification using aerial photos and mining layout, photos, targeted inspection results (including photos) and characterisation of the impact in accordance with the relevant TARP). |

| Report | Triggers | Relevant Statutory Conditions | Requirements |
|---|---|---|---|
| | | | ○ Details if impacts were likely mining-induced.<br>▪ Actions to be undertaken to prevent recurrence of any mining induced impacts;<br>▪ a comprehensive summary of relevant quantitative and qualitative environmental monitoring results.<br>▪ Any revisions to the TARP undertaken in consultation with stakeholders.<br>▪ Any other adaptive management measures as relevant |
| Annual Review | Annual Review report required under development consent condition 11 (Schedule 6), SSD_5581. | Condition 11 (Schedule 6), SSD_5581 | Report to include:<br>▪ All aspects detailed in Condition 11(a)-(f), Schedule 6 of consent (detailed in the Extraction Plan and Subsidence Monitoring Program) as relevant to this document.<br>▪ Information presented in the above periodic Subsidence Impacts and Environmental Monitoring Reports (as per the *Extraction Plan Guideline* (DPE, 2022));<br>▪ The review is required to be submitted by 31st March each year unless otherwise agreed by the Secretary (DPE). Copies of the last five (5) reviews to be published on Centennial Airly website as per Condition 14, Schedule 6 of consent. |
| Annual Controlled Action Compliance Report (EPBC 2013/ 7076) | Annual report required under EPBC 2013 / 7076 | Condition 4 of EPBC 2013 / 7076. | ▪ Compliance report published on Centennial Airly website within 3 months of every annual (12 month) anniversary **of commencement** of controlled action (first workings).<br>▪ Details of report in accordance with Condition 4 of EPBC 2013/7076.<br>▪ Documentary evidence providing proof of date of publication to website and non-compliance with any conditions to be provided to the Department (DoEE) at same time the compliance report is published. |
| Formal Notification of SCA Access to Mudgee NPWS Office | Contractor requiring monitoring access to the SCA | Routine (or other) monitoring | ▪ Notification of proposed access dates/times to be provided to NPWS Area Office in Mudgee prior to accessing the Mugii Murum-ban SCA. |

*Notes:*

1) *The above table is not intended to and does not represent reporting and notification requirements defined by WHS legislation other than that noted above (including all other 'notifiable incidents') – refer the mine Safety Management System (SMS) for all such requirements. High Potential Incidents under the WHS in relation to subsidence are identified and defined above. Incidents under Development Consent SSD_5581 are defined as "A set of circumstances that causes or threatens material harm to the environment; and/or breaches of exceeds the limits or performance measures/criteria in this consent".*

2) *EPBC Approval 2013/7076 was received from DoEE on 18th May 2017. Centennial Airly provided written notice to DoEE on 29th May 2017 advising the date for commencement of controlled action as Saturday 20th May 2017. For clarity, the notification applies to the entire development consent approval area and was satisfied for activities undertaken in relation to a previous Extraction Plan.*

3) *High Potential Incidents that relate to this Extraction Plan are defined by Section 124 (5) (a) as:*

> *'an event referred to in section 190 (1) (i)-(xviii) that would have been a dangerous incident if a person were reasonably in the vicinity at the time when the incident or event occurred and in usual circumstances a person could have been in that vicinity at that time', relevant Dangerous Incidents listed in section 190(1)(a)-(qi) include:*
>
> > *190 (1) (p) - a failure of ground, or of slope stability control measures, or*
> >
> > *190 (1) (q) - rock falls, instability of cliffs, steep slopes or natural dams, occurrence of sinkholes, development of surface cracking or deformations or release of gas at the surface, due to subsidence'.*

*And Section 124 (5) (m) as:*

> *'Any indication from monitoring data of the development of subsidence which may result in damage to any plant or structure or a failure of ground*

4) *The intention of reporting for aerial/remote monitoring results will be to provide relevant and focused reporting and analysis for both mined and unmined areas within the EP Area in each reporting period, whilst assembling significant raw data sets for the entire EP Area which can be further interrogated if required/triggered. Significant raw data collected from high definition LiDAR and high-resolution 3D photogrammetry throughout the EP Area will initially be processed to detect potential changes relevant to baseline and performance measures/indicators (the process and results of which will be summarised in reports). Detailed analysis and reporting will subsequently be focused on areas mined within each reporting period (including specific features undermined) and if/where change has been detected (including within unmined areas where natural rock falls may occur and within previously mined areas). Detailed analysis and reporting on each and every feature located within the entire EP Area is not intended to be undertaken, although noting aerial monitoring survey data is held for such wherever required.*

### 5.7.2 Periodic Auditing

Comprehensive Independent Environmental Audits of the entire approved development under development consent SSD_5581 are undertaken within 1 year of commencement and every 3 years thereafter (unless directed otherwise) in accordance with Conditions 12 and 13.

Auditing of any rehabilitation undertaken for the mine (including for subsidence if triggered) is undertaken in accordance with the Mining Operations Plan / Rehabilitation Management Plan under Condition 27 of development consent SSD_5581.

Additionally, in accordance with section 20(c) of the WHSMP Regulation (2022), auditing will be undertaken in accordance with the Airly Mine Safety Management System (**SMS),** against the performance standards for measuring the effectiveness of all aspects of the SMS, including the methods, frequency and results of the audit process. The audit should also consider the following matters:

- (1) competency of the auditor,
- (2) the person responsible for ensuring the audit is conducted, and
- (3) the person responsible for implementing the results of the audit.

# 6 PLAN ADMINISTRATION AND RESPONSIBILITIES

## 6.1 Review of Other Management Plans

To maintain consistency with existing management plans and previous Extraction Plans at the mine, relevant management plans will be reviewed in the event that the following occur:

- Stakeholders raise issues that necessitate a review;
- There are other changes to management requirements (e.g. changes to other related approvals besides consent, such as Mining Lease and/or EPL conditions);
- Where unpredicted impacts or consequences have required implementation of contingency actions under this plan;
- Monitoring or audit processes demonstrate that a review is warranted;
- Where otherwise triggered by the MW17-18 Master TARP;
- Where triggered by (or for) review of other related management plans (if applicable); or
- Every three (3) years as a minimum (where not already triggered above).

Any amendments to relevant management plans will be undertaken in accordance with Consent/relevant approvals and in consultation with key relevant stakeholders where required. Following any significant changes a copy of the amended management plans will be forwarded to DPE and the IEP.

## 6.2 Review of the Extraction Plan

In accordance with Schedule 6 in Condition 3 of SSD_5581, as a minimum Airly will review this Plan within three months of the following:

- Submission of an incident report;
- Submission of an Annual Review (required 31 March annually);
- Submission of an Independent Environmental Audit; or
- Any modification to the conditions of SSD_5581.

Where this leads to revisions of the document, within four (4) weeks of the review the revised document must be submitted to DPE for the approval of the Secretary. Continual improvement shall be achieved through monitoring, internal and external communication with stakeholders, implementation of corrective and preventative actions and through monitoring progress against the objectives included in the environmental management plans. The reporting framework[34] will document the effectiveness of this Extraction Plan (and the supporting Management Plans) through comparison of the predicted negligible impacts of subsidence against actual outcomes.

Each variation to this Plan will be identified in the Document Control Table at the beginning of this document.

In addition to planning development consent requirements, Airly Mine must review and as necessary revise the risk control measures implemented for subsidence in accordance with Section 15 of the *WHSMP Regulation (2022)*. This is primarily related to public safety which is managed under the Public Safety Management Plan for MW17-18 (MW17-18 PSMP) and is also relevant to the Land Management Plan for MW17-18 (MW17-18 LMP) due to the landscape features which were identified as directly related to potential risk to public safety (including cliffs and pagodas).

34 See Section 5.7.1

Monitoring and review processes[35] will provide essential feedback for:

- Detecting changes,
- Verifying the risk assessments previously conducted,
- Ensuring the effectiveness and reliability of risk control measures, and
- Supporting continual improvement and change management.

In accordance with the *Managing Risks of Subsidence Guideline* (NSWRR, 2017) in triggering and undertaking reviews the following will be considered:

- Risk control for subsidence should be reviewed and revised as necessary when:

  (1) a significant change from the assumptions used or the results of risk assessments is detected;[36]

  (2) a significant change in the site-specific conditions is identified,[37]

  (3) there are early warnings of abnormal subsidence where significant surface or subsurface features exist,[38]

  (4) the control measure does not control the risk it was implemented to control so far as is reasonably practicable,

  (5) a new relevant hazard or risk is identified,

  (6) the results of consultation indicate that a review is necessary,

  (7) an incident or notifiable incident has occurred, or

  (8) the results of an audit indicate that a review is necessary

- key stakeholders must, so far as is reasonably practicable, be consulted and the following questions should be addressed:

  (1) Have all subsidence hazards been identified?

  (2) Is the mine operator's understanding of subsidence hazards still current and correct?

  (3) Have the implemented risk control measures been working effectively?

  (4) Are the risks of subsidence being adequately managed?

  (5) Have there been any early warnings of changes from the results of risk assessments, which warrant corrective or proactive management actions or the commencement of emergency procedures?

  (6) Have any incidents of subsidence occurred and what is the learning from the investigations of these incidents?

  (7) Should the implemented risk control measures be revised according to the results of subsidence monitoring and review?

35 Airly mine must ensure that any interpretation of subsidence information (e.g. reviewing the risk control measures for subsidence) is carried out only by a competent person.
36 A change (from the assumptions used or the results of risk assessments) is significant if the implemented risk controls may become less effective or ineffective as a result of this change.
37 A change in the site-specific conditions is significant if the implemented risk controls may become less effective or ineffective as a result of this change (e.g., identification of geological structures that may cause abnormal subsidence).
38 In the context of subsidence risk management, the significance of surface or subsurface features is determined by the severity of the potential health and safety consequences if these features are adversely affected by subsidence

## 6.3 Key Responsibilities

The responsibility for implementation, monitoring and review of the Extraction Plan lies with the Technical Services Manager. The ultimate responsibility for the implementation of the Extraction Plan lies with the Mine Manager, who shall make appropriate resources available. The roles and responsibilities for the current Extraction Plan are outlined in **Table 6.1**.

**Table 6.1: Key Personnel and Accountabilities**

| Position | Responsibility |
|---|---|
| Mine Manager | • Ensuring that sufficient resources are available to implement and execute the requirements of this Plan<br>• Reporting triggers/non-conformances to external stakeholders |
| Technical Services Manager | • Coordinate the implementation, monitoring and review of the Extraction Plan<br>• Coordinate underground inspections and subsidence monitoring program associated with this EP and relevant sub-management plans<br>• Coordinate implementation of the mine design and Master TARP<br>• Reporting triggers/non-conformances internally to the mine manager as appropriate<br>• Reporting to DPE and NSW Resources Regulator of subsidence and pillar system performance upon completion of specified monitoring intervals |
| Production Manager | • Implement mine design<br>• Establish and maintain underground monitoring and inspections program<br>• Auditing as required |
| Mine Surveyor | • Survey as built initial development pillars<br>• Establish and maintain subsidence monitoring program<br>• Internal reporting as required<br>• Mark up centre lines for driveage in pillars<br>• Produce final mining plan for extraction workings to be carried out in consultation with the Technical Services Manager |
| Environment and Community Superintendent | Implementation, monitoring and review of this plan, including:<br>• The carrying out of targeted inspections<br>• The installation and maintenance of signage where required<br>• Reporting triggers/non-conformances internally to the Mine Manager as appropriate<br>• Consulting with land owners, landholders and managers regarding any land management issues arising from subsidence within the EP Area. This includes (but may not be limited to) NPWS, Office of Crown Lands and private landowners within the EP Area (if and as applicable)<br>• Consultation during the review process with relevant stakeholders and distributing this EP and relevant sub-management plans<br>• Coordinating any remediation work as required<br>• Inspecting targeted accessible areas susceptible to tensile and compressive strains and potential cracking as required (e.g. accessible tracks and trails)<br>• Co-ordinating the generation and submission of formal reporting requirements outlined in this Plan<br>• Reviewing this EP and relevant sub-plans |

# 7 REFERENCES

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SCT (2023). *MW17-18 Pillar and Panel Optimisation Assessment (Report No. AIRLY5612)*

Strata$^2$ (2020). *Panel and Pillar Mining Zone: Geotechnical Issues Related to the Update of the Extraction Plan for Miniwalls 7 to 9 (Report No: AIR-017-Rev0)*

Strata$^2$ (2019a). *Panel and Pillar Mining Zone: Revised Subsidence Estimates and Impacts (Report No. AIR-006-Rev1)*

Strata$^2$ (2019b). *Estimation of Surface Impacts (including Cliffs) due to the Extraction of Miniwalls 2 to 15' (Report No. AIR-004-Rev0)*

RPS (2022a). *Airly Extraction Plan for the Cliff Line Zone ML1814 and MW17-19 Extraction Plan Area Historical Heritage Management Plan Update & Phase 1 Baseline Historical Heritage Assessment (Report No. PR152234-1)*

RPS (2022b). *Desktop review of ML 1814 area and MW17-19 EP Area for Aboriginal Cultural Heritage (Report No. AU213005571)*

RPS (2023). *Baseline Biodiversity Report MW17-19 EP Area and CLZ (ML1814) EP Area (Report No. 152229)*

# ABBREVIATIONS

| | |
|---|---|
| **BMP** | Biodiversity Management Plan |
| **CLZ** | Cliff Line Zone of First Workings (approved mining zone under consent SSD_5581) |
| **DP&E** | NSW Department of Planning and Environment |
| **DOC** | Depth of Cover |
| **ESU** | Environmental Sustainability Unit, formerly within the Division of Resources and Geoscience (DRG), now within the NSW Resources Regulator within NSW DP&E. |
| **EP** | Extraction Plan |
| **EP&A Act** | Environmental Planning and Assessment Act 1979 |
| **EPL** | Environment Protection License |
| **ESU** | Environmental Sustainability Unit (NSW Resources Regulator) |
| **HHMP** | Historic Heritage Management Plan |
| **IEP** | Independent Expert Panel (post-consent) |
| **IRP** | Independent Review Panel (pre-consent) |
| **LCC** | Lithgow City Council |
| **LMP** | Land Management Plan |
| **MEP** | Airly Mine Extension Project |
| **ML** | Mining Lease |
| **MOD** | Modification to Airly Mine's former Development Consent (DA162/91) |
| **MW** | Miniwall (secondary extraction panel) |
| **NPWS** | NSW National Parks and Wildlife Service |
| **NSW-RR** | NSW Resources Regulator |
| **OEH** | NSW Office of Environment & Heritage |
| **PPMZ** | Partial Pillar Mining Zone (approved mining zone under consent SSD_5581) |
| **PSMP** | Public Safety Management Plan |
| **SCA** | State Conservation Area |
| **SSD** | State Significant Development |
| **SMP** | Subsidence Monitoring Program |
| **SMZ** | Shallow Mining Zone (approved mining zone under consent SSD_5581) |
| **TARP** | Trigger Action Response Plan |
| **WMP** | Water Management Plan |

# SUB-MANAGEMENT PLANS

## APPENDIX 1 Airly Mine Water Management Plan

- The Airly Mine Water Management Plan can be found at: https://www.centennialcoal.com.au/operations/airly/

# APPENDIX 2Land Management Plan for MW17-18

CENTENNIAL

# Land Management Plan (MW17-18 LMP)

## MW17-18 Panel & Pillar Mining Zone Extraction Plan

**Airly Mine (SSD_5581)**

**November 2023**

# DOCUMENT CONTROL / TITLE BLOCK

| | | |
|---|---|---|
| **EXTRACTION PLAN DETAILS** | **Title:** | Land Management Plan: MW17-18 Panel & Pillar Mining Zone Extraction Plan |
| | **Applicant:** | Centennial Airly Mine |
| | **Revision No.:** | MW17-18 LMP_Rev_3[1] |

## REVISION

| | Revision No. | Details of Revision | Date Sent |
|---|---|---|---|
| **REVISION DETAILS** | Rev_0 | Draft for external consultation | 21/02/2023 |
| | Rev_1 | Updated following external consultation to incorporate a revision of mine design (reduction in miniwall panels) and accompanying pillar width modelling and subsidence predictions and impact assessments | 11/07/2023 |
| | Rev_2 | Updated to address comments following external consultation | 23/08/2023 |
| | Rev_3 | Updated subsidence monitoring layout with two additional GNSS units | 7/11/2023 |
| | | | |

[1] An integrated Document Control Procedure is incorporated into Centennial Airly Mine's Safety Management System (SMS). Documents, data and records pertaining to this plan will be managed according to the ***Airly Mine Document and Data Control Management Plan*** **(AIR-MP-1034).**

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# Attachments
## *(refer to EP Main Report)*

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Attachment B – Relevant Legal and Other Requirements
Attachment C – Subsidence and Environmental Risk Assessment (EP Area)
Attachment D – Stakeholder Consultation
Attachment E – Technical Report: Pillar Width Modelling (SCT, 2023)
Attachment F – Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023)
Attachment G – Technical Report: Baseline Biodiversity Assessment (RPS, 2023)
Attachment H – Technical Report: Baseline Historic Heritage Assessment (RPS, 2022A)
Attachment I – Technical Report: Baseline Aboriginal Heritage Assessment (RPS, 2022B)

# Abbreviations

| | |
|---|---|
| **BMP** | Biodiversity Management Plan |
| **CLZ** | Cliff Line Zone of First Workings (approved mining zone under consent SSD_5581) |
| **DP&E** | NSW Department of Planning and Environment (now DPIE) |
| **DPIE** | NSW Department of Planning, Industry and Environment (DPIE) |
| **DOC** | Depth of Cover |
| **ESU** | Environmental Sustainability Unit, formerly within the Division of Resources and Geoscience (DRG), now within the NSW Resources Regulator within NSW DP&E. |
| **EP** | Extraction Plan |
| **EP&A Act** | Environmental Planning and Assessment Act 1979 |
| **EPL** | Environment Protection License |
| **ESU** | Environmental Sustainability Unit (NSW Resources Regulator) |
| **HHMP** | Historic Heritage Management Plan |
| **IEP** | Independent Expert Panel (post-consent) |
| **IRP** | Independent Review Panel (pre-consent) |
| **LCC** | Lithgow City Council |
| **LMP** | Land Management Plan |
| **MEP** | Airly Mine Extension Project |
| **ML** | Mining Lease |
| **MOD** | Modification to Airly Mine's former Development Consent (DA162/91) |
| **NPWS** | NSW National Parks and Wildlife Service |
| **NSW-RR** | NSW Resources Regulator |
| **OEH** | NSW Office of Environment & Heritage |
| **PPMZ** | Panel & Pillar Mining Zone (approved mining zone under consent SSD_5581) |
| **PSMP** | Public Safety Management Plan |
| **SCA** | State Conservation Area |
| **SSD** | State Significant Development |
| **SMP** | Subsidence Monitoring Program |
| **SMZ** | Shallow Mining Zone (approved mining zone under consent SSD_5581) |
| **TARP** | Trigger Action Response Plan |
| **WMP** | Water Management Plan |

# 1 INTRODUCTION

## 1.1 Background

Airly Mine is an existing underground coal mine located approximately 40 kilometres (km) northwest of Lithgow in New South Wales, 170km northwest of Sydney and 4 km to the northeast of Capertee, as illustrated on **Figure 1.1**. The mine is partly located within the Mugii Murum-ban State Conservation Area (SCA). Centennial Airly Pty Limited (Centennial Airly) is the operator of the mine and is a wholly owned subsidiary of Centennial Coal Company Pty Limited (Centennial).

Development Consent for the Airly Mine Extension Project (MEP) was approved on 15 December 2016 subject to the Conditions in Schedule 2 to 6 of State Significant Development 5581 (SSD_5581). The consent allows extraction of 1.8 million tonnes of run-of-mine (ROM) coal per calendar year for a period of 20 years, which is supplied to both domestic and international markets. As per commitments within the Environmental Impact Statement (EIS) for SSD_5581, Airly Mine is implementing a conservative and staged approach to mining, with different mining methods applied in different areas of the mining lease called Mining Zones[2].

The *MW17-18 Panel & Pillar Mining Zone Extraction Plan* as detailed in the *Extraction Plan Main Report (the EP Main Report)* and the supporting component plans, continues the conservative and staged approach to mining being implemented by Airly Mine, with secondary extraction proposed in two miniwall panels (MW17 to MW18). The miniwall panels are located within the *Panel and Pillar Mining Zone* as detailed within SSD_5581.

Airly Mine have undertaken extensive modelling and mine design revisions, with panel (void) and pillar widths specifically designed to reduce subsidence levels to be consistent with EIS predictions (i.e., maximum vertical subsidence <125mm). Conservative setbacks to key sensitive features located within the *Cliff Line Zone of First Workings* will continue to be implemented for the MW17-18 PPMZ Extraction Plan, and extensive monitoring and management measures are proposed to demonstrate the subsidence modelling and effectiveness of the mining. The *Extraction Plan Area (EP Area)* is further defined in **Section 1.3**.

The *EP Main Report* and the supporting component plans have been developed using a risk-based approach and in accordance with:

- Relevant requirements listed under *Condition 7 in Schedule 3* of SSD_5581;
- *Extraction Plan Guideline,* NSW Department of Planning and Environment 2022;
- *Managing Risks of Subsidence Guideline*, NSW Department of Industry, Resources Regulator (NSWRR), 2017; and
- *Consultation with all relevant key stakeholders* (potentially affected by subsidence) and the Independent Expert Panel (IEP) established by NSW Department of Planning and Environment (DPE) for the project.

An Extraction Plan is required to be developed and approved prior to undertaking secondary extraction, including the development of this ***Land Management Plan for MW17-18 (MW17-18 LMP)***.

2 Airly Mine has five (5) mining zones approved under development consent SSD_5581 as shown in Figure 2 in Appendix 3 of SSD_5581. These zones provide design criteria for different mining methods based on the differing levels of environmental sensitivity of surface features and depth of cover across the Airly mining leases. Section 8 of the Airly Mine EIS (2014) provides further details on the definitions of each of these approved mining zones if required.

## 1.2 Purpose and Scope

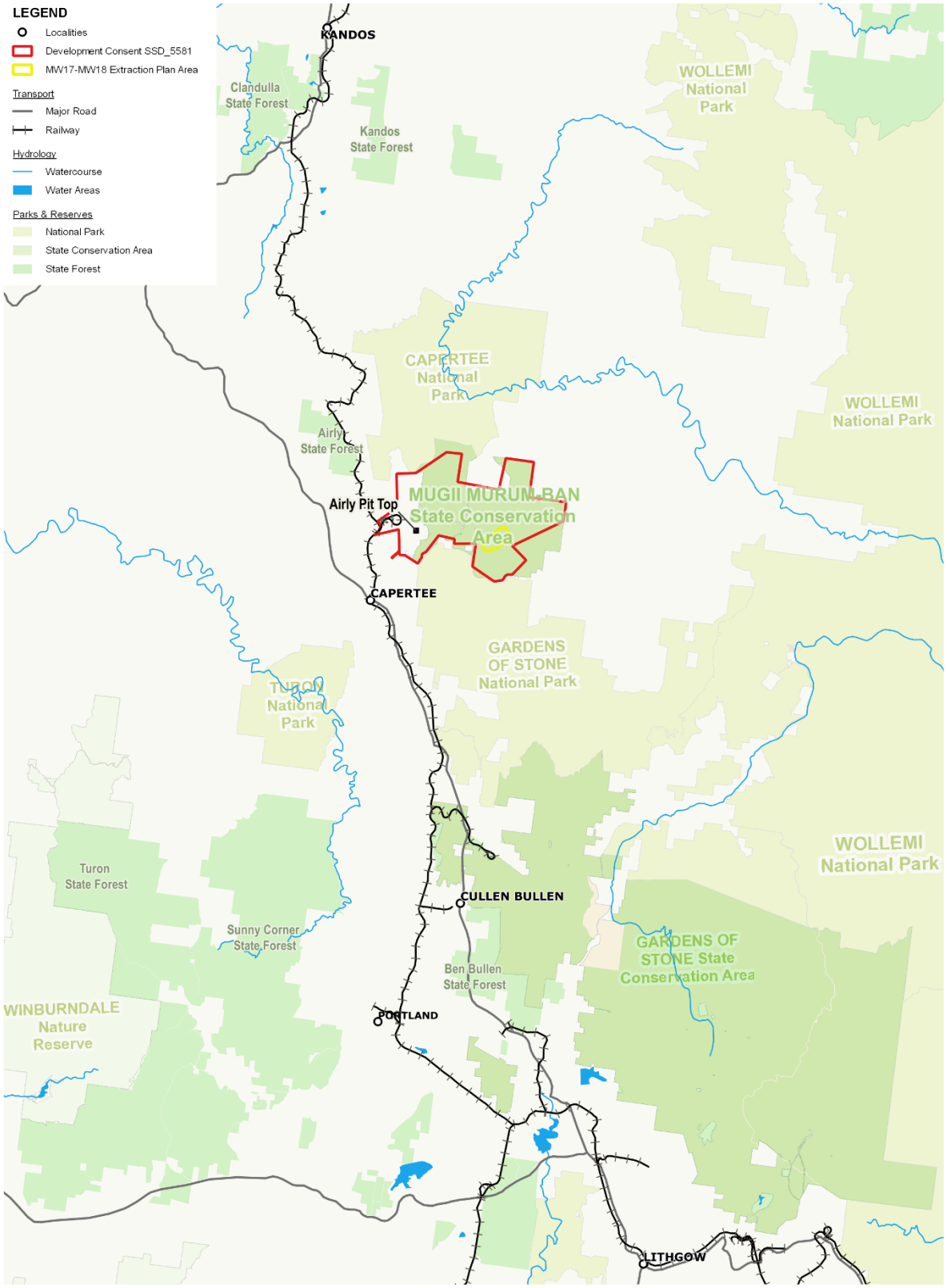
The purpose of this ***MW17-18 LMP*** is to outline the monitoring and management measures to be implemented to address any potential impacts to land (**Section 3.2**) resulting from subsidence associated with secondary extraction via panel and pillar mining within the EP Area (**Section 1.3**).

Void and pillar widths have been specifically designed to support the overlying overburden with minimal subsidence effects. The final pillars left following panel extraction are specifically designed to provide long term stable support to the surface with no surface cracking and minimal ground movement.

Whilst no surface cracking or related impacts have been predicted for panel and pillar mining activities, this management plan importantly continues established monitoring and management frameworks to confirm such for the EP Area, whilst also providing baseline monitoring.

A directly related *Subsidence Monitoring Program for MW17-18 (MW17-18 SMP)* (Appendix 5 of the EP Main Report) has also been specifically developed for the Extraction Plan to address the project performance measures prescribed by consent SSD_5581, supported by a *Master Trigger Action Response Plan for MW17-18 (MW17-18 TARP)* (Appendix 6 of the EP Main Report), including adaptive management measures if required.

## Figure 1.1: Locality Plan




Regional Context

MW17-MW18 PPMZ Extratcion Plan

*The data displayed on this figure has been collected from various sources. The source data may contain inconsistencies or omissions, may not be to scale, may not be current and may present indicative information only. Catalyst Environmental Management does not warrant the accuracy or completeness of the contents of this figure.*

## 1.3 Extraction Plan Area

Two miniwalls are proposed for extraction in the south-eastern area of Genowlan Mountain within the Airly mining leases being miniwalls (MW) 17 and 18. The miniwall panels are located within the *Panel and Pillar Mining Zone* as detailed within SSD 5581. Centennial Airly has applied a 26.5 degree Angle of draw (AoD) around all cliffs mapped within the *Cliff Line Zone of First Workings*. No secondary extraction will occur within the 26.5 degree angle of draw of cliffs within the *Cliff Line Zone of First Workings*.

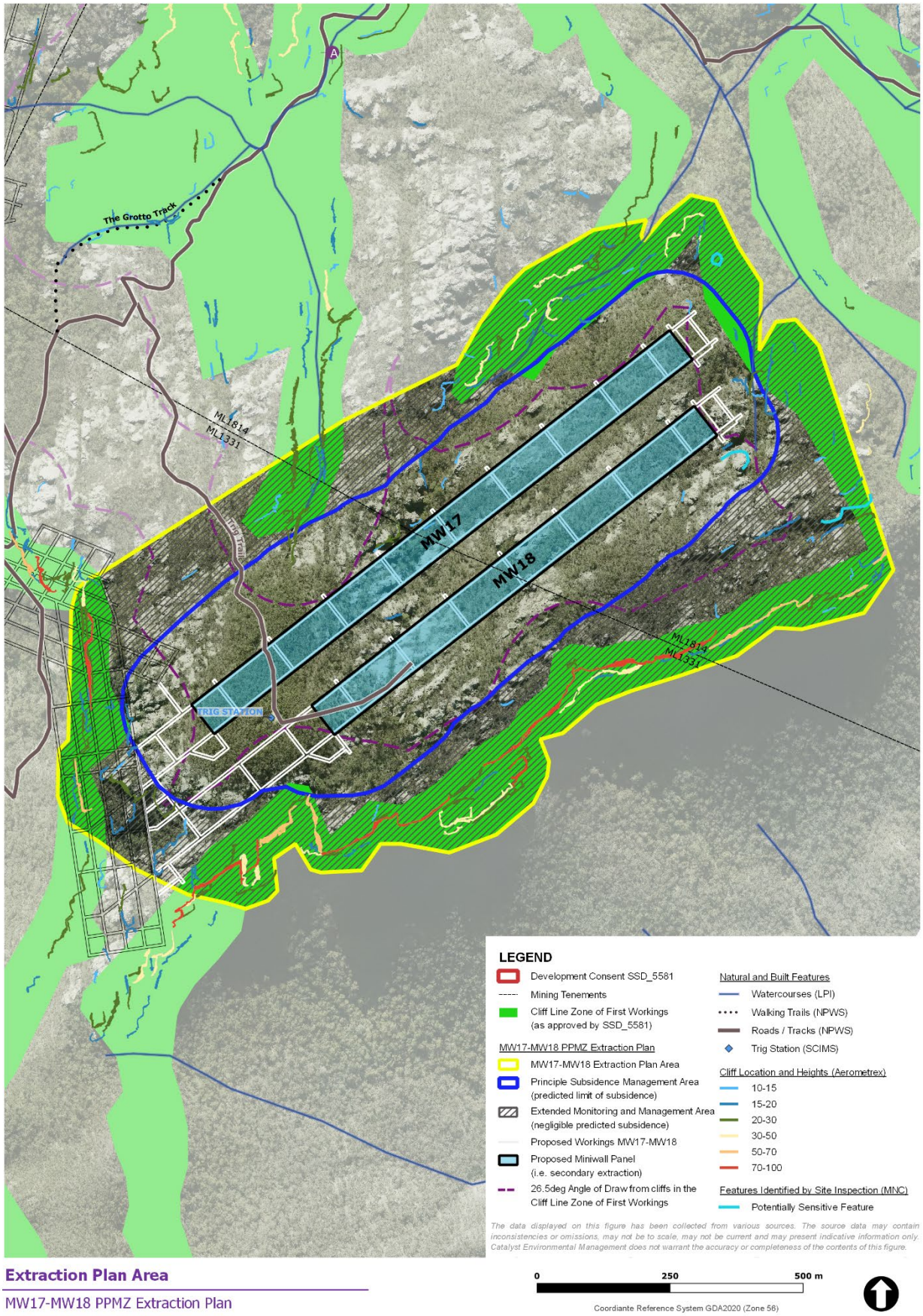
The Extraction Plan Area (EP Area) is comprised of two key components as defined below and illustrated on **Figure 1.2**. The proposed overall EP Area boundary includes an Extended / Far Field Monitoring and Management Area which is beyond the predicted extent of subsidence and involves monitoring and management of sensitive features, primarily the cliffs and pagodas contained within the *Cliff Line Zone of First Workings* surrounding Genowlan Mountain as a precautionary approach to demonstrate the mining methods.

**Table 1.1: MW17-18 Panel & Pillar Mining Zone Extraction Plan Area**

| EP Area Components | Defining Comments |
|---|---|
| **Near-Field / Principal Subsidence Management Area** *(Secondary Extraction Area)* | • Approved area of secondary extraction in accordance with the development consent SSD_5581<br>• The proposed miniwall extraction (second workings) within the **Panel and Pillar Mining Zone** associated with **miniwall panels MW17-MW18**<br>• **No second workings within 26.5 degree setback from the tops of cliffs** located within the Cliff Line Zone of First Workings **to all miniwall panels i.e. MW17-MW18**<br>• **Predicted 20mm limit of vertical subsidence**<br>• Located within parts of both Mining Lease ML1331 and ML1814 |
| **Extended / Far Field Monitoring and Management Area** | • **Monitoring and management area only** for this Extraction Plan, no proposed mining within this Extraction Plan[3]<br>• This area lies entirely **beyond** the 26.5 degree setback from the tops of cliffs located within the Cliff Line Zone of First Workings to all panels MW17-MW18<br>• Conservatively monitors sensitive features located **beyond** the *Near-field / Principal Subsidence Management Area* for potential subsidence effects further afield<br>• Primarily comprises cliffs and pagodas contained within the Cliff Line Zone of First Workings |

3 Parts of the Extended / Far-field Monitoring and Management Area overlap with the Cliff Line Zone of First Workings. First workings within the Cliff Line Zone of First Workings requires a separate Extraction Plan and any mining undertaken in the Cliff Line Zone of First Workings will be managed in accordance with an approved Extraction Plan.

**Figure 1.2: Extraction Plan Area (EP Area) and Relevant Features within the EP Area**



## 1.4 Relevant Features

The following section provides an overview of the key relevant features managed and monitored in the EP Area as illustrated on **Figure 1.2**. The natural and built features identified within the EP Area include:

- Surface Water
- Groundwater
- Aquatic ecology
- Cliffs, Minor Cliffs and Pagodas
- Mugii Murum-ban SCA General Surface Area, including steep slopes and rock outcrops
- The deeply incised canyons/gorge including an area known as the Grotto
- Tracks and Trails, Fences & Gates
- Habitat
- Threatened Flora & Fauna
- Endangered Ecological Communities (EEC)
- Groundwater Dependent Ecosystems (GDE)
- Public Safety / Safety of 'others' associated with potential for subsidence.
- Publicly accessible sections of the EP Area within Mugii Murum-ban State Conservation Area including tracks and trails and general SCA surface area.

The features identified within the EP Area, and which are subject to this *MW17-18 LMP* are summarised below and detailed in the following sections:

- **Section 1.4.1** – Cliffs, Minor Cliffs and Pagodas
- **Section 1.4.2** – General Mugii Murum-ban SCA Area
- **Section 1.4.3** – Incised Gorges (including The Grotto)
- **Section 1.4.4** – Unsealed roads and tracks

### 1.4.1 Cliffs, Minor Cliffs and Pagodas

Cliffs and pagodas are a primary focus for protection of sensitive features at Airly Mine, and subsequently for Extraction Plans and supporting Land Management Plans. As detailed further below, in addition to detailed studies undertaken for the Airly MEP EIS and approval process, further detailed survey has been undertaken to identify, monitor and manage cliffs and pagodas as defined by development consent SSD_5581.

The term "**Cliff**" has been defined in the SSD_5581 Development Consent as "*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°)*". It is additionally noted that subsidence sensitivity increases with height and in certain areas cliffs exceeding 20m and up to ~100m exist within ML1331. These areas are of key focus for protection and conservative mine design as detailed within the EP and this plan.

The term "**Minor cliff**" has been defined in the SSD_5581 Development Consent as "*a continuous rock face including overhangs, which has a minimum length of 20 metres and a height **between 5 metres and 10 metres**; and minimum slope of 2 to 1 (> 63.4°)".*

The relatively high strength of the Narrabeen sandstone units, combined with the presence of near vertical jointing of the rock mass, leads to the formation of sizeable cliffs within Mugii Murum-ban

SCA. The sandstone cliffs sit atop the Permian talus slopes and form an external boundary to the upper portion of the two prominent mesas of Mount Airly and Genowlan Mountain.

Tectonic forces and mountain uplift cause fracturing of the sandstone units and result in sub-vertical jointing that can penetrate the full depth of the sandstone unit. Subsequent erosion of the underlying Permian strata to form the surrounding valleys by rivers and streams has caused a removal of support from the overlying sandstone. Over time the continuing removal of support destabilises the sandstone causing it to naturally break off on the pre-existing joints and fall onto the lower talus slopes (i.e. rock falls are a natural process of cliff formation and evolution). The result is a vertical or near vertical rock face that can reach well over 100 m tall in the broader mountain complex area.

Review of time-lapse aerial imagery of the lease areas indicates that the natural frequency of larger scale cliff falls in the area is approximately once every four years. Falls of isolated rocks occur more frequently, but are not noticeable at any great distance. Ongoing baseline monitoring of the EP Areas (including the Cliff Line Zone) and other areas yet to be progressively mined will provide further information in relation to incidence of natural rock falls as discussed in **Section 4.2**.

The term "**Pagoda**" has been defined in the SSD_5581 Development Consent as "*Conical or sub-conical rock formations, whether smooth, platy, stepped or terraced, generally between 5 and 20 metres in height and that are not cliffs or minor cliffs"*.

Within the land above Airly Mine in general (including beyond the EP Area), pagodas tend to occur mainly at the top of external and internal cliffs and around deeply incised gorges and canyons. Some do occur as isolated rock outcrops within larger plateau landscapes, but these are very minor in comparison to the numbers found around cliffs and gorges.

Pagodas tend to be the most resilient part of the rock mass remaining after erosion and are often bounded on pre-existing joint lines. The behaviour of pagodas when subjected to subsidence differs from sandstone cliffs.

Cliffs within the EP Area have been mapped by Aerometrex in accordance with the definitions provided below using GIS analysis of LiDAR point cloud of 4 points per square meter. The studies provided data for the tops and toes of geological features meeting the criteria of Cliffs, as well as sensitivity analysis and verification cross-checks using high resolution 3D Oblique Photogrammetry.

In addition to remote analysis, MNC "ground truthed" cliffs identified by Aerometrex by walking over the mesas near all the cliffs and site inspecting the larger cliffs to check that there are no large overhangs at these cliffs and to confirm that the desktop mapping and identification process did not miss sensitive rock formations/features that could be susceptible to small mining induced subsidence ground movements.

Centennial plan to protect the major external cliffs over south eastern areas of Genowlan Mountain, with a revised mine plan for MWs 17 to 18. These cliffs are being protected by an AoD of 26.5° from the top of the external major cliffs, instead of 8°. The maximum predicted subsidence is 88 mm.

### 1.4.2 General Mugii Murum-ban SCA Area

The EP Area is wholly located within Mugii Murum-ban SCA (MMBSCA).

Mugii Murum-ban SCA is 3,650 hectares and is bounded to the south by the Glen Davis Road and Gardens of Stone National Park, and to the north by Capertee National Park. Land to the east and west is largely cleared farming land, with some remnant bushland. Lands not included in the SCA include Airly Gap Trail and a number of partially cleared private properties along Airly Gap Trail and at the

base of the Genowlan mesa (OEH, 2015).Additionally, the MMBSCA lies within the South Eastern Highlands Bioregion, it is relatively contiguous system of protected bushland, stretching from the Hunter Valley in the north to Wollondilly River in the south, and including nearby Capertee, Gardens of Stone and Wollemi National Parks (OEH, 2015). MMBSCA contains a great diversity of ecosystems, supporting several threatened plants and animals. In addition, the SCA contains four relatively pristine sub catchments which are important in maintaining water quality in creek and river systems in the area (OEH, 2015).

The Mugii Murum-ban State Conservation Area (SCA) managed by NPWS and is a focal point of environmental protection that requires low impact, non-intrusive monitoring and management. The broader Mugii Murum-ban SCA is characterised by a steep and rugged topography with large areas of cliffs and significant rock outcrops dominated by Mount Airly and Genowlan Mountain. There are small areas of flatter land on plateaus and the west of Mount Airly there are undulating areas. Mount Airly and Genowlan Mountain form an irregular -shaped mesa complex dissected by a low saddle or valley known as Airly Gap, through which Gap Creek flows north beyond the outlier to join Genowlan Creek, which rises in Genowlan Mountain and eventually flows into the Capertee River. The saddle area of Airly Gap provides the primary unsealed access to Mount Airly and conveys the ephemeral headwaters of Gap Creek. A second unsealed 4WD access trail further east leads from Glen Davis Road onto Genowlan Mountain.

Mugii Murum-ban SCA is dominated by two prominent mesas which are major visual features of the Capertee Valley – Mt Airly (where panel and pillar mining has been undertaken to date), and Genowlan Mountain, a western portion of which is the subject of the current EP Area. MMBSCA contains extensive and intricate pagoda clusters, numerous deep gorges, canyons and unusual rock formations. These features combine to create an extremely scenic landscape and is a focal point of environmental protection that requires low impact, non-intrusive monitoring and management.

The term “Steep slope” has been defined in the SSD_5581 Development Consent as “an area of land having a gradient between 1 in 3 (33% or 18.3°) and 2 in 1 (200% or 63.4°)”. Steep slopes typically include scree and rubble covered talus slopes below the sandstone cliffs within the angle of repose. These are thickly vegetated, with hardy vegetation communities that endure constant change and are not particularly well watered.

Topography within the mesas varies from gently undulating to steep sided valleys, major cliff lines and gorges. There are a number of rock formations including ‘pagodas’ which are formed by differential erosion of the overlying strata forming dome shaped rock structures, sometimes referred to as ‘beehives’. The ‘pagodas’ are mainly smooth surfaced, although some are benched (platy pagodas), which occur when harder layers such as leached ironstone is present within the structure.

In addition to the geodiversity and watercourses of the SCA, some other relevant characteristics of this area are steep slopes and the native vegetation cover. Thick native vegetation dominates the entire Mugii Murum-ban SCA, including (in places) Endangered Ecological Community’s and threatened flora and fauna species.

There are no Threatened Ecological Communities (TECs) or Endangered Ecological Communities (EECs) identified within the current EP Area. However, two threatened ecological communities have been identified on Genowlan Point, which is located beyond the EP Area. As low levels of subsidence are predicted over the area of the mesa that is affected by the proposed extraction, it is expected that the proposed extraction should not cause physical impacts (i.e. surface cracking) that have potential to alter the environment or habitat for this natural vegetation. This is further discussed in the Biodiversity Management Plan.

The thick native vegetation which dominates the SCA, including threatened flora and fauna species, are managed under the Biodiversity Management Plan prepared for the Extraction Plan Area (EP-BMP).

The area is of particular significance to the Wiradjuri Aboriginal People and also contains numerous significant historic heritage sites. The SCA also contains important mineral deposits and is recognised in particular as having economically significant deposits of coal (OEH, 2015).

Prior to gazettal, the area now encompassing Mugii Murum-ban SCA had no formal visitation management and therefore there are minimal visitor facilities. The SCA is currently used for four-wheel driving, bushwalking, heritage tourism, picnicking, birdwatching, camping and cycling. Information on SCA visitation is limited but suggests up to 200 four-wheel drive vehicles may enter the SCA each year. The main public entry point to the SCA is via the Airly Gap Trail, a two-wheel drive public road off Glen Davis Road, located west of the current EP Area. Public vehicle access is also provided to the SCA via the four-wheel drive Genowlan Trail (OEH, 2015) which is located within the current EP Area. The SCA is considered most suitable for dispersed, self-reliant, nature-based recreation utilising existing visitor nodes and routes.

In addition to managing the broader SCA, NPWS also currently manage portions of Crown Land (excluding Crown Roads and reserves) under licence from the Division of Crown Lands (NSW DTIRIS), which are in the process of formal transition into the SCA. These are primarily located within Airly gap located to the west of the current EP Area.

### 1.4.3 Incised Gorges (including The Grotto)

The Grotto is a narrow slot canyon, or gorge feature, with surrounding internal cliff lines topped by pagoda clusters. There are no mine workings associated with this extraction plan (development or extraction) proposed beneath The Grotto. Whilst The Grotto, or incised gorges are not directly located within the Principal Subsidence Management Area or the Extraction Plan, a watercourse connected to the Grotto is within the EP Area. Therefore, the Grotto has been considered in this LMP, but it is unlikely to be affected by subsidence impacts.

### 1.4.4 Unsealed roads and tracks

Unsealed roads and tracks are located within the EP Area and the Principal Subsidence Management Area. These roads/tracks are only accessible by 4WD vehicles. It is noted that no sealed roads are located within the EP Area. It is unlikely that the unsealed road and track surfaces over the South-eastern area of Genowlan Mountain will be adversely impacted by the proposed miniwall extraction, as the Principal Subsidence Management Area is expected to only be subjected to low levels of subsidence that are no greater than 125mm.

## 1.5 Structure of the MW17-18 LMP

The main text sections of this MW17-18 LMP include:

**Section 1** Provides an introduction, purpose, scope, extraction plan area, relevant features to land and document structure.

**Section 2** Provides the statutory regulatory requirements, risk identification and consultation.

**Section 3** Provides the predicted subsidence impacts assessment and subsidence performance indicators to be used to assess against the relevant subsidence performance measures for land.

**Section 4** Outlines the monitoring and management measures in place for the key features in the EP Area.

**Section 5** Summarises the management, mitigation, remediation and reporting measures for this MW17-18 LMP, including relevant performance measures and indicators, contingency response, adaptive management, reporting and auditing.

**Section 6** Provides an outline of the plan administration and roles and responsibilities for this MW17-18 LMP.

**Section 7** Provides a historical review of references leading to the development of this MW17-18 LMP.

# 2 PLAN DEVELOPMENT AND CONSULTATION

## 2.1 Statutory Requirements

Centennial Airly conducts its operations in accordance with:

- The conditions of the Development Consent (SSD_5581);
- Relevant licences and permits, including conditions attached to the Environment Protection Licence (EPL No. 12374) and Mining Leases (i.e. ML 1331 and ML 1814); and
- other relevant State and Commonwealth environmental, planning, mining, safety, and natural resource legislation and guidelines.

Centennial Airly maintains a register of relevant environmental legislative and regulatory requirements in a compliance database.

The relevant statutory requirements applicable to *Miniwall 17-18 Extraction Plan* and this supporting MW17-18 LMP are presented in the EP Main Report *(refer Section 2.1 and Attachment B)*.

This MW17-18 LMP is a component of the EP Main Report and has been prepared specifically to address Condition 7(i)(v) of Schedule 3 which states:

> *(7) Prior to carrying out any first workings within the Cliff Line Zone and Zone of First Workings (refer to Figure 2 in Appendix 3) or second workings, the Applicant must prepare an Extraction Plan for the relevant workings to the satisfaction of the Secretary. Each Extraction Plan must:*
>
> *(i)…include a:*
>
> *(v) Land Management Plan which has been prepared in consultation with the IEP, Resources Regulator, BCD and any affected public authorities, to manage the potential impacts and/or environmental consequences of the proposed underground workings on land in general, with a specific focus on cliffs, pagoda formations, steep slopes and gorges.*

This ***MW17-18 LMP*** has been developed in accordance with Condition 2 in Schedule 6 of SSD_5581 (management plan requirements). **Table 2.1** details where these conditions have been addressed.

**Table 2.1: Land Management Plan Requirements**

| Key Conditions of Development Consent SSD_5581 | Section Addressed |
|---|---|
| **Schedule 6, Condition 2 *(Management Plan Requirements)*** | |
| The Applicant must ensure that the management plans required under this consent are prepared in accordance with any relevant guidelines, and include: | |
| a) Detailed baseline data; | Section 1.4, 4.2 |
| b) A description of: | |
| • The relevant statutory requirements (including any relevant approval, licence or lease conditions); | EP Main Report (Section 2.1, Attachment B) |
| • Any relevant limits or performance measures/criteria; | Section 5.1 |
| • The specific performance indicators or triggers that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures. | Section 5.4, MW17-18 Master TARP |
| c) A description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria. | Sections 2.1, 5.1, 5.4 |

| Key Conditions of Development Consent SSD_5581 | Section Addressed |
|---|---|
| d) A program to monitor and report on the: | |
| • Impacts an environmental performance of the development; | Section 4 |
| • Effectiveness of any management measures (see c) above); | Sections 5.4, 5.7 |
| e) A contingency plan to manage any unpredicted impacts and consequences | Section 5.5 |
| f) A program to investigate and implement ways to improve the environmental performance of the development over time | Section 5 |
| g) A protocol for managing and reporting any: | Section 5.6 |
| • Incidents; | |
| • Complaints; | |
| • Non-compliances with statutory requirements; and | |
| • Exceedances of the impact assessment criteria and/or performance criteria; and | |
| h) A protocol for periodic review of the plan. | Section 6.1 |

## 2.2 Specialist Assessments

This MW17-18 LMP has been informed by cliff identification assessments undertaken by Aerometrex (2021) and Michael Nicholson Consulting Pty Ltd (MNC) (2022).

The purpose of the cliff identification assessments was to identify and map the locations of cliffs and other sensitive surface features which can then be used as the basis for determining set back distances to the proposed secondary extraction (within the PPMZ) to minimise risk of surface impacts through appropriate mine layout design to reduce subsidence at sensitive high cliffs and escarpments located on the external parts of the Mount Airly and Genowlan Mountain mesas.

Extensive aerial photogrammetry and cliff identification work was undertaken by Aerometrex (2021). MNC was then engaged to undertake site inspections ("ground truthing") of the cliffs that were identified as being located within the CLZ or the PPMZ on Genowlan Mountain.

The relevant features within the EP Area, including the key cliffs and features identified by these reports, are illustrated on **Figure 3.1**.

MSEC (2023) were engaged to prepare and provide a subsidence prediction and impact assessment report, on the likely impacts of these predicted levels of subsidence on the natural and built features that exist over and near MWs 17 to 18, based on the subsidence modelling work provided by SCT (2023). The subsidence predictions and impact assessment is further discussed below in **Section 3.2** of this LMP.

## 2.3 Risk Identification and Assessment

Centennial Airly has undertaken a dedicated ***Subsidence and Environmental Risk Assessment*** *(Stature RA Number: 1001308023[4])* directly in support of this Extraction Plan which provide a risk framework basis for development of the component management plans.

The *Subsidence and Environmental risk* assessment was completed on the 13 July 2022 with key staff from the Airly Mine including the Technical Services Manager, Statutory Mine Surveyor, Mining Engineer / Compliance Manager and Environment and Community Officer, as well as the General

[4] Centennial Airly has adopted the Stature Risk Assessment Program which was developed to ensure consistency in all risk assessments across the Centennial operations. The Stature Risk Assessment Program sets out a consequences table and risk ranking matrix for managing identified risks consistent with AS/NZS ISO 31000:2009.

Manager of Technical Services for Centennial and the Lead Consultant for the EP Project Team from Catalyst Environmental Management. The risk assessment was facilitated by the Mining Engineer / Compliance Manager and has been reviewed by key EP Project Team members for Heritage, Ecology and Subsidence.

Risks were identified and assessed through the review of known surface and sub-surface features within the EP Area. The risk assessment also specifically assessed key heads of consideration required by the Managing Risks of Subsidence Guideline (NSW RR, 2017).

A risk ranking (low, moderate, significant, high or extreme) was assigned to each risk/hazard in consideration of the Maximum Reasonable Consequence (MRC) for the given controls. There were 49 potential risks scenarios assessed during the Risk Assessment; 8 moderate, 41 low and two were assessed as not applicable.

The risk assessment determined that the risk of impact for landscape features (noting the extensive controls identified) was **Low to Moderate** including aspects associated with cliffs and pagodas within the EP Area.

A copy of the risk assessment is included in the EP Main Report (refer Attachment C). Additional details regarding the management and monitoring of subsidence related impacts within the EP Area have been detailed in **Section 4** and **Section 5**.

## 2.4 Consultation

Condition 7 of Schedule 3 under development consent SSD_5581 requires the preparation of this ***MW17-18 LMP*** in consultation with key relevant stakeholders as detailed below:

- IEP;
- NSW Resources Regulator; and
- NSW Biodiversity Conservation Division (BCD) within the NSW Department of Planning, Industry and Environment (DPE).

The outcomes of consultation undertaken for the project is provided in the EP Main Report (refer Attachment D), including copies of relevant correspondence such as project presentations delivered by the mine to key stakeholders and relevant formal correspondence received from key stakeholders.

Stakeholder feedback provided has been reviewed and addressed as necessary as part of the development and review of this Extraction Plan and key component plans.

# 3 SUBSIDENCE ASSESSMENT

## 3.1 Mine Planning and Design

Mine design is the primary control utilised at Airly Mine for subsidence impact avoidance. Centennial Airly have adopted a conservative mine design to control subsidence to levels predicted in the EIS. Approvals for Panel and Pillar Mining are based on predicted surface subsidence levels of up to 100-125mm.

Void and pillar widths have been specifically designed to support the overburden with minimal subsidence effects at the surface. The final pillars left following panel extraction are specifically designed to provide long term stable support to the surface with no expected surface cracking and minimal ground movement.

The predicted subsidence is not expected to cause adverse impacts on the relevant features covered under this *MW17-18 LMP*.

Within the EP Area the pillar widths between the miniwall panels have been increased by more than double their original proposed width from 29.5m to 70m. Panel void widths have been slightly increased from 61m to 70.5m.

## 3.2 Subsidence Predictions

Condition 7(g) of Schedule 3 under Development Consent SSD_5581 and the Extraction Plan Guidelines (DPE, 2022) requires revised predictions of potential subsidence effects, subsidence impacts and environmental consequences to be presented within the Extraction Plan for the EP Area, including any relevant information obtained since the EIS and consent, in consultation with the Independent Expert Panel (IEP). A detailed review of the revised subsidence predictions is provided in the *EP Main Report (refer Section 3.2)*.

This Extraction Plan has relied on the most recently updated predictions of subsidence effects, subsidence impacts and environmental consequences. The subsidence assessments undertaken for this Extraction Plan are documented in the following reports:

- *SCT (2023). MW17-18 Pillar and Panel Optimisation Assessment (Airly 5612 dated 8 June 2023).* SCT (2023) were engaged to advise on a revision to the pillar and panel layout to **limit the maximum predicted subsidence to a precautionary upper design limit of 95mm** (+/-20mm). The proposed revised mining geometry includes two miniwall panels, MW17 and MW18, with panel void widths of 70.5m and 3.0m extraction height separated by a 70m wide barrier pillar. The predicted subsidence effects for the proposed miniwalls 17 to 18 have been provided by SCT (2023). The maximum vertical subsidence for the revised mine layout is predicted to be 88 mm (+/-20mm).

Centennial Airly, then engaged MSEC (2023) to prepare a Subsidence Prediction and Impact Assessment to support the Extraction Plan based on the subsidence prediction work provided by SCT (2023).

The subsidence predictions and impact assessment is documented in the following report:

- *MSEC (2023). Airly Mine MW17 to MW18 – Subsidence Predictions and Impact Assessments for the Natural and Built Features over and near the Proposed MWs 17 to 18 in Support of the Extraction Plan Application (MSEC1351).*

The primary management strategy being implemented by Airly Mine for the Extraction Plan is impact avoidance through the implementation of a conservative mine design, with panel and pillar widths

specifically designed to have minimal subsidence effects and prevent subsidence impacts. Conservative setbacks to key sensitive features within the *Cliff Line Zone of First Workings* continue to be implemented for this Extraction Plan (i.e. 26.5 degree Angle of Draw).

The maximum incremental vertical subsidence predictions for the EP Area are shown in **Table 3.1**. The predicted subsidence levels are minimal and well below levels expected to cause damage or any adverse impacts on the relevant features within the EP Area. This includes the extended / far-field subsidence monitoring and management area.

**Table 3.1: Maximum Incremental Subsidence Predictions (SCT, 2023)**

| Miniwall Panel Width | Maximum Predicted Subsidence (mm)[a] |
|---|---|
| **One Miniwall** | -39mm |
| **Two Miniwalls** | -88mm |

*a) SCT (2023) note that a subsidence tolerance/natural variability of +/-20mm should be applied to the modelled subsidence*

MSEC (2023) have predicted that if the measured subsidence above MW17 to MW18 is less than 125 mm:

- tilts should be less than 2.5 mm/m
- strains should be less than 2 mm/m

The cliff impact assessment for the Extraction Plan was prepared by MSEC (2023) and includes rock fall predictions for key cliffs within the EP Area. MSEC concluded that there should be little chance of exceeding the conditions of approval for identified cliffs over MW 17-18. However, ongoing natural weathering and erosion processed may result in small rockfalls at one of the identified cliff features. At Genowlan Mountain, this occurs every 3 to 4 years on average. If this should occur, MSEC states that based on available data, the size of these types of rock falls would be less than the consent condition that the fall should be less than 2% by area of cliffs. The Cliff Impact Assessment for cliffs within the 26.5-degree Angle of Draw (AoD) is detailed in **Table 3.2**.

Furthermore, subsidence impacts on the steep slopes and rock outcrops identified that the predicted level of subsidence and tilts over steep slopes and rock outcrop areas are very low and it is unlikely that these features will be impacted by the proposed mini wall extraction.

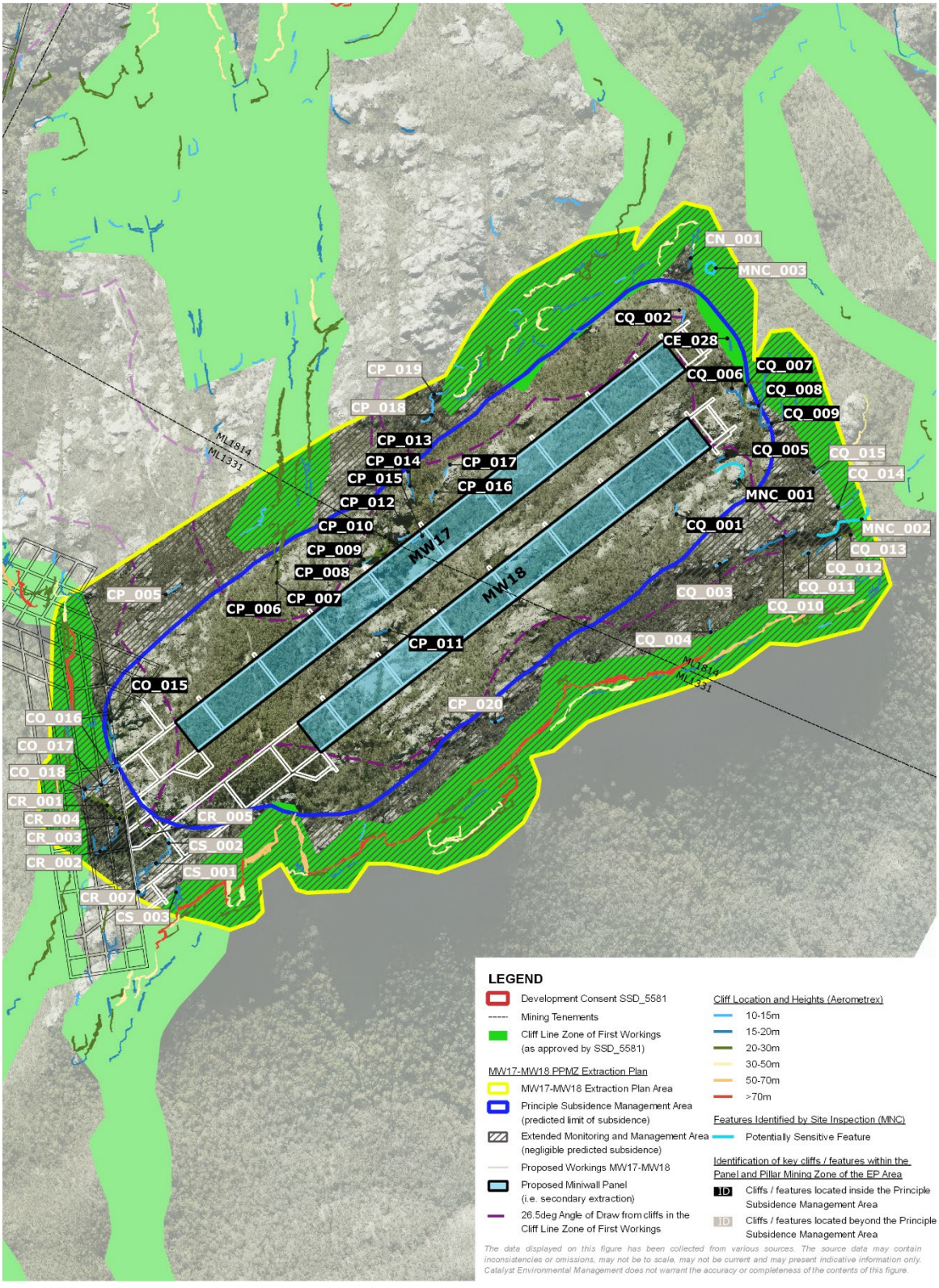
Notwithstanding this, appropriate responses have been conservatively developed for unexpected higher than predicted subsidence within a MW17-18 TARP (Appendix 6 of the EP Main Report) developed for the Extraction Plan and this MW17-18 LMP.

Extensive monitoring and management measures are proposed to demonstrate the subsidence modelling and effectiveness of the mining and monitoring systems. The proposed monitoring approach has been developed in consultation with key stakeholders to minimise further disturbance to the sensitive SCA and builds upon existing management and monitoring practices implemented successfully to date by Centennial Airly.

**Table 3.2: Cliff Impact Assessment for Cliffs within AoD of MWs 17 - 18**

| Cliff ID | Height Range | Length (m) | Max. Predicted Subsidence (mm) *(after all extraction)* | Cliff impactassessment |
|---|---|---|---|---|
| CO_015 | 15-20m | 85 | 15-20 | Falls are unlikely |
| CP_006 | 20-30m | 42 | 15-25 | Falls are unlikely |
| CP_007 | 20-30m | 79 | 20-30 | Falls are unlikely |
| CP_008 | 10-15m | 26 | 40-60 | Falls are unlikely |
| CP_009 | 20-30m | 37 | 40-60 | Falls are unlikely |
| CP_010 | 20-30m | 51 | 40-60 | Falls are unlikely |
| CP_011 | 15-20m | 31 | 60-80 | Falls are unlikely |
| CP_012 | 10-15m | 25 | 40-65 | Falls are unlikely |
| CP_013 | 15-20m | 27 | 20-40 | Falls are unlikely |
| CP_014 | 15_20m | 29 | 30-40 | Falls are unlikely |
| CP_015 | 10-15m | 22 | 50-60 | Falls are unlikely |
| CP_016 | 10-15m | 22 | 25-45 | Falls are unlikely |
| CP_017 | 10-15m | 24 | 20-40 | Falls are unlikely |
| CQ_001 | 10-15m | 21 | 30-50 | Falls are unlikely |
| CQ_002 | 10-15m | 32 | 10-30 | Falls are unlikely |
| CQ_005 | 15-20m | 21 | 20-40 | Falls are unlikely |
| CQ_006 | 15-20m | 47 | 15-30 | Falls are unlikely |
| CQ_007 | 20-30m | 31 | 15-30 | falls are unlikely |
| CQ_008 | 10-15m | 23 | 15-30 | falls are unlikely |
| CQ_009 | 15-20m | 115 | 15-30 | falls are unlikely |
| CE_028 | 15-20m | 26 | 15-30 | falls are unlikely |
| MNC_001 | 15-20m | 70 | 20-40 | Falls are unlikely |

**Figure 3.1: Key Cliffs & Features within the EP Area**




**Key Cliffs / Features Located within the Panel and Pillar Mining Zone**

MW17-MW18 PPMZ Extraction Plan

# 4 MONITORING PROGRAM

## 4.1 Land Features Monitoring Program

Environmental monitoring considerations for land are focused on the key sensitive features of cliffs, minor cliffs and pagodas. The proposed monitoring program and strategy is developed in consultation with key stakeholders including (but not limited to) the IEP, BCD, NSW Resources Regulator and NPWS, and is detailed within the dedicated MW17-18 SMP (Appendix 5 of the EP Main Report) for the EP Area. The proposed Integrated Subsidence Monitoring Program within the Subsidence Monitoring Program includes:

- **Underground Mining Control** - a key focus as noted above (routine survey of workings and inspections by mining officials);
- **Monitoring ground movement** and surface subsidence impacts via the following methods:
    - Global Navigation Satellite System (GNSS) Monitoring Stations / Continually Operating Reference Station (CORS) – Long occupation real time point data base stations;
- **Remote monitoring of the Surface Environment**:
    - LiDAR (40 points per square meter) – for monitoring of vertical subsidence over the EP Area relative to baseline and Performance Measures.
- **Trigger-based Targeted Surface Inspections** where required (where safely and readily accessible, such as where 4WD trails traverse or are close to the EP Area, and where otherwise triggered by the Master TARP).
- **Data Analysis** data analysis and reporting will monitor specifically for change and target:
    - Any areas detected for significant change by remote monitoring results (including pre and post mining areas), triggering further detailed analysis under the Master TARP, including a process for determining natural or mining-induced rock fall.
    - The process for this detection is detailed further in the Subsidence Monitoring Program and Master TARP respectively. Data for natural rock falls in areas yet to be mined will also provide additional data to the baseline data set.

Airly Mine will implement the monitoring program applicable to land as specified in **Table 4.1** and shown on **Figure 4.1** to monitor the development of possible subsidence related environmental impacts. It is noted that the table is reproduced from the original within the *Subsidence Monitoring Program for MW17-18*, therefore refer to the MW17-18 SMP for full details.

A contingency plan has been developed as a component of this MW17-18 LMP to outline management measures that will be implemented if predicted environmental consequences are exceeded (**Section 5.1**).

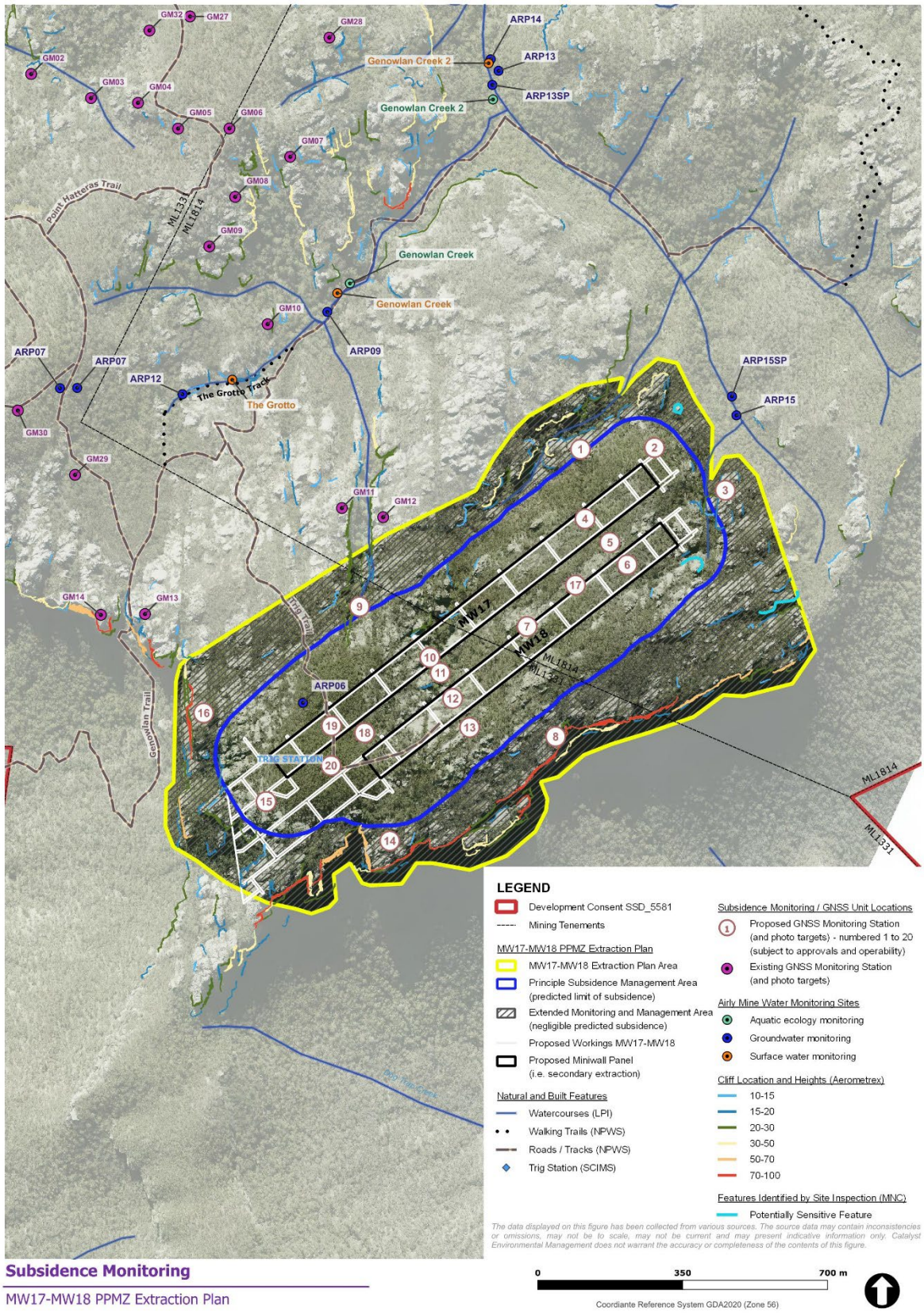
**Table 4.1: Land Features Subsidence Monitoring Program Summary**

| **Monitoring Component / Feature** (Management Plan) | **Purpose/Parameter** | **Monitoring Method** | **Frequency & Duration** |
|---|---|---|---|
| **Cliffs, Minor Cliffs & Pagodas** | Presence/absence of mine-induced damage or change to features (significant rock falls and surface cracking)<br>Various Parameters relevant to each method | LiDAR | Remote aerial monitoring is undertaken at approximately six-month intervals. At least 2 surveys will have been undertaken prior to miniwall extraction. At least one survey throughout extraction MW17-MW18 and at least one survey will be undertaken following completion of panels MW17-MW18. No further detailed analysis after post mining survey has indicated negligible impacts (in the undermined area). |
| | | Targeted GNSS Monitoring Stations | Installed prior to commencement, continuous data from installation, throughout extraction of MW17-MW18 and will remain in-situ until consistent results are obtained demonstrating completion of major subsidence movement (i.e. within survey error) following completion of panels MW17-MW18 |
| | | Targeted visual surface inspections | Only if triggered as per MW17-18 Master TARP triggers |
| **General Land Surface (excl. cliffs and pagodas)** | Evidence of subsidence impacts compared to baseline records | LiDAR | Remote aerial monitoring is undertaken at approximately six-month intervals. At least 2 surveys will have been undertaken prior to miniwall extraction. At least one survey throughout extraction MW17-MW18 and at least one survey will be undertaken following completion of panels MW17-MW18. No further detailed analysis after post mining survey has indicated negligible impacts (in the undermined area). |
| | | Targeted GNSS Monitoring Stations | Installed prior to commencement, continuous data from installation, throughout extraction of MW17-MW18 and will remain in-situ until consistent results are obtained demonstrating completion of major subsidence movement (i.e. within survey error) following completion of panels MW17-MW18 |
| | | Targeted visual surface inspections | Only if triggered as per MW17-18 Master TARP triggers |

| Monitoring Component / Feature (Management Plan) | Purpose/Parameter | Monitoring Method | Frequency & Duration |
|---|---|---|---|
| **The Grotto**[5] | Evidence of subsidence impacts compared to baseline records | LiDAR | Remote aerial monitoring is undertaken at approximately six-month intervals. At least 2 surveys will have been undertaken prior to miniwall extraction. At least one survey throughout extraction MW17-MW18 and at least one survey will be undertaken following completion of panels MW17-MW18. No further detailed analysis after post mining survey has indicated negligible impacts (in the undermined area). |
| | | Targeted GNSS Monitoring Stations | Installed prior to commencement, continuous data from installation, throughout extraction of MW17-MW18 and will remain in-situ until consistent results are obtained demonstrating completion of major subsidence movement (i.e. within survey error) following completion of panels MW17-MW18 |
| | | Undertake surface water quality monitoring in accordance with section 4.2 of the WMP | Undertake surface water quality monitoring in accordance with section 4.2 of the WMP |
| **Walking and 4WD tracks** | Evidence of subsidence impacts compared to baseline records | LiDAR | Remote aerial monitoring is undertaken at approximately six-month intervals. At least 2 surveys will have been undertaken prior to miniwall extraction. At least one survey throughout extraction MW17-MW18 and at least one survey will be undertaken following completion of panels MW17-MW18. No further detailed analysis after post mining survey has indicated negligible impacts (in the undermined area). |
| | | Targeted visual surface inspections | Only if triggered as per MW17-18 Master TARP triggers |

[5] The Grotto is located outside the EP Area, it is not expected that the proposed MW17 to 18 extractions will have any impact on this feature. Additionally, The Grotto is currently monitored as per the Point Hatteras MW13 to 16 EP. However, there is a watercourse located in the EP Area that is connected to the Grotto, hence why it is considered in this EP.

**Figure 4.1: Subsidence Monitoring**



## 4.2 Baseline Monitoring

Baseline monitoring of natural features as they relate to land within the EP Area has commenced and will be obtained by using a combination of the following methods:

- **Landscape Features** (including cliffs and pagodas) using both monitoring ground movement and remote monitoring methods as described (**Section 4.1**) with the EP Area;
    - The installation of the GNSS network is scheduled for completion prior to commencement of development workings with baseline continuous data from installation through to commencement of secondary extraction of nearest panel of MW17. [6]
    - LiDAR baseline flown in December 2022 and June 2023, an additional survey will potentially be flown prior to secondary extraction commencing in MW17.
    - High resolution stereo vertical and 3D oblique photogrammetry baseline flown in May 2020, November 2020, May 2021, May 2022 and December 2022.[7]

Further details including methodologies, locations, parameters, frequencies and duration of monitoring is provided in the MW17-18 SMP (Appendix 5 of the EP Main Report).

[6] Installation of this monitoring equipment is subject to a Review of Environmental Factors and subsequent approval from NPWS.

[7] Note, stereo vertical and 3D oblique photogrammetry is proposed to be replaced by routine LiDAR survey, however the baseline photogrammetry data may be used for data analysis or comparison against future stereo vertical and 3D oblique photogrammetry if required.

# 5 MANAGEMENT, MITIGATION, REMEDIATION AND REPORTING MEASURES

## 5.1 Performance Measures and Indicators

The approved subsidence impact performance measures are specified under Condition 2 in Schedule 3 of SSD_5581. The performance measures relating to potential subsidence impacts (as they relate to this *MW17-18 LMP*) are outlined in **Table 5.1**[8].

**Table 5.1: Relevant Subsidence Impact Performance Measures for Land**

| Land | Performance Measure | Performance Indicator | Applicability to this EP Area |
|---|---|---|---|
| The Grotto | Negligible subsidence impacts or environmental consequences | Presence/absence of mine-induced damage or change to features (no significant rock falls or surface cracking)<br>Watercourse flow volumes within or above historical monitoring data | Applicable [9] (*Located outside of the EP Area*) |
| Cliffs within a 26.5 degree angle of draw of the Airly underground mine workings. | No greater subsidence Impacts or environmental consequences than predicted In the EIS *(Ie occasional rock falls, displacement or dislodgment of boulders or slabs of less than 30 m³, or fracturing, that do not Impact Aboriginal heritage, EECs or public safety),* that in total do not Impact more than 2% of the total area of such cliffs. | Presence/absence of mine-induced damage or change to features (significant rock falls and surface cracking)<br>Various Parameters relevant to each monitoring method | Applicable |
| Pagodas within a 26.5 degree angle of draw of the Airly underground mine workings (other than pagodas affected by the New Hartley interaction zone). | | | Applicable |
| Pagodas within a 26.5 degree angle of draw of the New Hartley potential interaction zone (NHSMPIZ) | No greater subsidence Impacts or environmental consequences than predicted in the EIS. | | **Not Applicable** *(NHSMPIZ is located on Mt Airly. Current EP is on Genowlan Mountain)* |
| Minor cliffs | | | Applicable |
| Steep slopes | | | Applicable |
| All other land not covered by a performance measure above | | | Applicable |

Additional internal performance measures set by Centennial Airly for the mine design (to be monitored by the underground components of the Subsidence Monitoring Program) are detailed in

[8] extracts from Table 1, under Condition 2 in Schedule 3 of Development Consent SSD_5581

[9] The Grotto is located outside the EP Area, it is not expected that the proposed MW17 to 18 extractions will have any impact on this feature. However, there is a watercourse located in the EP Area that is connected to the Grotto, hence why it is considered in this EP.

the MW17-18 SMP (Appendix 5 of the EP Main Report) and have been reflected within the MW17-18 Master TARP (Appendix 6 of the EP Main Report).

To establish compliance with the performance measures, Airly Mine has developed a monitoring program with several integrated components (see **Section 4**) and an associated MW17-18 Master TARP (Appendix 6 of the EP Main Report).

These documents establish appropriate monitoring elements, parameters, and associated trigger levels to demonstrate that the environmental performance satisfies the criteria in Section 5.1 of the EP Main Report.

**Table 5.2** contains the performance indicators which have been established for key monitoring aspects with allocated trigger values to define the following key performance scenarios within the MW17-18 TARP (Appendix 6 of the EP Main Report).

**Table 5.2: Performance Indicators & TARP Risk Management Scenarios**

| Performance Indicator | General Description | Action / Response |
|---|---|---|
| **Level 1: Condition Green** | **Operations within predictions, and within approved impacts**. | Continued operations and monitoring as normal. |
| **Level 2: Condition Amber** | **Operations within approved impacts but potentially exceed / exceed predictions**. | Review and investigation processes are engaged, with adaptive management as required. |
| **Level 3: Condition Red** | **Operations exceed approved impact.**<br>*The approved Performance Measures (criteria thresholds) of Development Consent (and any other relevant approvals) are listed in Condition Red.* | Adaptive Management measures are fully engaged as per the TARP and relevant sections of the Extraction Plan and the SMP. |

## 5.2 Management and Mitigation Measures

As described in **Section 3.2**, the predicted subsidence levels in the EP Area[10] are minimal and well below levels expected to cause damage or any adverse impacts on the natural features. This includes the extended / far-field subsidence monitoring and management area.

The *Subsidence and Environmental* risk assessment (Section 2.2) determined that the risk of impact for landscape features was **Low to Moderate** including aspects associated with potential instabilities for cliffs and pagodas within the EP Area. There are two main management aspects of this MW17-18 LMP, including:

- Mine design to avoid impacts (**Sections 3.1 and 3.2**);
    - The primary management strategy being implemented is impact avoidance through the implementation of a conservative mine design. Mining methods which limit void widths are designed to leave sufficiently large and long term stable final pillars, and hence have minimal subsidence effects and prevent subsidence impacts, and
- Monitoring and management measures (**Sections 4.1 and 4.2**).
    - Monitoring to ensure the mine design is strictly implemented as designed through underground mining controls and monitoring of key landscape features for change (particularly cliffs and pagodas) will be undertaken to confirm that the mine design measures to prevent impact are adequate and remain within consent.

It is noted that management measures associated with public safety aspects of the EP Area are addressed separately within the *PSMP (MW17-18 PSMP)*.

The EP Area is located in rugged, largely inaccessible, terrain within the Mugii Murum-ban SCA which offers opportunities for self-reliant recreation including four-wheel driving, nature study, camping, mountain biking, bushwalking and birdwatching.

The overall management of Mugii Murum-ban SCA is the responsibility of the NPWS. In consultation with the NPWS, IEP, BCD and NSW Resources Regulator, Airly mine has committed to the following monitoring and management measures, as they related to land in the EP Area, including:

- Develop and install subsidence monitoring equipment prior to mining MW17 for baseline data and maintained for the required period post mining with the Subsidence Monitoring Program (SMP) (**Section 4.2**) (for further details refer to Section 4 of the EP Main Report and the Subsidence Monitoring Program (MW17-18 SMP) (Appendix 7);
- Develop an Integrated Subsidence Monitoring Program within the Subsidence Monitoring Program (MW17-18 SMP) that will provide data for trend analysis, that will inform adaptive management if required (**Section 5.2** (for further details refer to Section 4 of the EP Main Report and MW17-18 SMP (Appendix 7);
- In consultation with NPWS, consideration of safety warning signage for placement prior to mining in the vicinity of key areas such as Genowlan Mountain.

Therefore, it is expected with the above controls in place, the subsidence performance measures for land will be achieved. Noting, as detailed by MSEC (2023) and Section 3.2 of the EP Main Report, that

[10] For important context to the current EP Area, it is noted that the external cliffs of the mountain complex are located in the far-field / extended subsidence management and monitoring area (this is the same as the previously approved Cliff Line Zone of First Workings). There is predicted to be negligible subsidence beyond the near field / principal subsidence area, and no surface cracking within or beyond the EP Area.

cliff formations do experience rock falls naturally at a relatively rapid rate which is why they exist in the landform[11].

Notwithstanding this, appropriate responses have been conservatively developed for unexpected/higher than predicted subsidence within a ***Master Trigger Action Response Plan (TARP)*** developed for the Extraction Plan and this MW17-18 LMP.

## 5.3 Remediation and Rehabilitation Measures

Due to the minimal subsidence expected the need to implement remediation/rehabilitation measures for potential impacts are considered unlikely. However, if remediation is required, Airly Mine will undertake remediation in accordance with:

- Conditions 7a)-7c) in Schedule 6 of SSD_5581, noting in particular the requirement to submit a report to DPIE describing remediation options and any preferred remediation measures or other course of action;
- Any relevant actions prescribed in the MW17-18 TARP developed for the Extraction Plan;
- The current Mining Operations Plan and Rehabilitation Management Plan; and
- In consultation with key stakeholders including any affected land holders and relevant government agencies.

A Response Strategy will be adopted if a significant impact is detected as a result of mining activities within the Extraction Plan area.

## 5.4 Trigger Action Response Plan

A detailed MW17-18 TARP (Appendix 6 of the EP Main Report) has been developed for the Extraction Plan to reflect the commitments of this MW17-18 LMP and other related aspects. Whilst impacts are not predicted nor expected, the MW17-18 TARP provides a process of tiered and/or escalating trigger levels for contingency measures should subsidence and impacts be greater than predicted/approved. The MW17-18 TARP applies only to the EP Area (separate TARPs apply to other established EP Areas in various approved mining zones).

Given the mine has been designed specifically to avoid impacts, the MW17-18 TARP includes detailed measures for Underground Mining Controls to ensure that the mining geometry is formed as per the approved design specifications that determine the predicted subsidence movements and impacts.

The MW17-18 TARP includes detailed performance indicators for LMP management. The contingency plan where a performance indictor has been exceeded is outlined in the TARP. A trigger will result in additional investigations to determine if the exceedance is related to non-mining-factors or is a consequence of mining activity. The response to these exceedances will follow the TARP. Management / corrective actions can be implemented where required to remedy these non-conformities and report accordingly.

[11] See Section 1.1 of '*MSEC1270 Subsidence Predictions and Impact Assessments for the Natural and Built Features over and near the proposed MWs 17 to 18 in support of the Extraction Plan Area*'

## 5.5 Adaptive Management and Contingency Planning

An Adaptive Management Framework provides for flexible decision making, adjusted to consider uncertainties as management outcomes are understood. The adaptive management approach at Airly Mine is detailed in the EP Main Report *(refer Section 5.2)*.

In summary, adaptive management at Airly Mine involves monitoring and evaluation against performance measures and associated indicators in the MW17-18 TARP established for the extraction plan and supporting management plans. Where performance indicators indicate increasing levels of risk (i.e., where relevant thresholds of conditions green, amber or red are being exceeded), escalating adaptive management measures are engaged in accordance with the MW17-18 TARP. The process has been successfully implemented in existing Extraction Plan areas at Airly Mine and has been updated to reflect EIS commitments and consent requirements for the Airly Mine Extension Project, including specific performance measures.

## 5.6 Incidents, Complaints, Exceedances and Non-Compliances

Incidents, complaints, exceedances and non-compliances are managed accordance with the requirements of relevant approvals and licences including SSD_5581, EPL12374 and EPBC 2013/.7076, relevant legislation and regulations, and generally in accordance with the *Extraction Plan Guideline* (DPE, 2022). A detailed review of the notification requirements relevant to the Extraction Plan, including this MW17-18 LMP, is provided in the EP Main Report *(refer Section 5.7.1)*, including requirements for:

- Incident or non-compliance reporting in accordance with:
    - Consent condition 9 (Schedule 6) of SSD_5581.
    - EPBC 2013/7076 Condition 1, or as triggered by the TARP (reporting incidents under Management Plans as per Schedule 6, Condition 2 of SSD_5581).
    - EPL12374 condition R2
    - WHS Regulation (Mines and Petroleum Sites, 2022) Section 124 - Duty to notify regulator of certain incidents
    - Section 6 of the Guidelines for Managing Risks of Subsidence (WHS (Mines and Petroleum Sites), February 2017
- Managing complaints.

Incidents, complaints, exceedances and non-compliances will be managed in accordance with the requirements detailed in the EP Main Report *(refer Section 5.6).*

## 5.7 Reporting and Auditing

### 5.7.1 Reporting

Reporting is undertaken in accordance with the requirements of specific requirements of relevant approvals and licences including SSD_5581, EPL12374 and EPBC 2013/7076, and generally in accordance with the *Extraction Plan Guideline* (DPE, 2022). Additionally, high potential incident notifications for unexpected subsidence events in relation to the safety of other persons under WHS legislation has also been included.

A detailed review of the reporting and notification requirements relevant to the Extraction Plan, including this MW17-18 LMP, is provided in the EP Main Report *(refer Section 5.7.1*, including requirements for:

- Regular reporting of impacts and environmental monitoring results in accordance with Condition 10 of Schedule 6 under SSD_5581;
- Annual reporting required in accordance with condition 11 of Schedule 6 under SSD_5581 and separately under EPBC 2013 / 7076;

Reporting and notifications will be undertaken in accordance with the requirements detailed in the EP Main Report *(refer Section 5.7.1)*.

### 5.7.2 Periodic Auditing

Comprehensive Independent Environmental Audits of the entire approved development under development consent SSD_5581 are undertaken within 1 year of commencement and every 3 years thereafter (unless directed otherwise) in accordance with Conditions 12 and 13 of SSD_5581.

Auditing of any rehabilitation undertaken for the mine (including for subsidence if triggered) is undertaken in accordance with the Mining Operations Plan / Rehabilitation Management Plan under Condition 27 in Schedule 4 of development consent SSD_5581.

Additionally, in accordance with section 20(c) of the WHSMP Regulation (2022), auditing will be undertaken in accordance with the Airly Mine Safety Management System (SMS), against the performance standards for measuring the effectiveness of all aspects of the SMS, including the methods, frequency and results of the audit process. The audit should also consider the following matters:

(1) competency of the auditor,

(2) the person responsible for ensuring the audit is conducted, and

(3) the person responsible for implementing the results of the audit.

# 6 PLAN ADMINISTRATION AND RESPONSIBILITIES

## 6.1 Review

In accordance with the requirements under Condition 3 in Schedule 6 of Development Consent SSD_5581, as a minimum Centennial Airly will review this Plan within three months of the following:

a) Submission of an incident report;

b) Submission of an Annual Review (required 31 March annually);

c) Submission of an Independent Environmental Audit; or

d) Any modification to the conditions of SSD_5581.

Where this leads to revisions of the document, within four (4) weeks of the review the revised document must be submitted to DPE for the approval of the Secretary. Continual improvement shall be achieved through monitoring, internal and external communication with stakeholders, implementation of corrective and preventative actions and through monitoring progress against the objectives included in the environmental management plans. The reporting framework (refer **Section 5.7**) will document the effectiveness of this document (and the related Extraction Plan) through comparison of the predicted negligible impacts of subsidence against actual outcomes.

Each variation to this Plan will be identified in the Document Control Table at the beginning of this document.

Additionally, to maintain consistency with existing management plans and previous Extraction Plans at the mine, this MW17-18 LMP will also be reviewed in the event that the following occur:

- Stakeholders raise issues that necessitate a review;
- There are other changes to management requirements (e.g. changes to other related approvals besides consent, such as Mining Lease and/or EPL conditions);
- Where unpredicted impacts or consequences have required implementation of contingency actions under this plan;
- Monitoring or audit processes demonstrate that a review is warranted;
- Where otherwise triggered by the MW17-18 TARP;
- Where triggered by (or for) review of other related management plans (if applicable); or
- Every three (3) years as a minimum (where not already triggered above).

Any amendments to the MW17-18 LMP will be undertaken in accordance with Consent/relevant approvals and in consultation with key relevant stakeholders where required. Following any significant changes, a copy of the amended MW17-18 LMP will be forwarded to all relevant stakeholders.

In addition to planning development consent requirements, Airly Mine must review and as necessary revise the risk control measures implemented for subsidence in accordance with section 20 of the *WHSMP Regulation (2022)*. Any review triggered by WHS Legislation Requirements will be addressed via the process identified in the EP Main Report *(refer Section 5.5)* and the MW17-18 PSMP (Appendix 6 of the EP Main Report).

## 6.2 Key Responsibilities

The responsibility for implementation, monitoring and review of the MW17-18 LMP lies with the Superintendent Environment and Community. The ultimate responsibility for the implementation of the MW17-18 LMP lies with the Mine Manager, who shall make appropriate resources available. The roles and responsibilities for this MW17-18 LMP are outlined in **Table 6.1.**

**Table 6.1: Key Personnel and Accountabilities**

| Position | Responsibility |
|---|---|
| Mine Manager | • Ensuring that sufficient resources are available to implement and execute the requirements of this Plan; and<br>• Reporting triggers/non-conformances to external stakeholders. |
| Technical Services Manager | • Coordinate underground inspections and subsidence monitoring program associated with this MW17-18 LMP;<br>• Coordinate implementation of the mine design and MW17-18 TARP.<br>• Reporting triggers/non-conformances internally to the mine manager as appropriate.<br>• Reporting to DPE and NSW RR of subsidence and pillar system performance upon completion of specified monitoring intervals. |
| Production Manager | • Implement mine design<br>• Establish and maintain underground monitoring and inspections program;<br>• Auditing as required |
| Mine Surveyor | • Survey as built initial development pillars<br>• Establish and maintain subsidence monitoring program;<br>• Internal reporting as required.<br>• Mark up centre lines for driveage in pillars<br>• Produce final mining plan for extraction workings to be carried out in consultation with the Technical Services Manager. |
| Superintendent Environment and Community | Implementation, monitoring and review of this plan, including:<br>• The carrying out of targeted inspections;<br>• The installation and maintenance of signage where required;<br>• Reporting triggers/non-conformances internally to the Mine Manager as appropriate;<br>• Consulting with land owners, landholders and managers regarding any land management issues arising from subsidence within the EP Area. This includes (but may not be limited to) NPWS, Office of Crown Lands and private landowners within the EP Area (if and as applicable);<br>• Reviewing this MW17-18 LMP, including consultation during the review process with relevant stakeholders;<br>• Coordinating any remediation work as required;<br>• Inspecting targeted accessible areas susceptible to tensile and compressive strains and potential cracking as required (e.g. accessible tracks and trails); and<br>• Co-ordinating the generation and submission of formal reporting requirements outlined in this Plan. |

# 7 REFERENCES

Golder (2014a). *Airly Mine Extension Project Environmental Impact Statement*, Golder Associates, April 2014

Golder (2014b). *Subsidence Predictions and Impact Assessment (SIA) for Airly Mine (127621105-003-R-Rev0)*, Golder Associates, January 2014

Golder (2014c). *Subsidence Impact Assessment on the Cliff Lines and Associated Landforms for Airly Mine. Report Number (127621105-001-RRevA)*

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MSEC (2021a). *MSEC1189 Airly Mine – Point Hatteras Cliff Site Inspection Report & Point Hatteras Cliff Impact Assessment Report due to proposed extraction of Miniwalls 13 to 16*

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Office of Environment & Heritage (2015). *Mugii Murum-ban State Conservation Area Draft Plan of Management,* NSW National Parks and Wildlife Service

SCT (2021a). *Airly Mine: Subsidence and Pillar Geometry Modelling Assessment (Report No. AIRLY5240)*

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SCT (2022). *South East Genowlan (MW17-19) Pillar and Panel Width Numerical Modelling Assessment (Report No. AIRLY 5521_Rev1)*

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Strata$^2$ (2019a). *Panel and Pillar Mining Zone: Revised Subsidence Estimates and Impacts (Report No. AIR-006-Rev1)*

RPS (2022a). *Airly Extraction Plan for the Cliff Line Zone ML1814 and MW17-19 Extraction Plan Area Historical Heritage Management Plan Update & Phase 1 Baseline Historical Heritage Assessment (Report No. PR152234-1)*

RPS (2022b). *Desktop review of ML 1814 area and MW17-19 EP Area for Aboriginal Cultural Heritage (Report No. AU213005571)*

RPS (2023). *Baseline Biodiversity Report MW17-19 EP Area and CLZ (ML1814) EP Area (Report No. 152229)*

# APPENDIX 3Biodiversity Management Plan for MW17-18

CENTENNIAL

# Biodiversity Management Plan (MW17-18 BMP)

## MW17-18 Panel & Pillar Mining Zone Extraction Plan

**Airly Mine (SSD_5581)**

**July 2023**

# DOCUMENT CONTROL / TITLE BLOCK

| | | |
|---|---|---|
| **EXTRACTION PLAN DETAILS** | **Title:** | Biodiversity Management Plan: MW17-18 Panel & Pillar Mining Zone Extraction Plan |
| | **Applicant:** | Centennial Airly Mine |
| | **Revision No.:** | MW17-18 BMP_Rev_1 |

## REVISION

| | **Revision No.** | **Details of Revision** | **Date Sent** |
|---|---|---|---|
| **REVISION DETAILS** | Rev_0 | Draft for external consultation | 7/02/2023 |
| | Rev_1 | Updated following external consultation to incorporate a revision of mine design (reduction in miniwall panels) and accompanying pillar width modelling and subsidence predictions and impact assessments | 11/07/2023 |
| | | | |
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Attachment B – Relevant Legal and Other Requirements

Attachment C – Subsidence and Environmental Risk Assessment (EP Area)

Attachment D – Stakeholder Consultation

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Attachment F – Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023)

Attachment G – Technical Report: Baseline Biodiversity Assessment (RPS, 2023a)

Attachment H – Technical Report: Baseline Historic Heritage Assessment (RPS, 2022a)

Attachment I – Technical Report: Baseline Aboriginal Heritage Assessment (RPS, 2022b)

# Abbreviations

| | |
|---|---|
| **BC Act** | *Biodiversity Conservation Act* 2016 |
| **BMP** | Biodiversity Management Plan |
| **CLZ** | Cliff Line Zone of First Workings (approved mining zone under consent SSD_5581) |
| **DP&E** | NSW Department of Planning and Environment |
| **DOC** | Depth of Cover |
| **EEC** | Endangered Ecological Community |
| **ESU** | Environmental Sustainability Unit, formerly within the Division of Resources and Geoscience (DRG), now within the NSW Resources Regulator within NSW DP&E. |
| **EP** | Extraction Plan |
| **EP&A Act** | *Environmental Planning and Assessment Act* 1979 |
| **EPBC Act** | *Environment Protection and Biodiversity Conservation Act* 1999 |
| **EPL** | Environment Protection License |
| **ESU** | Environmental Sustainability Unit (NSW Resources Regulator) |
| **GDE** | Groundwater Dependant Ecosystem |
| **HHMP** | Historic Heritage Management Plan |
| **IEP** | Independent Expert Panel (post-consent) |
| **IRP** | Independent Review Panel (pre-consent) |
| **LCC** | Lithgow City Council |
| **LMP** | Land Management Plan |
| **MEP** | Airly Mine Extension Project |
| **ML** | Mining Lease |
| **MOD** | Modification to Airly Mine's former Development Consent (DA162/91) |
| **NPWS** | NSW National Parks and Wildlife Service |
| **NSW-RR** | NSW Resources Regulator |
| **OEH** | NSW Office of Environment & Heritage |
| **PPMZ** | Partial Pillar Mining Zone (approved mining zone under consent SSD_5581) |
| **PSMP** | Public Safety Management Plan |
| **SCA** | State Conservation Area |
| **SSD** | State Significant Development |
| **SMP** | Subsidence Monitoring Program |
| **SMZ** | Shallow Mining Zone (approved mining zone under consent SSD_5581) |
| **TARP** | Trigger Action Response Plan |
| **TEC** | Threatened Ecological Community |
| **WMP** | Water Management Plan |

# 1 INTRODUCTION

## 1.1 Background

Airly Mine is an existing underground coal mine located approximately 40 kilometres (km) northwest of Lithgow in New South Wales, 170km northwest of Sydney and 4 km to the northeast of Capertee, as illustrated on **Figure 1.1**. The mine is partly located within the Mugii Murum-ban State Conservation Area (SCA). Centennial Airly Pty Limited (Centennial Airly) is the operator of the mine and is a wholly owned subsidiary of Centennial Coal Company Pty Limited (Centennial).

Development Consent for the Airly Mine Extension Project (MEP) was approved on 15 December 2016 subject to the conditions set out in Schedules 2 to 6, as State Significant Development 5581 (SSD_5581). The consent allows extraction of 1.8 million tonnes of run-of-mine (ROM) coal per calendar year for a period of 20 years, which is supplied to both domestic and international markets. As per commitments within the Environmental Impact Statement (EIS) for SSD_5581, Airly Mine is implementing a conservative and staged approach to mining, with different mining methods applied in different areas of the mining lease (ML) called 'Mining Zones'[1].

The *MW17-18 Panel and Pillar Mining Zone Extraction Plan* as detailed in the *Extraction Plan Main Report (the EP Main Report)* and the supporting component plans, continues the conservative and staged approach to mining being implemented by Airly Mine, with secondary extraction proposed in two miniwall (MW) panels (MW17 to MW18). The miniwall panels are located within the *Panel and Pillar Mining Zone* (PPMZ) as detailed within SSD_5581.

Airly Mine have undertaken extensive modelling and mine design revisions, with panel (void) and pillar widths specifically designed to reduce subsidence levels to be consistent with EIS predictions (i.e., maximum vertical subsidence <125 mm). Conservative setbacks to key sensitive features located within the *Cliff Line Zone of First Workings* will continue to be implemented for the MW17-18 PPMZ Extraction Plan, and extensive monitoring and management measures are proposed to demonstrate the subsidence modelling and effectiveness of the mining. The *Extraction Plan Area (EP Area)* is further defined in **Section 1.3.**

The *EP Main Report* and the supporting component plans have been developed using a risk-based approach and in accordance with:

- Relevant requirements listed under *Condition 7 in Schedule 3* under SSD_5581;
- *Extraction Plan Guideline,* NSW Department of Planning and Environment, 2022;
- *Managing Risks of Subsidence Guideline*, NSW Department of Industry, Resources Regulator (NSWRR), 2017; and
- *Consultation with all relevant key stakeholders* (potentially affected by subsidence) and the Independent Expert Panel (IEP) established by NSW Department of Planning and Environment (DPE) for the project.

An Extraction Plan is required to be developed and approved prior to undertaking secondary extraction, including the development of this *Biodiversity Management Plan for MW17-18 (MW17-18 BMP)*.

[1] Airly Mine has five (5) mining zones approved under development consent SSD_5581 as shown in Figure 2 in Appendix 3 of SSD_5581. These zones provide design criteria for different mining methods based on the differing levels of environmental sensitivity of surface features and depth of cover across the Airly mining leases. Section 8 of the Airly Mine EIS (2014) provides further details on the definitions of each of these approved mining zones if required.

## 1.2 Purpose and Scope

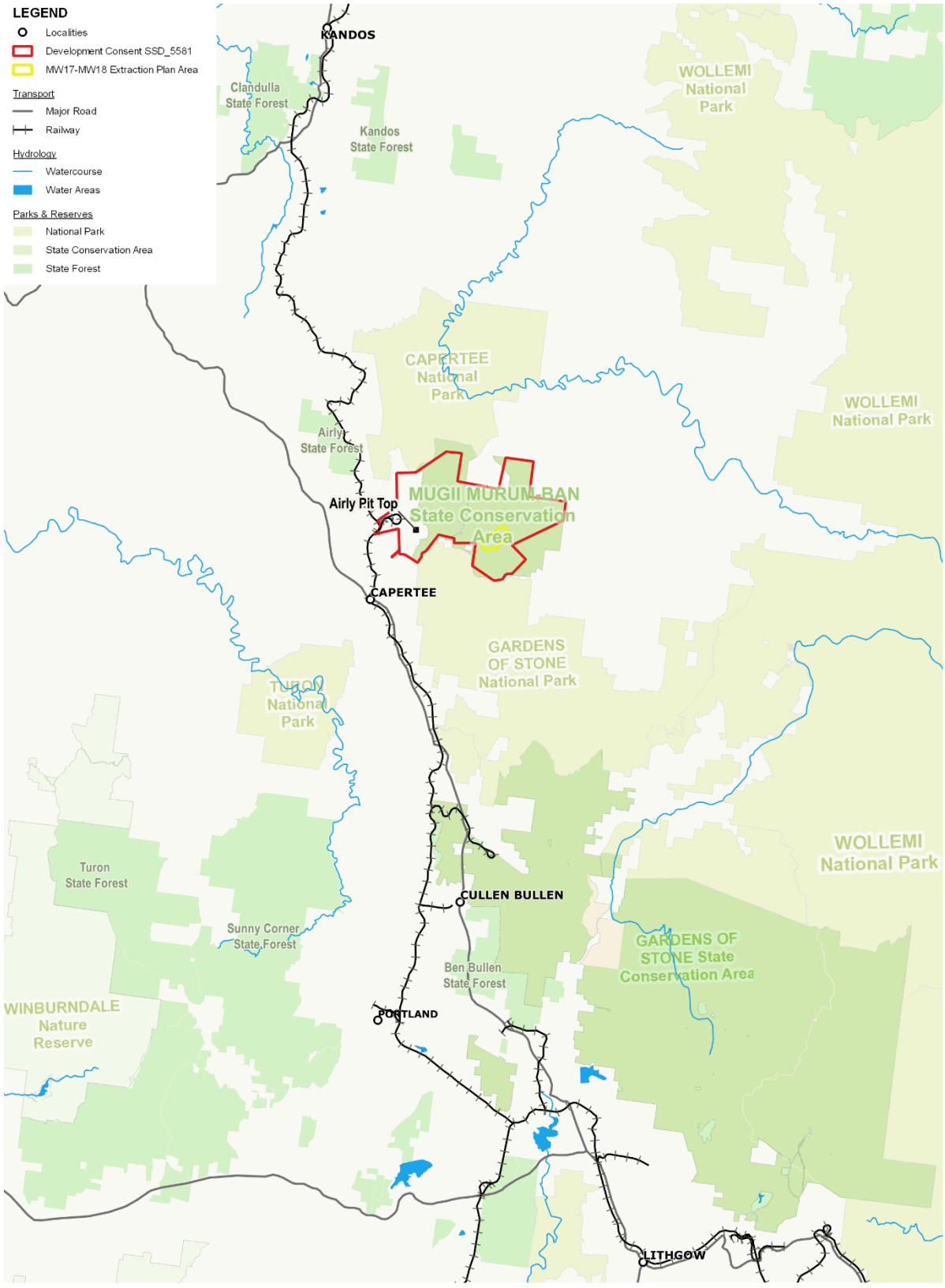
The purpose of this ***MW17-18 BMP*** is to outline the monitoring and management measures to be implemented to address any potential impacts to biodiversity resulting from subsidence associated with secondary extraction via panel and pillar mining within the EP Area.

Void and pillar widths have been specifically designed to support the overlying overburden with minimal subsidence effects. The final pillars left following panel extraction are specifically designed to provide long term stable support to the surface with no surface cracking and minimal ground movement.

Whilst no surface cracking or related impacts have been predicted for panel and pillar mining activities, this management plan importantly continues established monitoring and management frameworks to confirm such for the EP Area, whilst also providing baseline monitoring.

A directly related *Subsidence Monitoring Program for MW17-18 (MW17-18 SMP)* (Appendix 5 of the EP Main Report) has also been specifically developed for the Extraction Plan to address the project performance measures prescribed by consent SSD_5581, supported by a *Master Trigger Action Response Plan for MW17-18 (MW17-18 TARP)* (Appendix 6 of the EP Main Report), including adaptive management measures if required.

## Figure 1.1: Locality Plan




Regional Context

MW17-MW18 PPMZ Extratcion Plan

*The data displayed on this figure has been collected from various sources. The source data may contain inconsistencies or omissions, may not be to scale, may not be current and may present indicative information only. Catalyst Environmental Management does not warrant the accuracy or completeness of the contents of this figure.*

## 1.3 Extraction Plan Area

Two miniwalls are proposed for extraction in the south-eastern area of Genowlan Mountain within the Airly mining leases (ML1331 and ML1814) being MW17 and MW18. The miniwall panels are located within the PPMZ as detailed within SSD 5581. Centennial Airly has applied a 26.5 degree Angle of draw (AoD) around all cliffs mapped within the *Cliff Line Zone of First Workings*. No secondary extraction will occur within the 26.5 degree angle of draw of cliffs within the *Cliff Line Zone of First Workings*.

The EP Area is comprised of two key components as defined below and illustrated on **Figure 1.2**. The proposed overall EP Area boundary includes an Extended/Far Field Monitoring and Management Area which is beyond the predicted extent of subsidence. The Extended/Far Field Monitoring and Management Area involves monitoring and management of sensitive features, primarily being the cliffs and pagodas contained within the *Cliff Line Zone of First Workings* surrounding Genowlan Mountain, as a precautionary approach to demonstrate the mining methods.

**Table 1.1: MW17-18 Panel & Pillar Mining Zone Extraction Plan Area**

| EP Area Components | Defining Comments |
|---|---|
| **Near-Field/Principal Subsidence Management Area** *(Secondary Extraction Area)* | • Approved area of secondary extraction in accordance with the development consent SSD_5581;<br>• The proposed miniwall extraction (second workings) within the **Panel and Pillar Mining Zone** associated with **miniwall panels MW17-MW18;**<br>• **No second workings within 26.5 degree setback from the tops of cliffs** located within the Cliff Line Zone of First Workings to **all miniwall panels i.e. MW17-MW18;**<br>• **Predicted 20 mm limit of vertical subsidence**; and<br>• Located within parts of both Mining Lease ML1331 and ML1814. |
| **Extended/Far Field Monitoring and Management Area** | • **Monitoring and management area only** for this Extraction Plan, no proposed secondary extraction within this Extraction Plan[2];<br>• This area lies entirely **beyond** the 26.5 degree setback from the tops of cliffs located within the Cliff Line Zone of First Workings to all panels MW17-MW18;<br>• Conservatively monitors sensitive features located **beyond** the *Near-field/Principal Subsidence Management Area* for potential subsidence effects further afield; and<br>• Primarily comprises cliffs and pagodas contained within the Cliff Line Zone of First Workings. |

[2] Parts of the Extended/Far-field Monitoring and Management Area overlap with the Cliff Line Zone of First Workings. First workings within the Cliff Line Zone of First Workings requires a separate Extraction Plan and any mining undertaken in the Cliff Line Zone of First Workings will be managed in accordance with an approved Extraction Plan.

## 1.4 Relevant Features

The following section provides an overview of the key relevant features in the EP Area as illustrated on **Figure 1.2**. The natural and built features identified within the EP Area include:

- Surface water;
- Groundwater;
- Aquatic ecology;
- Cliffs, minor cliffs and pagodas;
- Mugii Murum-ban SCA General Surface Area, including steep slopes and rock outcrops;
- Deeply incised canyons/gorges;
- Tracks and trails, fences and gates;
- Flora and fauna habitat;
- Threatened flora and fauna species;
- Facultative Ecosystems existing as sheltered gully forests or along creek lines;
- Public safety/safety of 'others' associated with potential for subsidence; and
- Publicly accessible sections of the EP Area within Mugii Murum-ban State Conservation Area including tracks and trails and general SCA surface area.

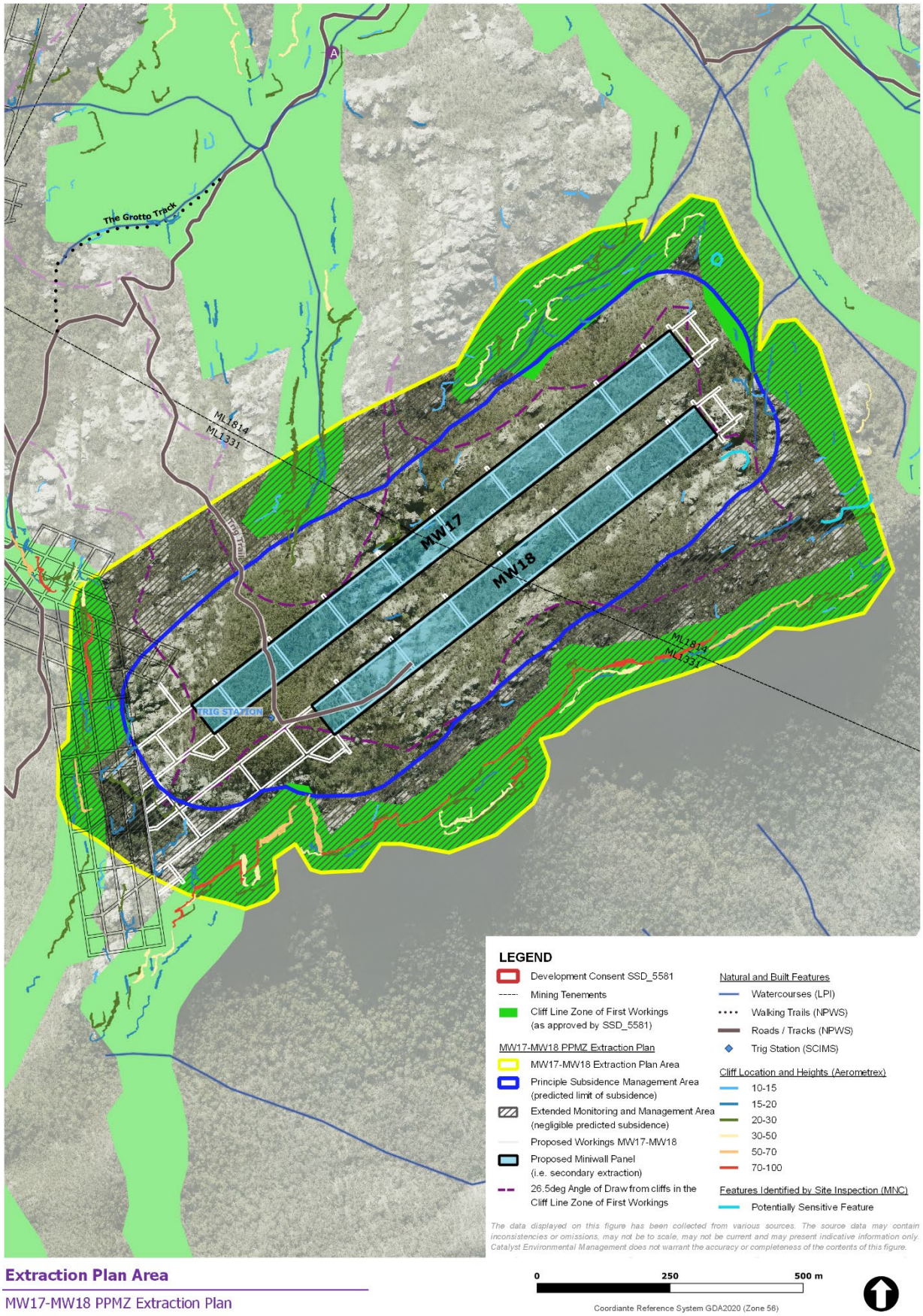
In summary, the features identified within the EP Area and which are subject to this MW17-18 BMP include:

- Flora and fauna habitat;
- Threatened flora and fauna species;
- Threatened fauna species and their habitats; and
- Sensitive vegetation communities such as 'Facultative Ecosystems'.

It is important to note that various sensitive habitat features including the *Pultenaea sp.* Genowlan Point, Genowlan Point *Allocasuarina nana* Heathland, the Grotto and the Oasis do not occur within the EP Area. It is also noted there are no threatened ecological communities (TECs) within the EP Area.

The key biodiversity management features in the EP Area are discussed in further detail in **Section 4**.

**Figure 1.2: Extraction Plan Area (EP Area) and Relevant Features within the EP Area**



## 1.5 Structure of the MW17-18 BMP

The main text sections of this MW17-18 BMP include:

**Section 1** Provides an introduction, purpose, scope, extraction plan area, relevant features to biodiversity and document structure.

**Section 2** Provides the statutory regulatory requirements, risk identification and consultation.

**Section 3** Provides the predicted subsidence impacts assessment and subsidence performance indicators to be used to assess against the relevant subsidence performance measures for biodiversity.

**Section 4** Outlines the key biodiversity management features in the EP Area.

**Section 5** Outlines the management and monitoring to be undertaken for the key features in the EP Area.

**Section 6** Summarises the management, mitigation, remediation and reporting measures for this MW17-18 BMP, including relevant performance measures and indicators, contingency response, adaptive management, reporting and auditing.

**Section 7** Provides an outline of the plan administration and roles and responsibilities for this MW17-18 BMP.

**Section 8** Provides a historical review of references leading to the development of this MW17-18 BMP.

# 2 PLAN DEVELOPMENT AND CONSULTATION

## 2.1 Statutory Requirements

Centennial Airly conducts its operations in accordance with:

- The conditions of the Development Consent (SSD_5581);
- Relevant licences and permits, including conditions attached to the Environment Protection Licence (EPL No. 12374) and Mining Leases (i.e. ML 1331 and ML 1814); and
- Other relevant State and Commonwealth environmental, planning, mining, safety, and natural resource legislation and guidelines.

Centennial Airly maintains a register of relevant environmental legislative and regulatory requirements in a compliance database.

The relevant statutory requirements applicable to the *Pt Hatteras PPMZ Extraction Plan* and this supporting ***MW17-18 BMP*** are presented in the *EP Main Report (refer Section 2.1 and Attachment B)*.

This MW17-18 BMP is a component of the EP Main Report and has been prepared specifically to address Condition 7(i)(iv) of Schedule 3 which states:

> *(7) Prior to carrying out any first workings within the Cliff Line Zone and Zone of First Workings (refer to Figure 2 in Appendix 3) or second workings, the Applicant must prepare an Extraction Plan for the relevant workings to the satisfaction of the Secretary. Each Extraction Plan must:*
>
> *(i)…include a:*
>
> *iv) Biodiversity Management Plan which has been prepared in consultation with DoEE and BCD, which provides for the management of potential impacts and/or environmental consequences of the proposed first and second workings on aquatic and terrestrial flora and fauna, with a specific focus on threatened species populations and their habitats, endangered ecological communities and groundwater dependent ecosystems including, but not limited to:*
>
> - *Pultenaea sp. Genowlan Point;*
> - *Genowlan Point Allocasuarina nana Heathland;*
> - *Prostanthera stricta (Mount Vincent Mint-bush); and*
> - *Eucalyptus cannonii (Capertee Stringybark).*

This ***MW17-18 BMP*** has been developed in accordance with Condition 2 in Schedule 6 of SSD_5581 (management plan requirements). **Table 2.1** details where these conditions have been addressed.

## Table 2.1: Management Plan Requirements

| Key Conditions of Development Consent SSD_5581 | Section Addressed |
|---|---|
| **Schedule 6, Condition 2** ***(Management Plan Requirements)*** | |
| The Applicant must ensure that the management plans required under this consent are prepared in accordance with any relevant guidelines, and include: | |
| a) Detailed baseline data; | Section 4 |
| b) A description of: | |
| • The relevant statutory requirements (including any relevant approval, licence or lease conditions); | EP Main Report (Section 2.1) |
| • Any relevant limits or performance measures/criteria; | Section 3.2 |
| • The specific performance indicators or triggers that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures. | Section 6.1 |
| c) A description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria. | Sections 2.1, 2.3, 3.2, 5, 6.1 |
| d) A program to monitor and report on the: | |
| • Impacts an environmental performance of the development; | Section 5 |
| • Effectiveness of any management measures (see c) above); | Section 6.6 |
| e) A contingency plan to manage any unpredicted impacts and consequences | Sections 5, 6.1 |
| f) A program to investigate and implement ways to improve the environmental performance of the development over time | Section 6.5 |
| g) A protocol for managing and reporting any: | Section 6.6 |
| • Incidents; | |
| • Complaints; | |
| • Non-compliances with statutory requirements; and | |
| • Exceedances of the impact assessment criteria and/or performance criteria; and | |
| h) A protocol for periodic review of the plan. | Section 6.7 |

## 2.2 Specialist Assessment

This *MW17-18 BMP* has been informed by a Baseline Ecology Assessment that was developed by RPS (2023a) for the EP Area with the purpose of reviewing the relevant biodiversity information within the region.

The key biodiversity management features in the EP Area, as detailed in the Baseline Ecology Assessment, are discussed in **Section 4**. Key biodiversity features include:

- Vegetation communities - that predominately consists of heath communities and open forests typical of ridgetops. The EP Area contains eight plant community types (PCTs) dominant in PCT 3865, 3686 and 3695. See **Section 4.2.1**.
- Groundwater Dependent Ecosystems - no high priority GDEs have been identified within the EP Area however, two facultative ecosystems may occur within the gullies on the edges of the EP area. See **Section 4.2.1.2**.
- One threatened flora species is known to occur within this EP area being *Prostanthera stricta* (Mount Vincent Mint Bush). See **Section 4.2.2**.
- One threatened fauna species is persistent within the EP area. The Glossy Black-Cockatoo (*Calyptorhynchus lathami*), frequents the area feeding on abundant stands of *Allocasuarina* species. See **Section 4.2.3**.
- Other mobile threatened fauna species particularly woodland birds, microbats, reptiles and arboreal mammals would utilise the habitat features within the area. Key habitat features (**Section 4.2.3.5**) include:
    - First order creeks;
    - Sandstone habitats;
    - Flowering and fruiting plants;
    - *Allocasuarina* species; and
    - Koala feed trees.

It is important to note that various sensitive habitat features including TECs, *Pultenaea sp.* Genowlan Point, Genowlan Point *Allocasuarina nana* Heathland, the Grotto and the Oasis do not occur within the EP Area. See **Section 4.2.1**.

## 2.3 Risk Identification and Assessment

Centennial Airly has undertaken a dedicated ***Subsidence and Environmental Risk Assessment*** *(Stature RA Number: 1001308023[3])* directly in support of this Extraction Plan which provide a risk framework basis for development of the component management plans.

The *Subsidence and Environmental risk* assessment was completed on the 13 July 2022 with key staff from the Airly Mine including the Technical Services Manager, Statutory Mine Surveyor, Mining Engineer/Compliance Manager and Environment and Community Officer, as well as the General Manager of Technical Services for Centennial and the Lead Consultant for the EP Project Team from Catalyst Environmental Management. The risk assessment was facilitated by the Mining Engineer/Compliance Manager and has been reviewed by key EP Project Team members for Heritage, Ecology and Subsidence.

Risks were identified and assessed through the review of known surface and sub-surface features within the EP Area. The risk assessment also specifically assessed key heads of consideration required by the Managing Risks of Subsidence Guideline (NSW RR, 2017).

A risk ranking (low, moderate, significant, high or extreme) was assigned to each risk/hazard in consideration of the Maximum Reasonable Consequence (MRC) for the given controls. There were 49 potential risks scenarios assessed during the Risk Assessment; eight moderate, 41 low and two assessed as not applicable.

The risk assessment determined that the risk of impact for landscape features (noting the extensive controls identified) was **low to moderate** including aspects associated with cliffs and pagodas within the EP Area.

A copy of the risk assessment is included in the EP Main Report (refer Attachment C). Additional details regarding the management and monitoring of subsidence related impacts within the EP Area have been detailed in **Section 5** and **Section 6.**

## 2.4 Consultation

Condition 7 in Schedule 3 of SSD_5581 requires the preparation of this ***MW17-18 BMP*** in consultation with key relevant stakeholders as detailed below:

- Department of Climate Change, Energy, the Environment and Water (DCCEEW; formerly DoEE); and
- Biodiversity and Conservation Division (BCD), within the Department of Planning & Environment (DPE).

The outcomes of consultation undertaken for the project is provided in the *EP Main Report (refer Attachment D)*, including copies of relevant correspondence such as project presentations delivered by the mine to key stakeholders and relevant formal correspondence received from key stakeholders.

Stakeholder feedback provided has been reviewed and addressed as necessary as part of the development and review of this Extraction Plan and key component plans.

[3] Centennial Airly has adopted the Stature Risk Assessment Program which was developed to ensure consistency in all risk assessments across the Centennial operations. The Stature Risk Assessment Program sets out a consequences table and risk ranking matrix for managing identified risks consistent with AS/NZS ISO 31000:2009.

# 3 SUBSIDENCE ASSESSMENT

## 3.1 Mine Planning and Design

Mine design is the primary control utilised at Airly Mine for subsidence impact avoidance. Centennial Airly have adopted a conservative mine design to control subsidence to levels predicted in the EIS. Approvals for Panel and Pillar Mining are based on predicted surface subsidence levels of up to 100-125 mm.

Void and pillar widths have been specifically designed to support the overburden with minimal subsidence effects at the surface. The final pillars left following panel extraction are specifically designed to provide long term stable support to the surface with no expected surface cracking and minimal ground movement.

The predicted subsidence is not expected to cause adverse impacts on the relevant features covered under this ***MW17-18 BMP***.

Within the EP Area the pillar widths between the miniwall panels have been increased by more than double their original proposed width from 29.5 m to 70 m. Panel void widths have been slightly increased from 61 m to 70.5 m.

## 3.2 Subsidence Predictions

Condition 7(g) of Schedule 3 under Development Consent SSD_5581 and the Extraction Plan Guideline (DPE 2022) requires revised predictions of potential subsidence effects, subsidence impacts and environmental consequences to be presented within the Extraction Plan for the EP Area, including any relevant information obtained since the EIS and consent, in consultation with the Independent Expert Panel (IEP). A detailed review of the revised subsidence predictions is provided in the *EP Main Report (refer Section 3.2)*.

This Extraction Plan has relied on the most recently updated predictions of subsidence effects, subsidence impacts and environmental consequences. The subsidence assessments undertaken for this Extraction Plan are documented in the following reports:

- *SCT (2023). MW17-18 Pillar and Panel Optimisation Assessment (Airly 5612 dated 8 June 2023).* SCT (2023) were engaged to advise on a revision to the pillar and panel layout to limit the maximum predicted subsidence to a precautionary upper design limit of 95 mm (+/-20mm). The proposed revised mining geometry includes two miniwall panels, MW17 and MW18, with panel void widths of 70.5m and 3.0m extraction height separated by a 70 m wide barrier pillar. The predicted subsidence effects for the proposed miniwalls 17 to 18 have been provided by SCT (2023). The maximum vertical subsidence for the revised mine layout is predicted to be 88 mm (+/-20 mm).

Centennial Airly, then engaged MSEC (2023) to prepare a *Subsidence Prediction and Impact Assessment* to support the Extraction Plan based on the subsidence prediction work provided by SCT (2023).

The subsidence predictions and impact assessment is documented in the following report:

- *MSEC (2023). Airly Mine MW17 to MW18 – Subsidence Predictions and Impact Assessments for the Natural and Built Features over and near the Proposed MWs 17 to 18 in Support of the Extraction Plan Application (MSEC1351).*

The primary management strategy being implemented by Airly Mine for the Extraction Plan is impact avoidance through the implementation of a conservative mine design, with panel and pillar widths

specifically designed to have minimal subsidence effects and prevent subsidence impacts. Conservative setbacks to key sensitive features within the *Cliff Line Zone of First Workings* continue to be implemented for this Extraction Plan (i.e. 26.5 degree Angle of Draw).

The maximum incremental vertical subsidence predictions for the EP Area are shown in **Table 3.1**. The predicted subsidence levels are minimal and well below levels expected to cause damage or any adverse impacts on the relevant features within the EP Area. This includes the extended/far-field subsidence monitoring and management area.

**Table 3.1: Maximum Incremental Subsidence Predictions (SCT, 2023)**

| Miniwall Panel Width | Maximum Predicted Subsidence (mm)[a] |
|---|---|
| **One Miniwall** | -39mm |
| **Two Miniwalls** | -88mm |

*a) SCT (2023) note that a subsidence tolerance/natural variability of +/-20mm should be applied to the modelled subsidence*

MSEC (2023) have predicted that if the measured subsidence above MW17 to MW18 is less than 125 mm:

- tilts should be less than 2.5 mm/m
- strains should be less than 2 mm/m

Notwithstanding this, appropriate responses have been conservatively developed for unexpected higher than predicted subsidence within a MW17-18 TARP (Appendix 6 of the EP Main Report) developed for the Extraction Plan and this ***MW17-18 BMP***.

Extensive monitoring and management measures are proposed to demonstrate the subsidence modelling and effectiveness of the mining and monitoring systems. The proposed monitoring approach has been developed in consultation with key stakeholders to minimise further disturbance to the sensitive SCA and builds upon existing management and monitoring practices implemented successfully to date by Centennial Airly.

# 4 BIODIVERSITY MANAGEMENT FEATURES

## 4.1 Landscape Context

The EP Area lies within the Mugii Murum-ban SCA, with the Gardens of Stone National Park to the south and Capertee National Park to the north. The EP Area is characterised by steep sandstone escarpments and pagoda rock formations. The elevation of the EP Area varies from 1020 m above sea level (ASL) in the centre of the EP Area to less than 880 m ASL at the extent of the Genowlan Trig rock formation. Genowlan Trig steeply declines into the valley of tributaries of Genowlan Creek in the east and north.

The EP Area is within the Capertee Uplands of the South Eastern Highlands Interim Biogeographic Regionalisation for Australia (IBRA7) which is dominated by a temperate climate with significant areas in the north and south at higher elevations having a montane climate with milder summers. The EP Area is on the western margin of the Greater Blue Mountains World Heritage Area that surrounds the western rim of the Sydney Basin, preserving the sandstone-based links between the Sydney, Hunter and Central West regions of New South Wales (DECC 2008). This huge expanse of continuous habitat facilitates the movement of many fauna species across the landscape. Animals move through habitats to obtain food, shelter and breeding resources in response to seasonal resource ability and habitat conditions. Large tracts of habitat are generally required for successful dispersal away from natal areas or seasonal migrations (Van der Ree et al 2007).

The EP Area is dominated by the Newnes Plateau Wollemi NSW (Mitchell) landscape with Sydney Basin Diatremes, Volcanic landscape in the southwestern corner and Capertee Plateau, Capertee landscape in the south eastern corner (Mitchell 2002; DECC 2008). The underlying geology of the EP Area comprises Narrabeen Group—fine-grained lithic sandstone occasionally interbedded with thin shale lenses. It spans three mapped soil landscapes, predominately occurring on the 'Warragamba' soil landscape. The higher elevation points of the EP Area, typically above 1000 m ASL transition into 'Wollangambe' soil landscape, whilst as the terrain drops into lower elevation, the soil landscape transitions into 'Hassans Walls' soil landscape (DPE 2020a).

The EP Area occurs within the Capertee River sub-catchment, in the north-west of the Hawkesbury Nepean Catchment Management Authority (CMA). There are three mapped drainage lines within the EP Area which all flow into Genowlan Creek then on into the Capertee River.

## 4.2 Terrestrial Ecology

### 4.2.1 Vegetation Communities

Vegetation within the EP Area and surrounding Mining Lease have been previously mapped by DEC (2006a) (VIS_ID 2231). Vegetation mapping was revised by RPS (2014) through both field and desktop assessments including the use of on ground rapid data points and flora quadrats surveys across the Development Consent Area (including the Genowlan Trig EP Area). During the Baseline Assessment (RPS 2023a) the vegetation boundaries were reviewed and vegetation descriptions were converted to reflect current Plant Community Type (PCT) descriptions as according to the DPE BioNet Vegetation Classification database (DPE 2022b) and State Vegetetation Type Map (SVTM).

Vegetation communities within the EP Area are shown in **Figure 4.1**and are listed in **Table 4-1** and **Table 4-2**.

**Table 4-1: Vegetation communities within the Near Field/Principal Subsidence Management area**

| PCT | PCT Description | Area (ha) |
|---|---|---|
| 3686 | Mount Airly Sandstone Forest | 27.65 |
| 3687 | Newnes Plateau Peppermint-Ash Tall Forest | 0.38 |
| 3695 | Western Blue Mountains Peppermint Sheltered Forest | 4.21 |
| 3862 | Newnes Plateau Rockplate Heath | 3.10 |
| 3865 | Western Blue Mountains Pagoda Scrub | 22.62 |
| **Total** | | **57.95** |

**Table 4-2: Vegetation communities within the Extended/Far-Field Monitoring and Management Area**

| PCT | PCT Description | Area (ha) |
|---|---|---|
| 0 | Not native vegetation | 0.08 |
| 3210 | Blue Mountains Cool Wet Eucalypt Forest | 0.01 |
| 3226 | Western Blue Mountains Montane Wet Fern Forest | 1.45 |
| 3495 | Western Blue Mountains Monkey Gum Gully Forest | 9.95 |
| 3686 | Mount Airly Sandstone Forest | 41.23 |
| 3687 | Newnes Plateau Peppermint-Ash Tall Forest | 0.50 |
| 3695 | Western Blue Mountains Peppermint Sheltered Forest | 12.60 |
| 3731 | Newnes Plateau Rockplate Heath | 3.49 |
| 3865 | Western Blue Mountains Pagoda Scrub | 46.36 |
| **Total** | | **115.68** |

#### 4.2.1.1 Threatened Ecological Communities

No TECs occur within the EP Area (refer **Figure 4.2**).

#### 4.2.1.2 Groundwater Dependent Ecosystems

RPS (2014) and GHD (2021) assessed the potential for vegetation communities to be Groundwater Dependent Ecosystems (GDE) due to their dependency upon groundwater flows and/or shallow aquifers. Groundwater flows were considered too deep to have much interaction with potentially occurring GDEs. Therefore it was deemed that no high prioritiy GDEs occur within the EP Area.

However, there were areas of alluvium that contain shallow aquifers within surrounding Airly Mine lease area (**Figure 4.3**). Two vegetation community in the EP Area occurs within the 'shallow aquifer zone', and hence may interact with groundwater on a transient basis, being PCT 3495: Western Blue Mountains Monkey Gum Gully Forest and PCT 3226: Western Blue Mountains Montane Wet Fern Forest. These communities were ultimately considered to be a 'Facultative Ecosystem' as opposed to a GDE, as the community is not entirely dependent on groundwater, but potentially has some reliance on groundwater on a seasonal basis or only during extended drought periods (Serov et al 2012; RPS 2014).

Facultative GDEs in the predicted drawdown areas of the broader project approved in the MEP EIS (which included panel and pillar mining) have been surveyed upstream and downstream of the areas. No differences in flora species composition was identified, and due to their tolerance, the tree species are likely to persist even in the absence of groundwater. Therefore, the extent of facultative GDEs is unlikely to be significantly reduced (Centennial 2016).

Fractured Zone heights (expected to be in the order of 60 m) will be restricted to the Permian strata and further demonstrates the low likelihood of an impact occurring as a result of Panel and Pillar extraction.

**Figure 4.1: Vegetation Communities**

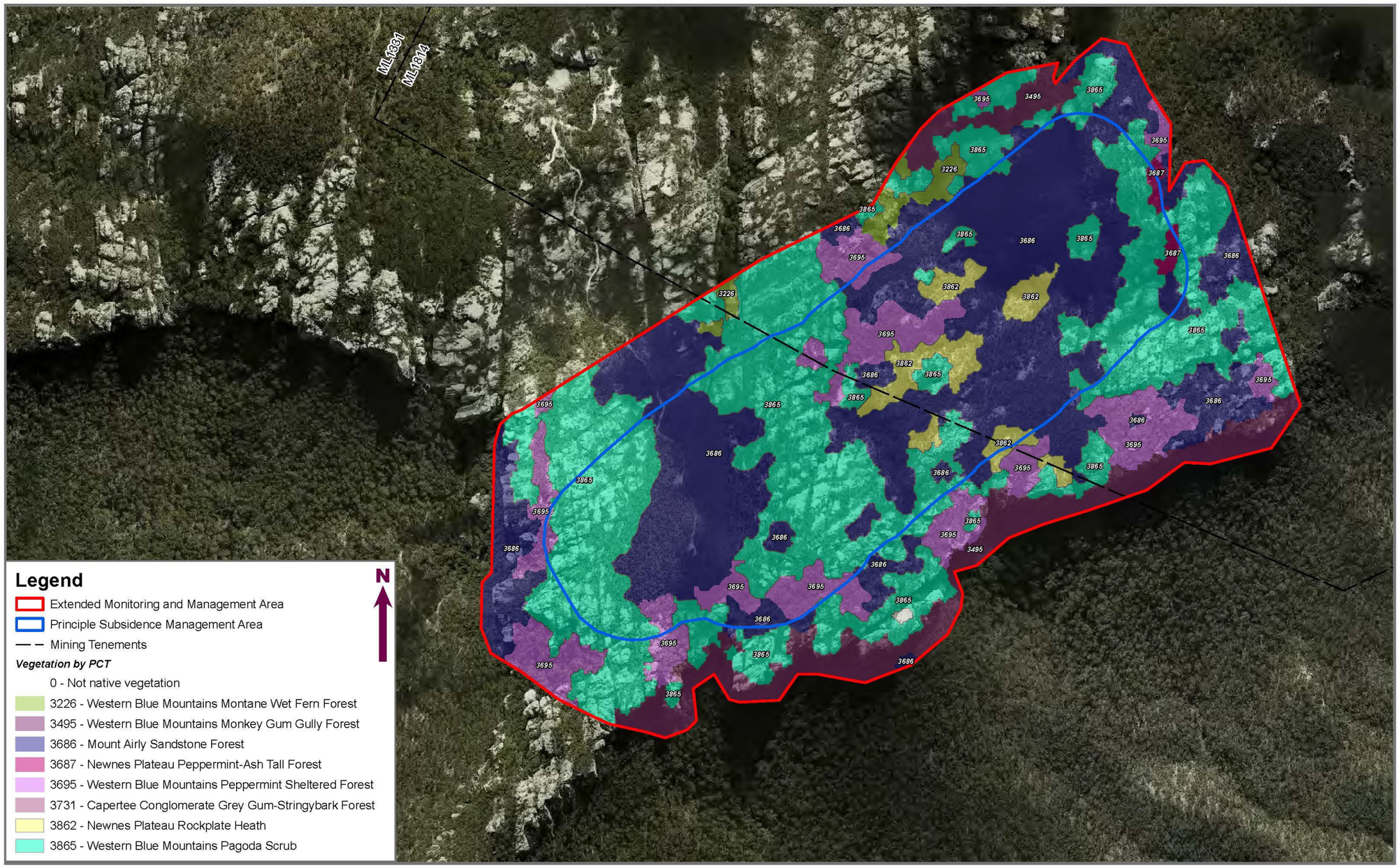


**Figure 4.2: Threatened Ecological Communities**

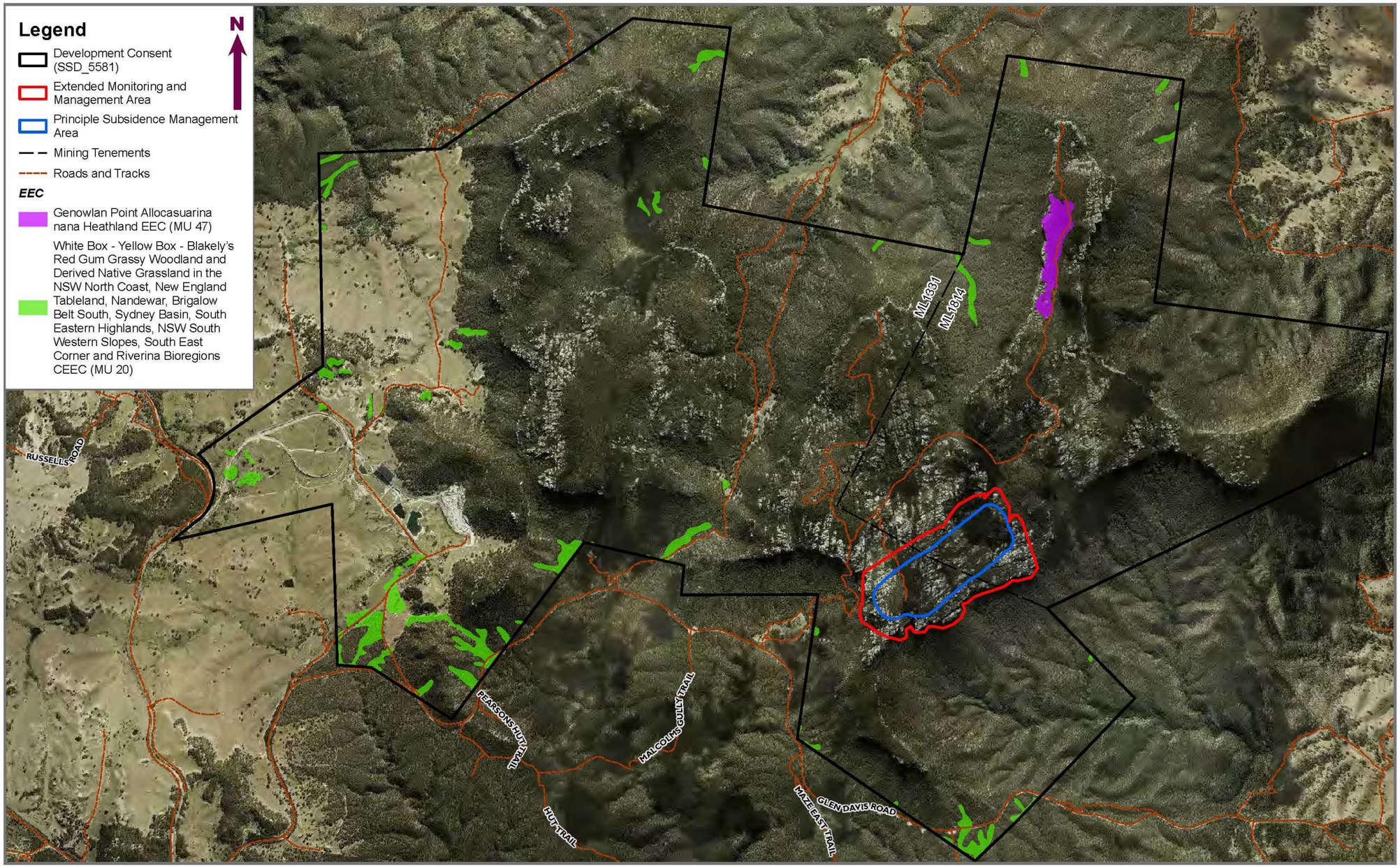



FIGURE 4-2:
THREATENED ECOLOGICAL COMMUNITIES

LOCATION: **AIRLY**

VERSION: **B**
DATE EXPORTED: **29/06/2023**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m

SCALE 1:30,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial Airly**
PROJ: **AU213005568**
PURPOSE: **MW17-18 EP BMP**

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PROJECT PATH: S:\Centennial\All Jobs\5568 - 152229 - Airly Cliff Line Zone EP BMP Update\10 - Drafting\ECO_BMP_MW17_18EP_Figures_.aprx

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**Figure 4.3: Groundwater Dependent Ecosystems**

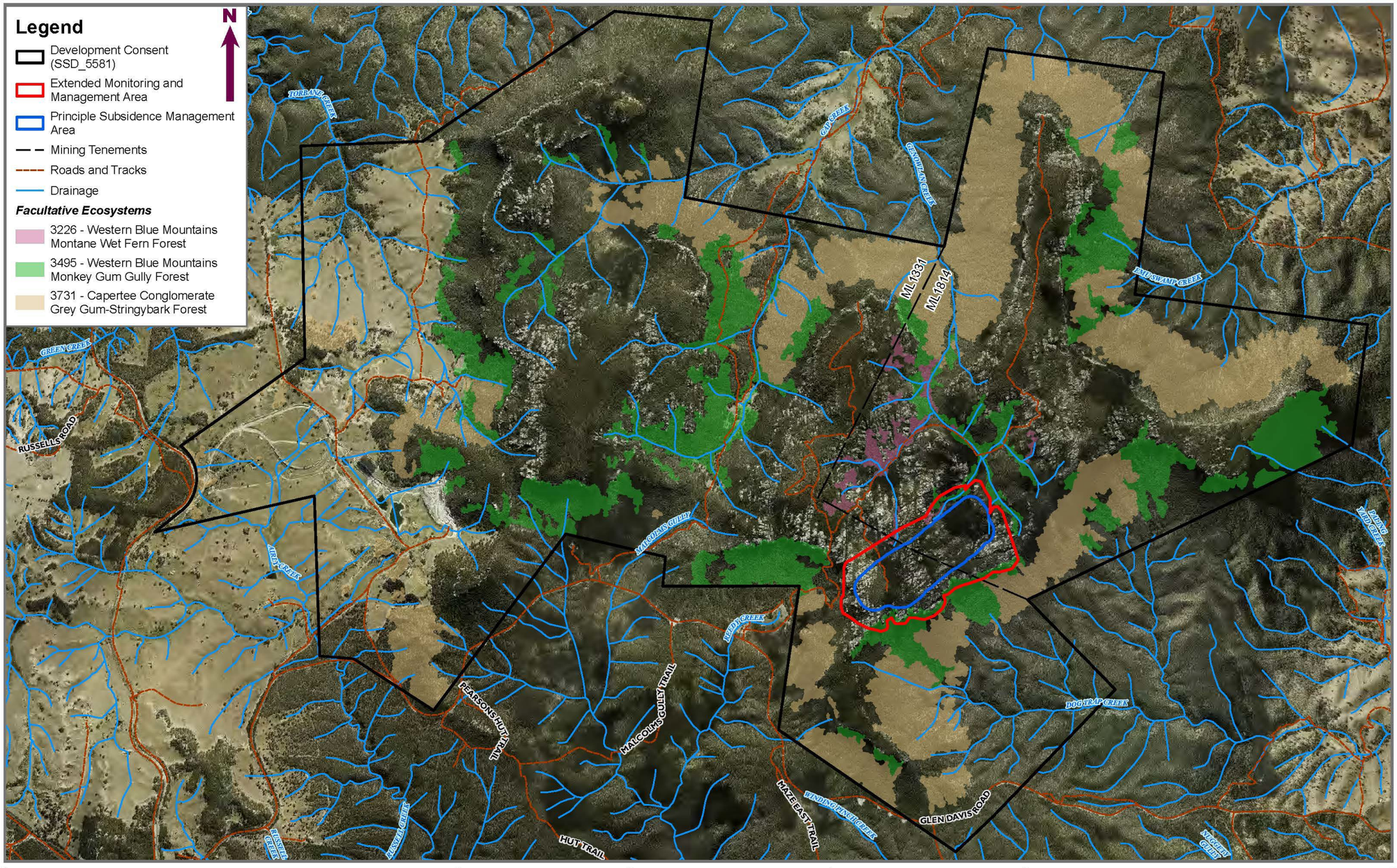


**FIGURE 4-3:**
**GROUNDWATER DEPENDENT ECOSYSTEMS AND HYDROLOGY**

LOCATION: **AIRLY**

VERSION: **B**
DATE EXPORTED: **29/06/2023**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

CLIENT: **Centennial Airly**
PROJ: **AU213005568**
PURPOSE: **MW17-18 EP BMP**

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PROJECT PATH: S:\Centennial\All Jobs\568 - 152228 - Airly Cliff Line Zone EP BMP Update\10 - Drafting\ECO_BMP_MW17_18EP_Figures_.aprx

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### 4.2.2 Threatened Flora

Targeted flora surveys were conducted in 2014 as part of the *Airly Mine 2012-2014 Flora and Fauna Baseline Survey Report* (RPS 2014). Additional field surveys as well as seasonal monitoring has added to this dataset which was compiled to inform the *Baseline Biodiversity Report: MW17-19 EP Area and CLZ (ML1814) EP Area* (RPS 2023a).

**One threatened flora species occurs within the EP Area**; *Prostanthera stricta* (Mount Vincent Mint Bush; BC Act: Vulnerable; EPBC Act: Vulnerable). See **Figure 4.4.**

***P. stricta* occurs within the Near-Field/Principal Subsidence Management Area.** Very low levels of vertical movement are predicted in the Near-Field/Principal Subsidence Management Area, therefore risk of impact to these species are low. *P. stricta* is also present in the **Extended/Far Field Monitoring and Management Area**, where negligible subsidence movements are predicted, and is therefore not expected to be impacted.

*Pultenaea* sp. Genowlan Point (BC Act: Critically Endangered; EPBC Act: Critically Endangered**) is not located within the current EP Area**. This species is located further east on Genowlan Mountain within ML1814. The locations of all threatened flora are displayed in **Figure 4.4.**

**Figure 4.4 Threatened Flora**

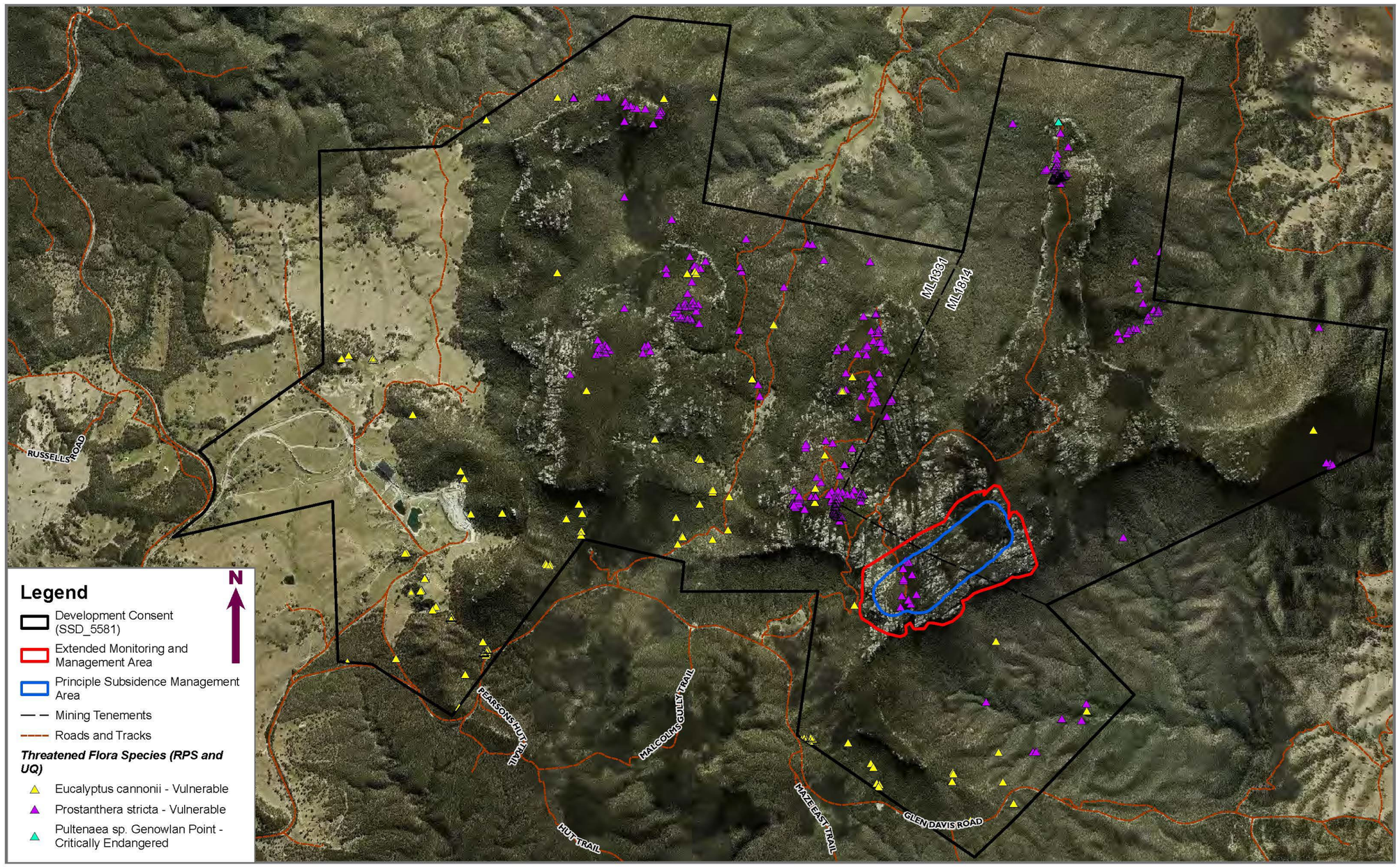


FIGURE 4-4:
THREATENED FLORA

LOCATION: **AIRLY**

VERSION: **B**
DATE EXPORTED: **29/06/2023**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m

SCALE 1:30,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial Airly**
PROJ: **AU213005568**
PURPOSE: **MW17-18 EP BMP**

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PROJECT PATH: S:\Centennial\All Jobs\5568 - 152229 - Airly Cliff Line Zone EP BMP Update\10 - Drafting\ECO_BMP_MW17_18EP_Figures_.aprx

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### 4.2.3 Threatened Fauna

Targeted fauna surveys were conducted in 2014 as part of the *Airly Mine 2012-2014 Flora and Fauna Baseline Survey Report* (RPS 2014). Fauna surveys were conducted across the entire Mining Lease Area (ML 1331 and ML 1814) and were not contained solely within the EP Area. However, given the contiguous habitats across the Mining Lease Area and the mobility of fauna, it is likely that most fauna species detected during surveys will occur within the EP Area.

Additional seasonal monitoring has added to this dataset which was compiled to inform the *Baseline Biodiversity Report: MW17-19 EP Area and CLZ (ML1814) EP Area* (RPS 2023a). The BioNet threatened species database, which informed the Likelihood of Occurrence Analysis have also identified additional threatened fauna species likely to utilise the EP Area based on habitat suitability, connectivity and mobility of the species.

A total of **42 threatened fauna** species occur within the locality (within 10 km of the EP Area) and have habitat in the EP Area as follows:

- 27 birds;
- 8 microbat;
- 5 mammal (excluding microbats); and
- 2 reptiles.

The locations of all threatened fauna records are displayed in **Figure 4.5**.

#### 4.2.3.1 Birds

A total of 27 threatened birds have been previously recorded within the locality; however, due to the mobility of these species and availability of niche habitat features within the EP areas it is presumed that all threatened bird species may periodically utilise resources in the study area as detailed in **Table 4-3**. Of these, two are known to occur within the EP Area (RPS 2022). The Glossy Black-Cockatoo (*Calyptorhynchus lathami*; BC Act: Vulnerable) frequents the area feeding on abundant stands of *Allocasuarina* species, while a single record of Varied Sitella (*Daphoenositta chrysoptera*; BC Act: Vulnerable) also occurs in the EP Area.

**Table 4-3: Threatened bird species dectected within the locality**

| Common Name | Scientific Name | Location | BC Act | EPBC Act | Count (DPE 2022b; RPS 2022) |
|---|---|---|---|---|---|
| Barking Owl | *Ninox connivens* | Locality | Vulnerable | Not Listed | 8 |
| Black Falcon | *Falco subniger* | Locality | Vulnerable | Not Listed | 1 |
| Black-chinned Honeyeater (eastern subspecies) | *Melithreptus gularis gularis* | Locality | Vulnerable | Not Listed | 17 |
| Brown Treecreeper (eastern subspecies) | *Climacteris picumnus victoriae* | Locality | Vulnerable | Not Listed | 94 |
| Diamond Firetail | *Stagonopleura guttata* | Locality | Vulnerable | Not Listed | 61 |
| Dusky Woodswallow | *Artamus cyanopterus cyanopterus* | Locality | Vulnerable | Not Listed | 52 |
| Flame Robin | *Petroica phoenicea* | Locality | Vulnerable | Not Listed | 3 |
| Gang-gang Cockatoo | *Callocephalon fimbriatum* | Locality | Vulnerable | Endangered | 48 |
| Gilbert's Whistler | *Pachycephala inornata* | Locality | Vulnerable | Not Listed | 1 |
| Glossy Black-Cockatoo | *Calyptorhynchus lathami* | Locality | Vulnerable | Vulnerable | 55 |
| Grey-crowned Babbler (eastern subspecies) | *Pomatostomus temporalis temporalis* | Locality | Vulnerable | Not Listed | 5 |
| Hooded Robin (south-eastern form) | *Melanodryas cucullata cucullata* | Locality | Vulnerable | Not Listed | 25 |
| Little Eagle | *Hieraaetus morphnoides* | Locality | Vulnerable | Not Listed | 15 |
| Little Lorikeet | *Glossopsitta pusilla* | Locality | Vulnerable | Not Listed | 55 |
| Masked Owl | *Tyto novaehollandiae* | Locality | Vulnerable | Not Listed | 1 |
| Painted Honeyeater | *Grantiella picta* | Locality | Vulnerable | Vulnerable | 1 |
| Powerful Owl | *Ninox strenua* | EP Area | Vulnerable | Not Listed | 9 |
| Regent Honeyeater | *Anthochaera phrygia* | Locality | Critically Endangered | Critically Endangered | 136 |
| Scarlet Robin | *Petroica boodang* | Locality | Vulnerable | Not Listed | 19 |
| Sooty Owl | *Tyto tenebricosa* | Locality | Vulnerable | Not Listed | 5 |
| Speckled Warbler | *Chthonicola sagittata* | Locality | Vulnerable | Not Listed | 17 |
| Square-tailed Kite | *Lophoictinia isura* | Locality | Vulnerable | Not Listed | 2 |
| Swift Parrot | *Lathamus discolor* | Locality | Endangered | Critically Endangered | 27 |
| Turquoise Parrot | *Neophema pulchella* | Locality | Vulnerable | Not Listed | 21 |
| Varied Sittella | *Daphoenositta chrysoptera* | EP Area | Vulnerable | Not Listed | 14 |
| White-bellied Sea-Eagle | *Haliaeetus leucogaster* | Locality | Vulnerable | Not Listed | 2 |
| White-fronted Chat | *Epthianura albifrons* | Locality | Vulnerable | Not Listed | 1 |

#### 4.2.3.2 Microbats

Eight threatened microbat species have been previously recorded within the locality, due to the mobility of these species and availability of niche habitat features it is presumed that all threatened microbat species may periodically utilise resources within the EP Area. Threatened microbat species associated with the EP Area are detailed in **Table 4-4** below.

**Table 4-4: Threatened microbat species dectected within the locality**

| Common name | Scientific name | Location | BC Act | EPBC Act | Count (DPE 2022b; RPS 2022) |
|---|---|---|---|---|---|
| Eastern False Pipistrelle | *Falsistrellus tasmaniensis* | Locality | Vulnerable | Not listed | 3 |
| Eastern Coastal Free-tailed Bat | *Mormopterus norfolkensis* | N/A | Vulnerable | Not listed | 0 |
| Large Bent-winged Bat | *Miniopterus orianae oceanensis* | Locality | Vulnerable | Not listed | 15 |
| Large-eared Pied Bat | *Chalinolobus dwyeri* | Locality | Vulnerable | Vulnerable | 15 |
| Little Bentwing-bat | *Miniopterus australis* | Locality | Vulnerable | Not listed | 1 |
| Little Pied Bat | *Chalinolobus picatus* | N/A | Vulnerable | Not listed | 0 |
| Greater Broad-nosed Bat | *Scoteanax rueppellii* | Locality | Vulnerable | Not listed | 1 |
| Yellow-bellied Sheathtail-bat | *Saccolaimus flaviventris* | Locality | Vulnerable | Not listed | 3 |

#### 4.2.3.3 Mammals

Five threatened mammal species (excluding microbat species) have been previously recorded in the locality, of which none of been observed within the EP Area. Due to the mobility of these species and availability of niche habitat features it is presumed that all threatened mammal species may periodically utilise resources within the EP Area as detailed in **Table 4-5** below.

**Table 4-5: Threatened mammal species dectected within the locality**

| Common name | Scientific name | Location | BC Act | EPBC Act | Count (DPE 2022b; RPS 2022) |
|---|---|---|---|---|---|
| Greater Glider | *Petauroides volans* | Locality | Endangered | Endangered | 4 |
| Grey-headed Flying-fox | *Pteropus poliocephalus* | Locality | Vulnerable | Vulnerable | 2 |
| Koala | *Phascolarctos cinereus* | Locality | Endangered | Endangered | 2 |
| Spotted-tailed Quoll | *Dasyurus maculatus maculatus* | Locality | Vulnerable | Endangered | 2 |
| Squirrel Glider | *Petaurus norfolcensis* | Locality | Vulnerable | Not listed | 4 |

#### 4.2.3.4 Reptiles

Two threatened reptile species have been previously recorded within the locality (DPE 2022b), Rosenburg's Goanna (*Varanus rosenbergi*; BC Act: Vulnerable) and Broad-headed Snake (*Hoplocephalus bungaroides*; BC Act: Endangered; EPBC Act: Vulnerable), these species are presumed to occur within the EP Area due to habitat suitability. See **Table 4-6** below.

**Table 4-6: Threatened reptile species dectected within the locality**

| Common name | Scientific name | Location | BC Act | EPBC Act | Count (DPE 2022b; RPS 2022) |
|---|---|---|---|---|---|
| Broad-headed Snake | *Hoplocephalus bungaroides* | Locality | Endangered | Vulnerable | 1 |
| Rosenberg's Goanna | *Varanus rosenbergi* | Locality | Vulnerable | Not listed | 1 |

**Figure 4.5: Threatened Fauna**

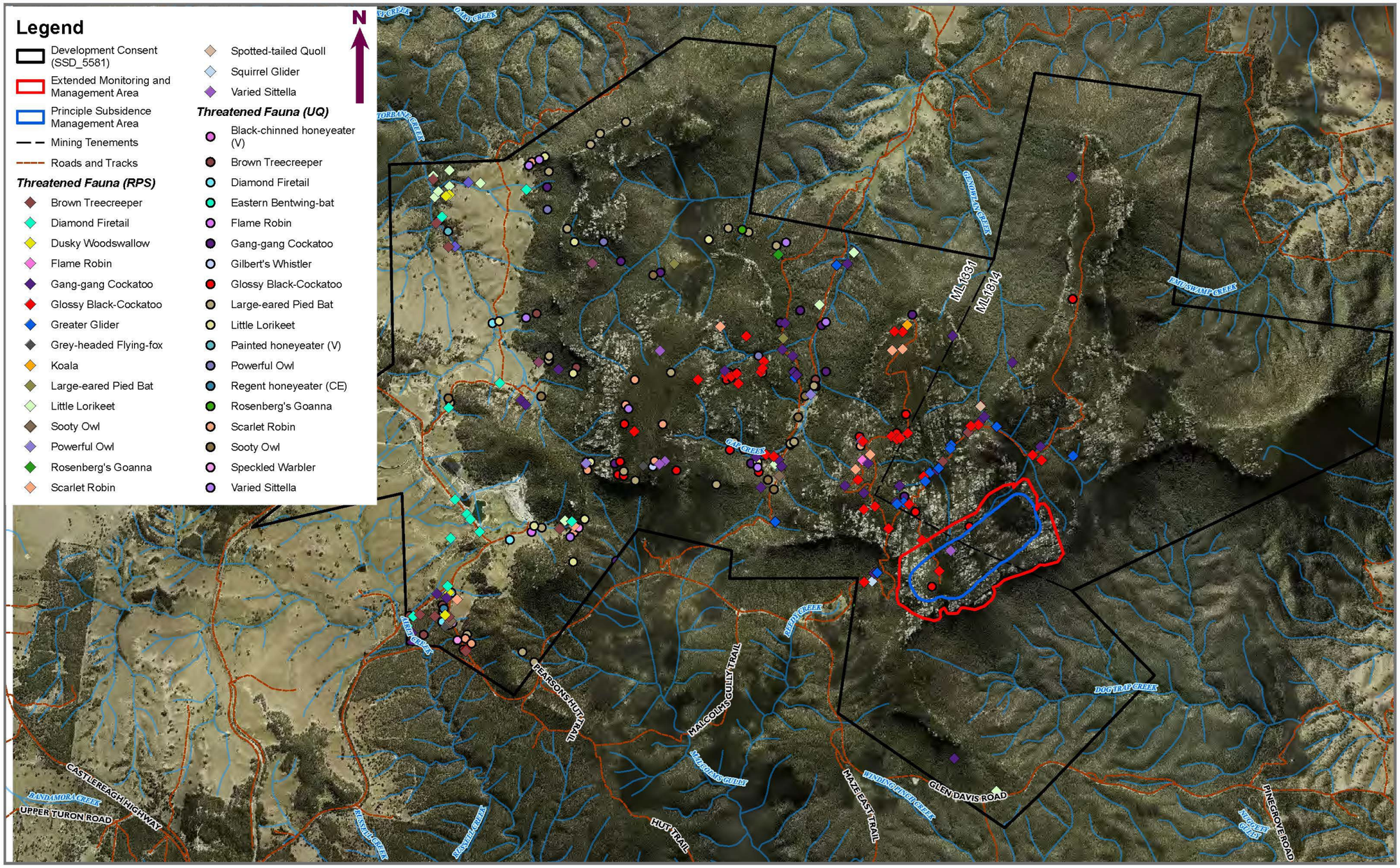


**FIGURE 4-5:**
**THREATENED FAUNA**

LOCATION: **AIRLY**

VERSION: **B**
DATE EXPORTED: **29/06/2023**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

CLIENT: **Centennial Airly**
PROJ: **AU213005568**
PURPOSE: **MW17-18 EP BMP**

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PROJECT PATH: S:\Centennial\All Jobs\5568 - 152229 - Airly Cliff Line Zone EP BMP Update\10 - Drafting\ECO_BMP_MW17_18EP_Figures_.aprx

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#### 4.2.3.5 Habitats

Five broad habitat types occur in the EP Area, being dry sclerophyll forest, wet sclerophyll forest, grassy woodlands, heath and cleared and disturbed areas (DEC 2006; RPS 2014). Dry sclerophyll, grassy woodlands and heath habitats evenly dominate the Genowlan Trig EP Area, occurring across the mesa. Wet sclerophyll habitats only occur in sheltered aspects and the gullies surrounding the Genowlan Trig mesa. Shrubby woodlands typically occur on the lowers slopes and flats of the EP Area. The EP Area entirely comprises of native vegetation with cleared and disturbed lands only occurring within existing tracks.

The **EP Area** includes both the **Near-Field/Principal Subsidence Management Area and Extended/Far Field Monitoring and Management Area** encompassing the mesa and lower slopes of internal and external cliffs. Habitats within the EP Area include sandstone habitats, hollow bearing trees, flowering and fruiting plants, mistletoe, logs and ground timber, aquatic habitats, *Allocasuarina* species, termite mounds and koala feed trees.

It is important to note that various sensitive habitat features including the *Pultenaea* sp. *Genowlan* Point, Genowlan Point *Allocasuarina nana* Heathland, the Grotto and the Oasis do **not** occur within the EP Area.

##### *4.2.3.5.1 Sandstone Habitats and Cliffs*

Internal cliffs are included within the **Near-Field/Principal Subsidence Management Area** and will not exceed the performance criteria stated in Schedule 3 Condition 2 Table 1 of SSD_5581. Habitats include distinctive pagodas, steeps cliffs and escarpments and rocky outcrops or piles of sandstone boulders providing good habitat opportunities for reptile species. Of note, the Broad-headed Snake (*Hoplocephalus bungaroides*) and Rosenburg's Goanna (*Varanus rosenbergi*) is likely to associate with rock crevices and flat sandstone rocks on exposed cliff edges.

The **Extended/Far Field Monitoring and Management Area** encompasses the **external cliffs** and are not expected to experience any impacts (refer to Section 1.3). These habitats include sandstone caves and overhangs that offer roosting habitat to obligate cave-roosting microbat species such as Eastern Horseshoe-bat (*Rhinolophus megaphyllus*) and Large-eared Pied Bat (*Chalinolobus dwyeri*). The Masked Owl (*Tyto novaehollandiae*; BC Act: Vulnerable), is also known to roost in caves and overhangs. Of note, the **Extended/Far Field Monitoring and Management Area** a canyon at the headwaters of Genowlan Creek, and known for its environmental significance. The Grotto contains a conjunction of important sheltering and breeding habitat features due to its dense vegetation or tall Eucalyptus, hollows, sheltered aspect, cliffs and water source. It is a common place to observe threatened fauna species, such as the Powerful Owl (*Ninox strenua*) and the Greater Glider (*Petauroides volans*).

##### *4.2.3.5.2 Hollow Bearing Trees*

The EP Area encompasses hollow-bearing trees in various forms for hollow-dependent arboreal fauna. These species rely on tree hollows for shelter, roosting, or nesting at some stage in their life cycle. Several threatened hollow-dependent species occur in the EP Area including the Greater Glider (*Petauroides volans*), Gang-gang Cockatoo (*Callocephalon fimbriatum*), Glossy Black-Cockatoo (*Calyptorhynchus lathami*), Little Lorikeet (*Glossopsitta pusilla*), Powerful Owl (*Ninox strenua*) and Brown Treecreeper (*Climacteris picumnus victoriae*).

##### *4.2.3.5.3 Flowering Plants*

The EP Area supports an abundance of flowering plants including a diversity of myrtaceous species, such as eucalypts, and other flowering species such as banksias and acacias. These species offer foraging resources including nectar, pollen, Eucalypt sap and Acacia gum to arboreal mammals of

importance the Greater Glider (*Petauroides volans*) and Squirrel Glider (Petaurus norfolkensis). These habitats provide foraging resources for threatened birds such as Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*), Gang-gang Cockatoo (*Callocephalon fimbriatum*; BC Act: Vulnerable), Little Lorikeet (*Glossopsitta pusilla*; BC Act: Vulnerable) and Painted Honeyeater (*Grantiella picta*).

#### *4.2.3.5.4 Mistletoes*

Mistletoe are known to be common throughout the EP Area; the fruits of many mistletoe species show a range of attributes that are attractive to many animals, as they are large, sweet and conspicuous. Mistletoes are also a valuable foraging resource for the threatened Regent Honeyeater (*Anthochaera phrygia*).

#### *4.2.3.5.5 Aquatic Habitats*

Permanent aquatic habitats are uncommon in the EP Area and are limited to ephemeral drainage lines. There are three mapped drainage lines within the EP Area. All creeks are ephemeral and flow into the main tributary of Genowlan Creek then on into the Capertee River. Drainage lines are low or zero flow for most of the year. When flowing, creeks may offer habitat to frog and reptile species.

Genowlan Creek has not been deemed as critical habitat under the BC Act or FM Act (Centennial 2016), however is mapped as Key Fish Habitat under the FM Act (DPI 2022). The Capertee River is also mapped as Key Fish Habitat under the FM Act (DPI 2022), and the Capertee River downstream from the EP Area is mapped as habitat for the Macquarie Perch (*Macquaria australasica*; Threatened species under the FM Act). The closest mapped habitat for the Macquarie Perch is located 25 km east of the EP Area in Glen Davis. Further discussion on aquatic ecology is provided in **Section 4.3**.

#### *4.2.3.5.6 Allocasuarina species*

*Allocasuarina spp.* are a specialist foraging resource for the Glossy Black-Cockatoo (*Calyptorhynchus lathami*) which feeds solely on the seed cones of this genus. It is these discarded cones (termed 'orts') that can be used to quantify the amount of time that Glossy-Black Cockatoos spend foraging in stands of She-oaks and estimate foraging periods (RPS 2023a).

#### *4.2.3.5.7 EP Area Koala Feed Trees*

The EP Area is located within the Central and Southern Tablelands Koala management area (DPE 2021). Several key Koala feed trees for this management area occur within the EP Area across all the PCTs present, with the exception of PCT 3731 heath community. Trees preferred by the Koala that are present on site include:

- *E. agglomerata* (Blue-leaved Stringybark);
- *E. albens* (White Box);
- *E. blakelyi* (Blakely's Red Gum) ;
- E. *cypellocarpa* (Monkey Gum);
- *E. dalrympleana* (Mountain Gum);
- *E. dealbata* (Tumbledown Gum);
- *E. dives* (Broad-leaved Peppermint);
- *E. macrorhyncha* (Red Stringybark);
- *E. melliodora* (Yellow Box);
- *E. mannifera* (Brittle Gum);

- *E. oblonga* (Stringybark);
- *E. piperita* (Sydney Peppermint);
- *E. polyanthemos* (Red Box);
- *E. punctata* (Grey Gum);
- *E. radiata* (Narrow leaved Peppermint);
- *E. rossii* (Inland Scribbly Gum);
- *E. sieberi* (Silvertop Ash); and
- *E. viminalis* (Ribbon Gum).

## 4.3 Aquatic Ecology

### 4.3.1 Hydrology

Airly Mine lies within the Capertee River catchment, which is part of the Greater Hawkesbury/Nepean catchment. The Capertee River flows in a south-east direction to its confluence with the Wolgan River to form the Colo River, which ultimately contributes to the Hawkesbury River and Broken Bay.

The following four major creek systems are located within the Airly Mine Lease Area:

- Airly Creek;
- Emu Swamp Creek;
- Gap-Genowlan Creek; and
- Torbane-Oaky Creek.

All of the watercourses draining the Airly Mine site area are ephemeral. Generally, these watercourses flow for relatively brief periods following significant rainfall events. Flows within Airly Creek, Oaky Creek, Coco Creek and Genowlan Creek become perennial outside the site boundary.

### 4.3.2 Surface water monitoring

Surface water and aquatic ecology baseline assessments and monitoring has been undertaken within waterways in the Airly Mine Lease Area biannually since spring 2015 as per Section 5.4.2 of the Water Management Plan (GHD 2018).

Surface water monitoring includes water quality, flow and aquatic ecology (GHD 2020). Monitoring sites and types are summarised below in **Table 4-7**.

**Table 4-7: Surface water monitoring sites (GHD 2020)**

| Creek System | Monitoring Location | Monitoring type |
|---|---|---|
| Airly Creek | Airly Creek Upstream | • Water quality<br>• Aquatic Ecology |
| | Airly Creek | • Aquatic Ecology |
| | Dog Trap Creek | • Aquatic Ecology |
| Gap-Genowlan Creek | Gap Greek | • Water quality<br>• Flow<br>• Aquatic Ecology |

| Creek System | Monitoring Location | Monitoring type |
|---|---|---|
| | The Grotto | • Water quality |
| | Genowlan Creek | • Flow<br>• Aquatic Ecology |
| | Genowlan Creek 2 | • Water quality<br>• Aquatic Ecology |
| Torbane-Oaky Creek | Torbane Creek | • Aquatic Ecology |

### 4.3.3 Aquatic ecology monitoring

Aquatic ecology monitoring has involved biannual assessment of seven sites across the Airly Mine Lease Area. Macroinvertebrate, water and sediment samples have been collected from biannually where sufficient water was present. Instream habitat surveys have also undertaken noting the condition of the riparian zone and instream vegetation.

Overall, the aquatic habitat in Genowlan Creek was determined to be in the best condition (GHD 2018). The combination of low nutrient and metal concentrations and diverse habitat availability at the site supports a diverse macroinvertebrate community which is largely sensitive to pollution. The macroinvertebrate communities at The Grotto and Gap Creek monitoring sites also contain pollution sensitive trace and there is little disturbance related to human activities at these sites.

Airly Creek, Torbane Creek and Dog Trap Creek were more highly disturbed by grazing and agricultural land use. Monitoring sites in these catchments were dominated by pollution dominant taxa. The similarity of the macroinvertebrate communities in the Airly Creek sites upstream and downstream of the surface facilities area indicated that there was no impairment of the community at the downstream site associate within overland flows from Airly Mine (GHD 2018).

The most recent aquatic ecology monitoring (GHD 2020) has found that there was no evidence of impacts on water quality, sediment quality, macroinvertebrate communities or instream habitat due to mining operations in 2020. Airly Creek impact site contained similar water quality and macroinvertebrate communities to Airly Creek background site and baseline sites Torbane Creek and Dog Trap Creek, reflecting the influence of surrounding land use (i.e. grazing and agriculture) and underlying geology on water quality, and limited instream habitats. Improved macroinvertebrate condition was observed at upland baseline sites on Genowlan Creek which reflects the minimal anthropogenic disturbance, and generally improved water, sediment and instream habitat quality, relative to the lowland sites.

#### 4.3.3.1 Stygofauna Baseline

Stygofauna samples were collected from three bores over four sampling events between May 2013 and June 2014. Additional monitoring was undertaken in March and December 2016 and February and August 2017. No stygofauna were collected from ground water bores associated with Airly Mine during these sampling events. Additional post-EIS monitoring was undertaken in March and December 2016, February and August 2017, November 2018, April 2019 and October 2020. Stygofauna have been collected in low densities and diversity during stygofauna monitoring conducted between 2018 and 2020 (GHD 2018, 2020, 2021).

No end date has been specified for the cessation of monitoring requirements for Stygofauna in the Airly Mine Water Management Plan or the Western Region Stygofauna Monitoring and Assessment Plan.

# 5 BIODIVERSITY MONITORING PROGRAM

## 5.1 Terrestrial Ecology

### 5.1.1 Current Biodiversity Monitoring

A **broadscale Biodiversity Monitoring Program is currently being undertaken at Airly within the Development Consent Area (SSD_5581)** as per the Western Region Biodiversity Management Plan – Appendix B Airly (Centennial 2019a) required by consent condition 15, Schedule 4. The broader monitoring program within the Mining Lease Area **includes the current EP Area (MW17-18).** The monitoring program commenced in 2012 by the University of Queensland (UQ) and was further developed and refined in 2015 by RPS whereby it has been carried out annually by RPS to present. The monitoring program has been conducted in line with the Development Consent (SSD-5581) except for the areas which have restricted access and are being monitored by NSW National Parks and Wildlife Service (NPWS) (*Pultenaea* sp. Genowlan Point and Genowlan Point *Allocasuarina nana* Heathland Endangered Ecological Community (EEC).

Considering the **low impacts predicted** (i.e. 20mm limit of vertical subsidence) within **the Near-Field/Principal Subsidence Management Area** and **nil potential for impacts within the Extended/Far Field Monitoring and Management Area**, the current Biodiversity Monitoring Program has been reviewed and updated within the context for the current EP Area (MW17-18) taking into consideration previous monitoring results and recommendations, and recent findings of the Baseline Assessment. This allows for the wealth of information obtained from previous monitoring efforts to be integrated into the baseline data and design.

Currently, the monitoring program includes the following:

**Flora**

- Point transects and floristic density plots for known locations of *Prostanthera stricta*;
- Tree health assessment for individual *Eucalyptus cannonii* to measure condition (crown density and crown extent), growth changes (height and diameter) and contextual data (erosion and weed presence);
- Biodiversity Assessment Method (BAM) plots to assess vegetation condition and species richness within *White Box – Yellow Box – Blakely's Red Gum Woodland* Critically Endangered Ecological Community (CEEC).; and
- Weed transects established in conjunction with point transects and BAM plots.

Monitoring and management measures for *Pultenaea sp*. Genowlan Point and Genowlan Point *Allocasuarina nana* Heathland is being undertaken by NPWS.

**Fauna**

- Site assessments within suitable habitat dominated by *Allocasuarina littoralis* to assess the presence and age of chewed orts, which is a primary food-source for the Glossy Black-Cockatoo (*Calyptorhynchus lathami*);
- Call playback and spotlighting for forest owls in addition to visiting known roosts to ascertain the level of continued activity in the area;
- Targeted surveys by song meter analysis for large forest owls and nocturnal mammals;
- 30-minute woodland bird surveys across permanent transects to target threatened bird species known to occur across the site and in the local area;

- Targeted surveys via echolocation recording apparatus (Anabat) at foraging, roosting sites and flyways of cave-dwelling microbats;
- Targeted trapping surveys by remote infrared cameras in gully habitats and lower lying rocky habitats within the Airly Mine consent boundary to develop a native and exotic vertebrate census; and
- Opportunistic surveys of all terrestrial vertebrates.

### 5.1.2 Monitoring Design

The principles of a Before-After-Control-Impact (BACI) monitoring design were applied in the initial UQ monitoring program (UQ 2014). In a BACI design, data is simultaneously collected at 'impact' and 'control' sites, before and after an impact occurs, thus establishing a comparative quantitative dataset suitable for determining causation where significant change is detected within an 'impact site'.

However, for reasons relating to monitoring site placement, all the control sites are located within the Development Consent Area (SSD_5581) have progressively transitioned into impact sites as new miniwalls were established. This is more akin to a Before-After monitoring framework. Such a framework is capable of detecting change however is insufficiently robust to identify causation (i.e. is change related to bushfire, rainfall, drought of from originating from operational activities).

#### 5.1.2.1 Monitoring Design Corrections

Additional control sites are required to maintain the BACI monitoring model as originally intended (SMI CMLR 2013). Four additional control sites in two locations have been added in 2022 (RPS 2023b) to correct for this issue, however these can plots would only serve as control plots to areas that have not yet been undermined (i.e. this BMP and future BMPs). Additional impact sites within this EP Area are also required to improve the reliability of monitoring analysis (i.e. increased power in statistical analysis), therefore a minimum of two transects have been installed within each EP Area.

Monitoring methodologies have been updated in-line with the advancement of technologies where feasible, practical and flexible. For example, previously surveys for forest owls have been conducted by means of active searches for evidence of recent activity. However, this can be enhanced by the deployment of song meters which would reduce the effect of error, observer bias and allow for increased consistency between years. As a wide range of fauna species use vocalizations for a variety of vital functions, the use of bioacoustics can be applied across different groups of fauna proving it versatile methodology (e.g. low cost surveys for the koala).

### 5.1.3 Monitoring Program

A summary of the biodiversity values relevant to this EP Area is provided in **Section 4**. Key biodiversity values are to be monitored at both impact and control sites across the Development Consent Area and EP Area annually prior to, during and after impact.

To date, monitoring performed within the EP Area is considered baseline monitoring as underground mining is yet to commence. **Table 5-1** describes the monitoring stratification, parameters and frequency for each biodiversity value within the broader Airly Development Consent Area and within the EP Area (shaded purple). Refer to **Figure 5.1** and **Figure 5.2** for monitoring locations.

**Table 5-1: Biodiversity Monitoring Program – Terrestrial Biodiversity**

| Biodiversity Value | Repetition/Site Type | Stratification Location | Method | Timing | Responsibility | EP Area |
|---|---|---|---|---|---|---|
| Vegetation Communities | | | | | | |
| White Box – Yellow Box – Blakey's Red Gum Woodland EEC | Four sites | Permanently established plots in PCT 703 within the Airly Development Consent Area | BAM Plot survey to assess vegetation condition (DPE 2020d) | Annually in Spring/Summer | Centennial Airly Ecologist | Site specific (Centennial 2019a); Airly (Centennial 2018; Centennial 2019b) |
| Genowlan Point *Allocasuarina nana* Heathland EEC | N/A. Carried out by NSW NPWS | Genowlan Point | N/A. Carried out by NSW NPWS | N/A | NSW NPWS | N/A |
| Facultative GDEs | Two sites | Permanently established plots in PCT 3495 within the Airly Development Consent Area | BAM Plot survey to assess vegetation condition (DPE 2020d) | Annually in Spring/Summer | Centennial Airly<br>Ecologist | Pt Hatteras MW 13-16 BMP (Centennial 2021) |
| Flora | | | | | | |
| *Prostanthera stricta*[1] | Two impact transects<br>'Impact' transects: 7 and 10[1]<br>'Control' transects: 14, 18[1], 19[1], 20[1],and 22[1] | Representative sample of known locations of *Prostanthera stricta* across the Airly Development Consent Area and EP Area. | Point intercept method and floristic density plots | Annually in Spring/ Summer | Centennial Airly Ecologist | **This EP area (MW17-18)**<br>All |

| Biodiversity Value | Repetition/Site Type | Stratification Location | Method | Timing | Responsibility | EP Area |
|---|---|---|---|---|---|---|
| *Eucalyptus cannonii* | 22 sites in total | Representative sample of known locations of *Eucalyptus cannonii* across the Airly Development Consent Area. | Tree condition, crown extent, growth changes and associated species assessment. | Annually in Spring/Summer | Centennial Airly Ecologist | Site specific (Centennial 2019a); Airly (Centennial 2018; Centennial 2019b); Pt Hatteras MW 13-16 BMP (Centennial 2021) |
| Weed species | Weed transects to occur in concurrence 4 White Box – Yellow Box – Blakey's Red Gum Woodland EEC sites. Weed species presence is also noted at the 22 *E. cannonii* sites. | Permanently established plots across the Airly Development Consent Area and EP Area | Point intercept method and floristic density plots | Annually in Spring/Summer | Centennial Airly Ecologist | **This EP area (MW17-18)** All |
| *Pultenaea sp. Genowlan Point* | N/A. Carried out by NSW NPWS | Genowlan Point | N/A. Carried out by NSW NPWS | N/A | NSW NPWS | N/A |
| Fauna | | | | | | |
| Birds | Glossy-black Cockatoo sites[2] | Areas of She-oak (*Casuarina spp.* and *Allocasuarina spp*., but specifically *Allocasuarina littoralis*) across the Airly Development Consent Area and EP Area | Percent cover of *Allocasuarina* species and the presence and quantity of orts recorded. | Annually in Summer | Centennial Airly Ecologist | **This EP area (MW17-18)** All |

| Biodiversity Value | Repetition/Site Type | Stratification Location | Method | Timing | Responsibility | EP Area |
|---|---|---|---|---|---|---|
| | Large forest owl sites – Song Meters | Valleys, known roosts and other areas of potential habitat within the Airly Development Consent Area | Targeted call-playback/spotlighting Stationary song meter installation to determine presence | Annually in Spring/Summer | Centennial Airly Ecologist | Site specific (Centennial 2019a); Airly (Centennial 2018; Centennial 2019b); Pt Hatteras MW 13-16 BMP (Centennial 2021) |
| | Diurnal bird sites | Across the Airly Development Consent Area | 30 minute surveys across permanent transects | Annually in Spring/Summer | Centennial Airly Ecologist | Site specific (Centennial 2019a); Airly (Centennial 2018; Centennial 2019b) |
| Microbats | Foraging and/or roost sites | Foraging and roosting sites and flyways within the Airly Development Consent Area | Anabat units to detect presence of microbat species | Annually in Summer | Centennial Airly Ecologist | **This EP area (MW17-18)**<br><br>All |
| Mammals (excluding microbats) and reptiles | Infrared camera trap sites to conduct:<br>- Vertebrate census<br>- Pest species census | Gully habitats and rock habitats within the Airly Development Consent area and EP Area in conjunction with the reptile census. | Baited stationary infrared cameras to determine presence and count | Annually in Summer | Centennial Airly Ecologist | **This EP area (MW17-18)**<br><br>All |

| Biodiversity Value | Repetition/Site Type | Stratification Location | Method | Timing | Responsibility | EP Area |
|---|---|---|---|---|---|---|
| | Koala sites (in conjunction with the Large Forest Owl sites) | Valleys and other areas of potential habitat within the Airly Development Consent Area in conjunction with Large Forest Owl census. | Stationary song mater installation to determine presence | Annually in Summer | Centennial Airly Ecologist | Site specific (Centennial 2019a); Airly (Centennial 2018; Centennial 2019b); Pt Hatteras MW 13-16 BMP (Centennial 2021) |
| | Gliders - Greater Glider and Squirrel Glider | Valleys and other areas of potential habitat within the Airly Development Consent Area in conjunction with Large Forest Owl census. | Targeted call-playback/spotlighting | Annually in Summer | Centennial Airly Ecologist | Site specific (Centennial 2019a); Airly (Centennial 2018; Centennial 2019b) |

Shaded rows are directly associated with this MW17-18 EP Area, whilst the non-shaded rows occur as part of the specific Airly Biodiversity Management Plan (RPS 2017a) no sites occur directly within this EP Area.

[1] Additional monitoring sites to be established at the commencement of this *MW17-18 BMP*. Previous *P. stricta* data collected at these sites from 2012 to 2014 by UQ.

[2] One additional Glossy-black Cockatoo monitoring sites introduced into the EP Area

**Figure 5.1: Flora Monitoring Locations**

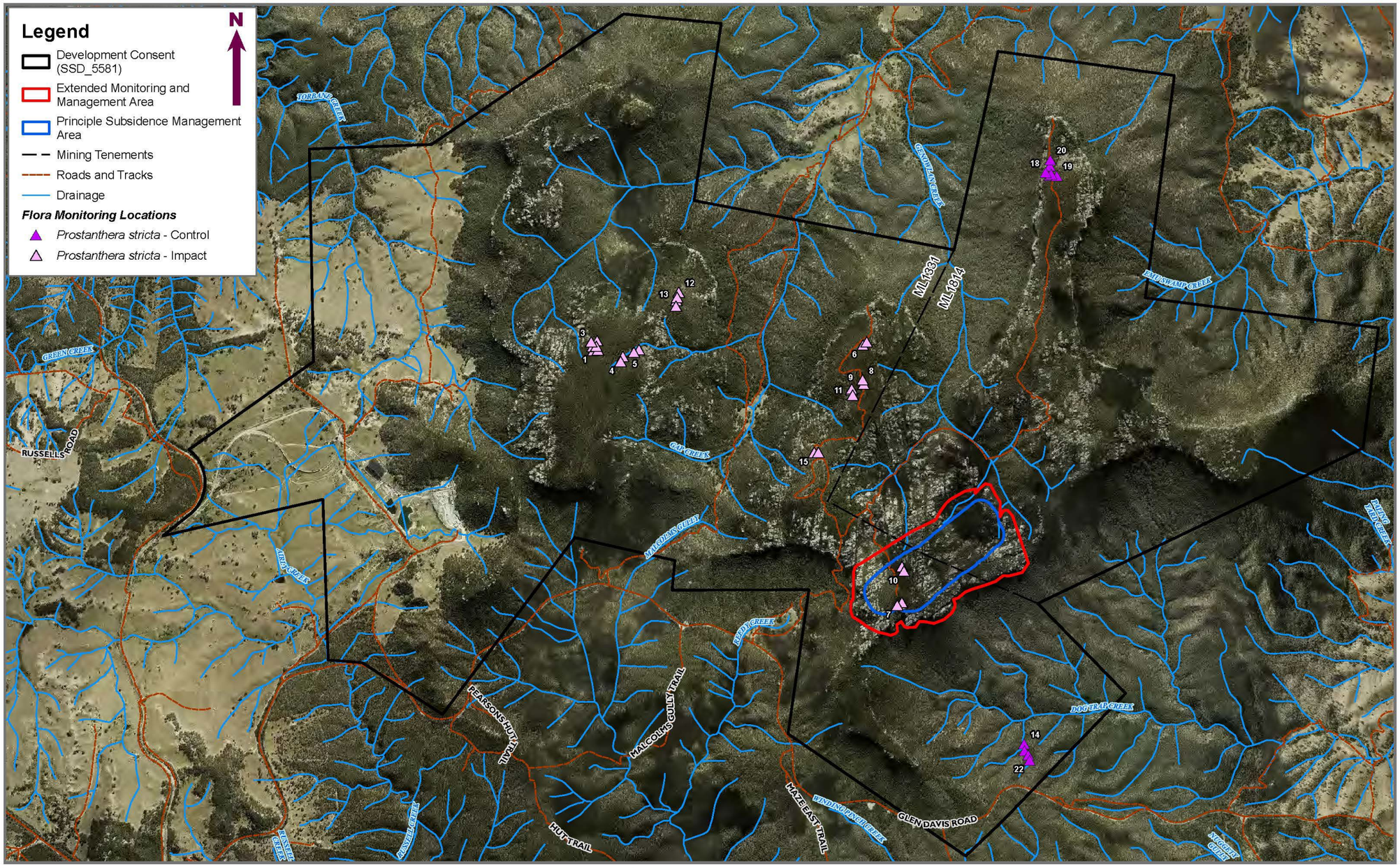


**FIGURE 5-1:**
**FLORA MONITORING LOCATIONS**

LOCATION: **AIRLY**

VERSION: **B**
DATE EXPORTED: **29/06/2023**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m

SCALE 1:30,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial Airly**
PROJ: **AU213005568**
PURPOSE: **MW17-18 EP BMP**

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**Figure 5.2: Fauna Monitoring Locations**

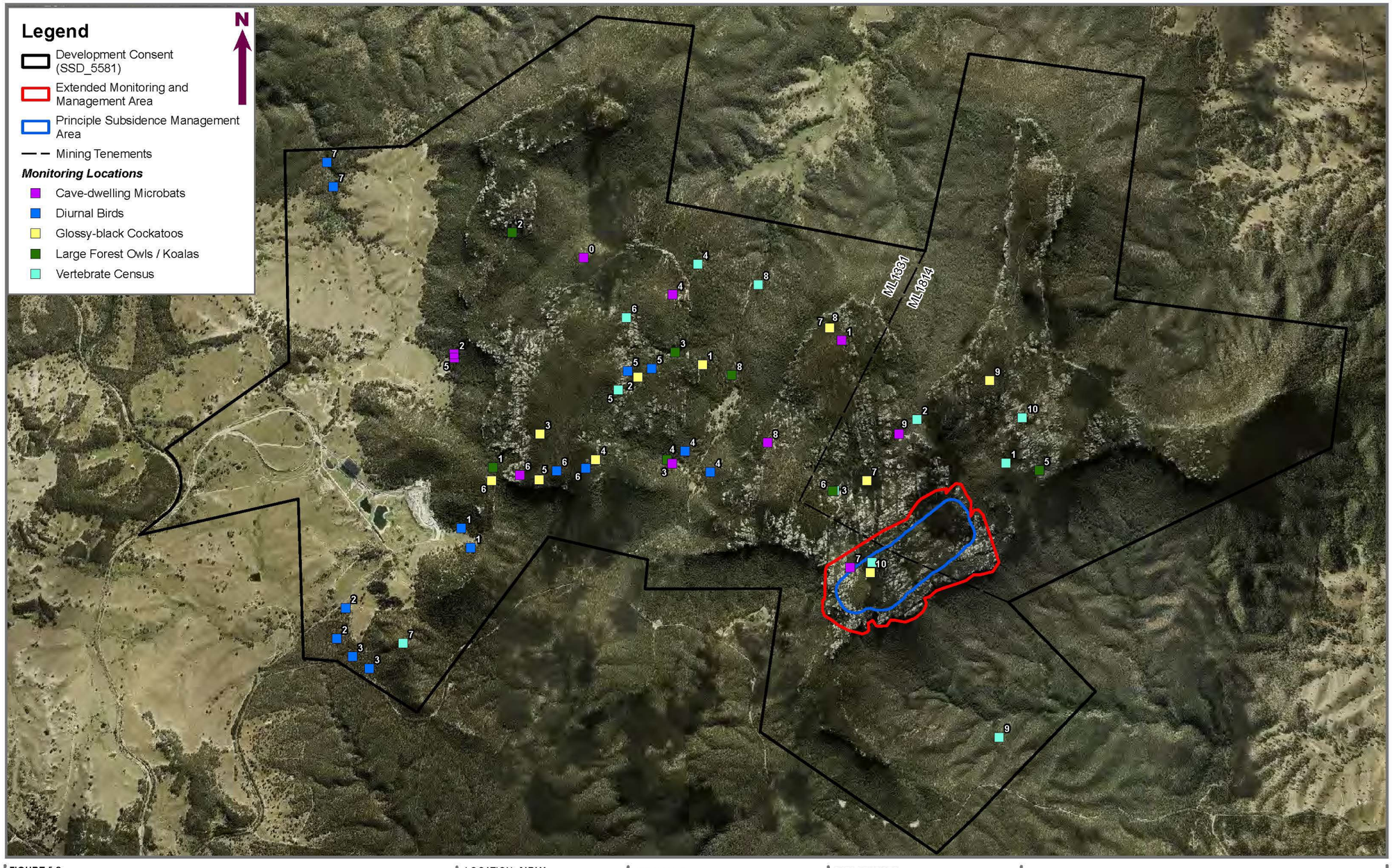


**FIGURE 5-2:**
**FAUNA MONITORING LOCATIONS**

LOCATION: **AIRLY**

VERSION: **B**
DATE EXPORTED: **29/06/2023**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m
SCALE 1:30,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial Airly**
PROJ: **AU213005568**
PURPOSE: **MW17-18 EP BMP**

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### 5.1.4 Monitoring Methods

#### 5.1.4.1 Vegetation Communities

No TECs occur within the EP Area. Accordingly, no vegetation type specific monitoring is required for this BMP. TEC monitoring is undertaken as per the broadscale Biodiversity Monitoring Program as per the Western Region Biodiversity Management Plan – Appendix B Airly (Centennial 2019a).

No GDEs occur within the EP Area. Two Facultative Ecosystems occurs within the Extended/Far Field Monitoring and Management Area only, therefore no additional monitoring is proposed for this BMP It is to note that monitoring of Facultative Ecosystems is carried out as part the of MW13-16 BMP (RPS 2021).

#### 5.1.4.2 Flora

##### *5.1.4.2.1 Prostanthera Stricta (Mount Vincent Mint-bush)*

*Prostanthera stricta* is monitored at 18 transect sites across the ML areas. Two impact sites, being transects 7 and 10, occur within the EP Area and five control sites being transects 14, 22 18, 19 and 20 occur outside of the EP Area. These transects form a part of the broadscale Biodiversity Monitoring Program as per the Western Region Biodiversity Management Plan – Appendix B Airly (Centennial 2019a).

*P. stricta* is monitored using 50 m long point intercept transects located across the Airly Development Consent Area. Start and end points coordinates are staked out and these coordinates are accurately recorded using a differential GPS units.

The point intercept method is used to determine the density of *P. stricta* populations across the 50 m transects. Any section of *P. stricta* that is seen to be overhanging or underneath the transect lines is measured to the nearest 5mm (Elzinga et al, 2001). Once transect point data is recorded, a percentage cover score is calculated for each transect. Additionally, floristic data within 5x5 m plots is also collected. These plots are to be carried out at the start of each transect with the aim to record all vascular flora present at the time of the survey. This data of the impact sites are statistically compared to the control sites and previous seasons data to determine if any significant change has occurred. Sites 10 and 22 are new to the current monitoring program; however, data was collected from 2012 to 2014 by UQ. Sites 18, 19 and 20 are new monitoring locations to provide supplementary control data.

#### 5.1.4.3 Fauna

##### *5.1.4.3.1 Birds*

###### *5.1.4.3.1.1 Glossy Black-Cockatoos*

Monitoring for evidence of Glossy Black-Cockatoos involves surveying for the presence of chewed orts within eight permanent 50 x 50 m stands of *Allocasuarina littoralis* in order to determine recent utilisation of the habitat.

Currently seven permanent monitoring plots occur within the Airly Development Consent Area. Since no plots occur within the EP Area, one additional plot was established within the EP Area to establish baseline data and continued monitoring for this ***MW17-18 BMP*.**

Attributes measured within each 50 $m^2$ search area include:

- Per cent canopy cover and per cent Allocasuarina species cover;
- Presence of orts; and

- Presence of Glossy-Black Cockatoos.

Additionally, if any Glossy-Black Cockatoo individuals were observed outside of these plots they are to be recorded by GPS location.

#### *5.1.4.3.1.2 Diurnal Birds*

Threatened bird monitoring is undertaken as per the broadscale Biodiversity Monitoring Program as per the Western Region Biodiversity Management Plan – Appendix B Airly (Centennial 2019a). As no change in bird species diversity has been detected (RPS 2023b), no additional bird monitoring transects are proposed for this ***MW17-18 BMP***.

#### *5.1.4.3.2 Microbats*

Deployment of Anabat detectors to be used to record ultrasonic bat calls of targeted cave-dwelling bats that are known to occur in specific habitat types within the Airly Development Consent Area to detect the presence/ absence of threatened microbat species. One Anabat dectors are installed seasonally within this this EP Area.

#### *5.1.4.3.3 Mammals (excluding microbats) and reptiles*

Deployment of baited stationary infrared cameras over the monitoring period across both gully and rocky habitats to target threatened mammals, threatened reptiles and pest species. One baited infrared camera in installed within this EP Area.

### 5.1.4.4 Finalisation of Monitoring

Finalisation of monitoring activities is not currently specified. Adaptive management allows for the review of the monitoring program as per the Consent Conditions. Reporting for the broader monitoring program will remain relevant to this BMP until the completion of potential subsidence movements and effects, as referred to in the updated subsidence report (Strata, 2019a) and EP-Subsidence Monitoring Program (EP-SMP).

## 5.2 Aquatic Ecology

### 5.2.1 Aquatic Ecology Monitoring Program

Aquatic Ecology monitoring is undertaken in accordance with Section 4.5.2 of the Water Management Plan (GHD 2021), which has been developed in consultation with key agencies including the Commonwealth DCCEEW, NSW Environment Protection Authority (EPA) and the NSW Department of Primary Industries – Water (DPI Water). Monitoring requirements outlined by GHD (2021) are summarised below.

Aquatic ecology monitoring occurs biannually in spring and autumn at the locations shown in **Figure** 5.3 (GHD 2020) and listed in **Table 5-2**.

**Table 5-2: Aquatic Ecology monitoring sites**

| Site name | Site type | Latitude | Longitude | Altitude (m AHD) |
|---|---|---|---|---|
| Dop Trap Creek | Baseline | 33.13475° | 150.11087° | 401 |
| Gap Creek | Baseline | -33.09753° | 150.04483° | 701 |
| Genowlan Creek | Baseline | -33.10456° | 150.06123° | 827 |
| Genowlan Creek 2 | Baseline | -33.10860° | 150.05760° | 890 |

| Site name | Site type | Latitude | Longitude | Altitude (m AHD) |
|---|---|---|---|---|
| Torbane Creek | Baseline | -33.08764° | 150.00706° | 666 |
| Airly Creek Upstream | Reference | -33.11967° | 150.00018° | 715 |
| Airly Creek | Impact | -33.12286° | 150.00262° | 714 |

### 5.2.2 Aquatic Ecology Monitoring Methodology

Aquatic ecology monitoring methodology include:

- Sampling, sorting and identification of macroinvertebrates, associated with pool edge habitat in accordance with the Australian Rivers Assessment System (AUSRIVAS) protocols (Turak. et al. 2004);
- Assessment of the condition of the aquatic habitat using modified NSW AUSRIVAS field sheets and riparian, channel and environmental inventory (RCE; Peterson 1992);
- Measurements of DO, EXC, pH, temperature and turbidity just below the surface of the water column and at depth where sufficient water is available; and
- Collection of surface water and sediment grab samples for water and sediment quality analysis.

Further detail of the aquatic ecology monitoring methodology and regional sampling extent is provided in the Western Biodiversity Monitoring Program.

### 5.2.3 Stygofauna Monitoring Program

Monitoring of stygofauna is undertaken in accordance with Section 4.4.3 of the Water Management Plan (GHD 2021) and is summarised below.

Monitoring occurs biannually in spring and autumn at groundwater bores ARP05, ARP09, ARP14, ARP15SP and ARP11 (GHD 2021) as displayed on Figure 4-2 of the Water Management Plan (GHD 2021). Stygofauna monitoring methodology includes:

- Measurement of groundwater quality parameters including alkalinity, DO, EC, pH, temperature and turbidity.
- Sampling of groundwater bores and identification of stygofauna in accordance with guidelines by WA EPA (2007; 2013).

Monitoring is considered baseline at potentially affected locations until the commencement of underground mining within the EP Area whereby it then becomes impact monitoring. Further detail of the stygofauna monitoring methodology and regional sampling extent is provided in the Western Region Stygofauna Monitoring and Assessment Plan.

**Figure 5.3. Aquatic Ecology Monitoring Locations (GHD 2021)**

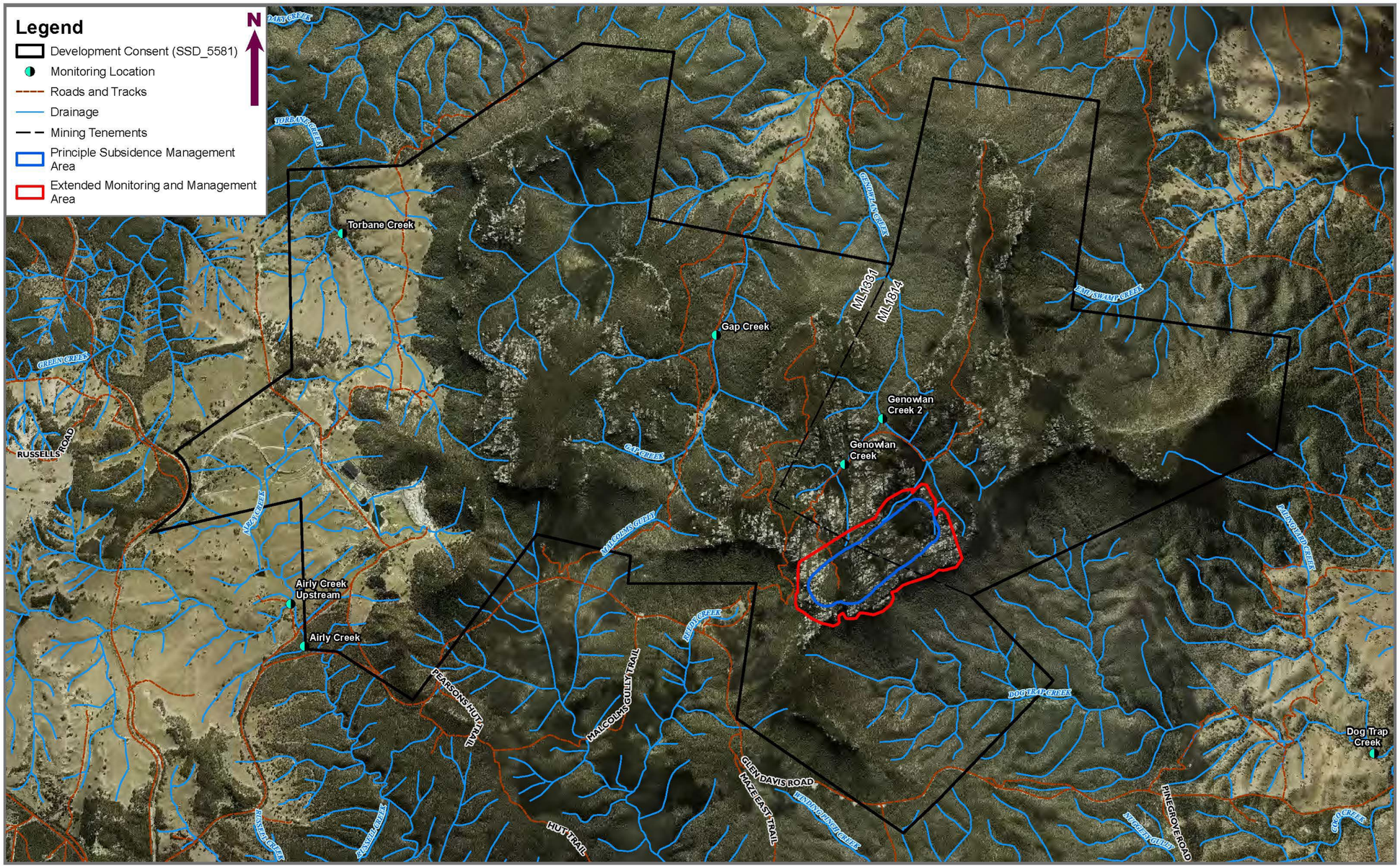


**FIGURE 5-3:**
**AQUATIC ECOLOGY MONITORING LOCATIONS (GHD 2021)**

LOCATION: **AIRLY**

VERSION: **B**
DATE EXPORTED: **29/06/2023**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 2,500 m

SCALE 1:32,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial Airly**
PROJ: **AU213005568**
PURPOSE: **MW17-19 EP BMP**

www.rpsgroup.com.au

PROJECT PATH: S:\Centennial\All Jobs\5568 - 152229 - Airly Cliff Line Zone EP BMP Update\10 - Drafting\ECO_BMP_MW17_18EP_Figures_.aprx

MAKING COMPLEX EASY

# 6 MANAGEMENT, MITIGATION, REMEDIATION AND REPORTING MEASURES

## 6.1 Performance Measures and Indicators

The approved subsidence impact performance measures are specified under Condition 2 in Schedule 3 of SSD_5581. The performance measures relating to potential subsidence impacts (as they relate to this *MW17-18 BMP*) are outlined in **Table 6.1**. [4]

**Table 6.1: Relevant Subsidence Impact Performance Measures for Biodiversity**

| Biodiversity | Performance Measure | Applicability to this EP Area |
|---|---|---|
| Threatened species and their habitats, and Groundwater Dependent Ecosystems (GDEs), with the exception of those listed below | Negligible environmental consequences | Applicable |
| *Pultenaea* sp. Genowlan Point population and Genowlan Point *Allocasurina nana* Heathland community | No environmental consequences | **Not Applicable** *(no proposed workings near to Genowlan Point in current EP)* |

Additional internal performance measures set by Centennial Airly for the mine design (to be monitored by the underground components of the Subsidence Monitoring Program) are detailed in the MW17-18 SMP (Appendix 5 of the EP Main Report) and have been reflected within the MW17-18 Master TARP (Appendix 6 of the EP Main Report).

To establish compliance with the performance measures, Airly Mine has developed a monitoring program with several integrated components (see **Section 5**) and an associated MW17-18 Master TARP (Appendix 6 of the EP Main Report).

These documents establish appropriate monitoring elements, parameters, and associated trigger levels to demonstrate that the environmental performance satisfies the criteria in Section 5.1 of the EP Main Report.

**Table 6.2** contains the performance indicators which have been established for key monitoring aspects with allocated trigger values to define the following key performance scenarios within the MW17-18 TARP (Appendix 6 of the EP Main Report).

[4] *extract from Table 1, Condition 2 in Schedule 3 of Development Consent SSD_5581)*

**Table 6.2: Performance Indicators & TARP Risk Management Scenarios**

| Performance Indicator | General Description | Action/Response |
|---|---|---|
| **Level 1: Condition Green** | **Operations within predictions, and within approved impacts**. | Continued operations and monitoring as normal. |
| **Level 2: Condition Amber** | **Operations within approved impacts but potentially exceed/exceed predictions**. | Review and investigation processes are engaged, with adaptive management as required. |
| **Level 3: Condition Red** | **Operations exceed approved impact.** *The approved Performance Measures (criteria thresholds) of Development Consent (and any other relevant approvals) are listed in Condition Red.* | Adaptive Management measures are fully engaged as per the *MW17-18 TARP* and relevant sections of the Extraction Plan, this management plan and the *MW17-18 SMP*. |

## 6.2 Management and Mitigation Measures

As described in **Section 3.2**, the predicted subsidence levels in the EP Area[5] are minimal and well below levels expected to cause damage or any adverse impacts on the natural features. This includes the extended/far-field subsidence monitoring and management area.

The *Subsidence and Environmental* risk assessment (**Section 2.2**) determined that the risk of impact for biodiversity features was **Low** including aspects associated with Groundwater Dependent Ecosystems, groundwater Stygofauna, threatened aquatic fauna and potential for key fish habitat, threatened terrestrial fauna and their potential habitat (including birds, mammals, reptiles and microbats), threatened flora, Endangered Ecological Communities and the general natural vegetation (including sheltered gullies) within the EP Area. There are two main management aspects of this MW17-18 BMP, including:

- Mine design to avoid impacts (**Section 3**);
    - The primary management strategy being implemented is impact avoidance through the implementation of a conservative mine design. Mining methods which limit void widths are designed to leave sufficiently large and long term stable final pillars, and hence have minimal subsidence effects and prevent subsidence impacts, and
- Monitoring and management measures (**Section 5**).
    - Monitoring to ensure the mine design is strictly implemented as designed through underground mining controls, monitoring of ground movements continuously through a network of GNSS units and monitoring key landscape features for change (particularly cliffs and pagodas) to confirm that the mine design measures to prevent impact are adequate and remain within consent.

[5] For important context to the current EP Area, it is noted that the external cliffs of the mountain complex are located in the far-field/extended subsidence management and monitoring area (this is the same as the previously approved Cliff Line Zone of First Workings). There is predicted to be negligible subsidence beyond the near field/principal subsidence area, and no surface cracking within or beyond the EP Area.

## 6.3 Remediation and Rehabilitation Measures

Due to the minimal subsidence expected the need to implement remediation/rehabilitation measures for potential impacts are considered unlikely. However, if remediation is required, Airly Mine will undertake remediation in accordance with:

- Conditions 7a)-7c) in Schedule 6 of SSD_5581, noting in particular the requirement to submit a report to DPIE describing remediation options and any preferred remediation measures or other course of action;
- Any relevant actions prescribed in the ***MW17-18 TARP*** developed for the Extraction Plan;
- The current Mining Operations Plan and Rehabilitation Management Plan; and
- In consultation with key stakeholders including any affected land holders and relevant government agencies.

A Response Strategy will be adopted if a significant impact is detected as a result of mining activities within the Extraction Plan area.

## 6.4 Trigger Action Response Plan

A detailed *MW17-18 TARP* has been developed for the Extraction Plan to reflect the commitments of this *MW17-18 BMP* and other related aspects. Whilst impacts are not predicted nor expected, the *MW17-18 TARP* provides a process of tiered and/or escalating trigger levels for contingency measures should subsidence and impacts be greater than predicted/approved. The *MW17-18 TARP* applies only to the EP Area (separate TARPs apply to other established EP Areas in various approved mining zones).

Given the mine has been designed specifically to avoid impacts, the *MW17-18 TARP* includes detailed measures for Underground Mining Controls to ensure that the mining geometry is formed as per the approved design specifications that determine the predicted subsidence movements and impacts.

The *MW17-18 TARP* includes detailed performance indicators for biodiversity management. The contingency plan where a performance indictor has been exceeded is outlined in the TARP. A trigger will result in additional investigations to determine if the exceedance is related to non-mining-factors or is a consequence of mining activity. The response to these exceedances will follow the TARP. Management/ corrective actions can be implemented where required to remedy these non-conformities and report accordingly.

## 6.5 Adaptive Management and Contingency Plan

An Adaptive Management Framework provides for flexible decision making, adjusted to consider uncertainties as management outcomes are understood. The adaptive management approach at Airly Mine is detailed in the EP Main Report (refer Section 5.2).

In summary, adaptive management at Airly Mine involves monitoring and evaluation against performance measures and associated indicators in the *MW17-18 TARP* established for the extraction plan and supporting management plans. Where performance indicators indicate increasing levels of risk (conditions green, amber then red being exceeded), escalating adaptive management measures are engaged in accordance with the *MW17-18 TARP*. The process has been successfully implemented in existing Extraction Plan areas at Airly Mine and has been updated to reflect EIS commitments and consent requirements for the Airly Mine Extension Project, including specific performance measures.

## 6.6 Incidents, Complaints, Exceedances and Non-Compliances

Incidents, complaints, exceedances and non-compliances are managed accordance with the requirements of relevant approvals and licences including SSD_5581, EPL12374 and EPBC 2013/.7076, relevant legislation and regulations, and generally in accordance with the *Extraction Plan Guideline* (DPE, 2022). A detailed review of the notification requirements relevant to the Extraction Plan, including this MW17-18 BMP, is provided in the EP Main Report *(refer Section 5.7.1)*, including requirements for:

- Incident or non-compliance reporting in accordance with:
    - Consent condition 9 (Schedule 6) of SSD_5581.
    - EPBC 2013/7076 Condition 1, or as triggered by the TARP (reporting incidents under Management Plans as per Schedule 6, Condition 2 of SSD_5581).
    - EPL12374 condition R2
    - WHS Regulation (Mines and Petroleum Sites, 2014) Clause 128 - Duty to notify regulator of certain incidents
    - Section 6 of the Guidelines for Managing Risks of Subsidence (WHS (Mines and Petroleum Sites), February 2017
- Managing complaints.

Incidents, complaints, exceedances and non-compliances will be managed in accordance with the requirements detailed in the EP Main Report *(refer Section 5.6).*

## 6.7 Reporting and Auditing

### 6.7.1 Reporting

Reporting is undertaken in accordance with the requirements of specific requirements of relevant approvals and licences including SSD_5581, EPL12374 and EPBC 2013/7076, and generally in accordance with the *Extraction Plan Guideline* (DPE, 2022). Additionally, high potential incident notifications for unexpected subsidence events in relation to the safety of other persons under WHS legislation has also been included.

A detailed review of the reporting and notification requirements relevant to the Extraction Plan, including this MW17-18 BMP, is provided in the EP Main Report *(refer Section 5.7.1*, including requirements for:

- Regular reporting of impacts and environmental monitoring results in accordance with Condition 10 of Schedule 6 under SSD_5581;
- Annual reporting required in accordance with condition 11 of Schedule 6 under SSD_5581 and separately under EPBC 2013/7076;

Reporting and notifications will be undertaken in accordance with the requirements detailed in the EP Main Report *(refer Section 5.7.1*

### 6.7.2 Periodic Auditing

Comprehensive Independent Environmental Audits of the entire approved development under development consent SSD_5581 are undertaken within 1 year of commencement and every 3 years thereafter (unless directed otherwise) in accordance with Conditions 12 and 13.

Auditing of any rehabilitation undertaken for the mine (including for subsidence if triggered) is undertaken in accordance with the Mining Operations Plan/Rehabilitation Management Plan under Condition 27 in Schedule 4 of development consent SSD_5581.

Additionally, in accordance with section 20(c) of the WHSMP Regulation (2022), auditing will be undertaken in accordance with the Airly Mine Safety Management System (**SMS),** against the performance standards for measuring the effectiveness of all aspects of the SMS, including the methods, frequency and results of the audit process. The audit should also consider the following matters:

(1) competency of the auditor,

(2) the person responsible for ensuring the audit is conducted, and

(3) the person responsible for implementing the results of the audit.

# 7 PLAN ADMINISTRATION AND RESPONSIBILITIES

## 7.1 Review

In accordance with the requirements under Condition 3 in Schedule 6 of Development Consent SSD_5581, as a minimum Centennial Airly will review this Plan within three months of the following:

a) Submission of an incident report;

b) Submission of an Annual Review (required 31 March annually);

c) Submission of an Independent Environmental Audit; or

d) Any modification to the conditions of SSD_5581.

Where this leads to revisions of the document, within four (4) weeks of the review the revised document must be submitted to DPE for the approval of the Secretary. Continual improvement shall be achieved through monitoring, internal and external communication with stakeholders, implementation of corrective and preventative actions and through monitoring progress against the objectives included in the environmental management plans. The reporting framework (refer **Section 6.6**) will document the effectiveness of this document (and the related Extraction Plan) through comparison of the predicted negligible impacts of subsidence against actual outcomes.

Each variation to this Plan will be identified in the Document Control Table at the beginning of this document.

Additionally, to maintain consistency with existing management plans and previous Extraction Plans at the mine, this MW17-18 BMP will also be reviewed in the event that the following occur:

- Stakeholders raise issues that necessitate a review;
- There are other changes to management requirements (e.g. changes to other related approvals besides consent, such as Mining Lease and/or EPL conditions);
- Where unpredicted impacts or consequences have required implementation of contingency actions under this plan;
- Monitoring or audit processes demonstrate that a review is warranted;
- Where otherwise triggered by the MW17-18 TARP;
- Where triggered by (or for) review of other related management plans (if applicable); or
- Every three (3) years as a minimum (where not already triggered above).

Any amendments to the MW17-18 BMP will be undertaken in accordance with Consent/relevant approvals and in consultation with key relevant stakeholders where required. Following any significant changes, a copy of the amended MW17-18 BMP will be forwarded to all relevant stakeholders.

In addition to planning development consent requirements, Airly Mine must review and as necessary revise the risk control measures implemented for subsidence in accordance with section 15 of the *WHSMP Regulation (2022)*. Any review triggered by WHS Legislation Requirements will be addressed via the process identified in the EP Main Report *(refer Section 5.5)* and the MW17-18 PSMP (Appendix 4 of the EP Main Report).

## 7.2 Key Responsibilities

The responsibility for implementation, monitoring and review of the ***MW17-18 BMP*** lies with the Superintendent Environment and Community. The ultimate responsibility for the implementation of the ***MW17-18 BMP*** lies with the Mine Manager, who shall make appropriate resources available. The roles and responsibilities for this ***MW17-18 BMP*** are outlined in **Table 7.1.**

**Table 7.1: Key Personnel and Accountabilities**

| Position | Responsibility |
|---|---|
| Mine Manager | • Ensuring that sufficient resources are available to implement and execute the requirements of this Plan; and<br>• Reporting triggers/non-conformances to external stakeholders. |
| Technical Services Manager | • Coordinate underground inspections and subsidence monitoring program associated with this MW17-18 BMP;<br>• Coordinate implementation of the mine design and MW17-18 TARP.<br>• Reporting triggers/non-conformances internally to the mine manager as appropriate.<br>• Reporting to DPE and NSW RR of subsidence and pillar system performance upon completion of specified monitoring intervals. |
| Production Manager | • Implement mine design<br>• Establish and maintain underground monitoring and inspections program;<br>• Auditing as required |
| Mine Surveyor | • Survey as built initial development pillars<br>• Establish and maintain subsidence monitoring program;<br>• Internal reporting as required.<br>• Mark up centre lines for driveage in pillars<br>• Produce final mining plan for extraction workings to be carried out in consultation with the Technical Services Manager. |
| Superintendent Environment and Community | Implementation, monitoring and review of this plan, including:<br>• The carrying out of targeted inspections;<br>• The installation and maintenance of signage where required;<br>• Reporting triggers/non-conformances internally to the Mine Manager as appropriate;<br>• Consulting with land owners, landholders and managers regarding any land management issues arising from subsidence within the EP Area. This includes (but may not be limited to) NPWS, Office of Crown Lands and private landowners within the EP Area (if and as applicable);<br>• Reviewing this MW17-18 BMP, including consultation during the review process with relevant stakeholders;<br>• Coordinating any remediation work as required;<br>• Inspecting targeted accessible areas susceptible to tensile and compressive strains and potential cracking as required (e.g. accessible tracks and trails); and<br>• Co-ordinating the generation and submission of formal reporting requirements outlined in this Plan. |

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# APPENDIX 4Public Safety Management Plan for MW17-18

CENTENNIAL

# Public Safety Management Plan (MW17-18 PSMP)

## MW17-18 Panel & Pillar Mining Zone Extraction Plan

**Airly Mine (SSD_5581)**

**November 2023**

# DOCUMENT CONTROL / TITLE BLOCK

| | | |
|---|---|---|
| **EXTRACTION PLAN DETAILS** | **Title:** | Public Safety Management Plan: MW17-18 Panel & Pillar Mining Zone Extraction Plan |
| | **Applicant:** | Centennial Airly Mine |
| | **Revision No.:** | MW17-18 PSMP_Rev_3[1] |

## REVISION

| | Revision No. | Details of Revision | Date Sent |
|---|---|---|---|
| **REVISION DETAILS** | Rev_0 | Draft for external consultation | 21/02/2023 |
| | Rev_1 | Updated following external consultation to incorporate a revision of mine design (reduction in miniwall panels) and accompanying pillar width modelling and subsidence predictions and impact assessments | 11/07/2023 |
| | Rev_2 | Updated following external consultation to include further controls for public safety including controlling access to extraction areas if triggered | 23/08/2023 |
| | Rev_3 | Updated subsidence monitoring layout with two additional GNSS units | 7/11/2023 |
| | | | |

[1] An integrated Document Control Procedure is incorporated into Centennial Airly Mine's Safety Management System (SMS). Documents, data and records pertaining to this plan will be managed according to the ***Airly Mine Document and Data Control Management Plan*** **(AIR-MP-1034).**

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# Attachments
## *(refer to EP Main Report)*

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Attachment B – Relevant Legal and Other Requirements
Attachment C – Subsidence and Environmental Risk Assessment (EP Area)
Attachment D – Stakeholder Consultation
Attachment E – Technical Report: Pillar Width Modelling (SCT, 2023)
Attachment F – Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023)
Attachment G – Technical Report: Baseline Biodiversity Assessment (RPS, 2023)
Attachment H – Technical Report: Baseline Historic Heritage Assessment (RPS, 2022a)
Attachment I – Technical Report: Baseline Aboriginal Heritage Assessment (RPS, 2022b)

# Abbreviations

| | |
|---|---|
| **BMP** | Biodiversity Management Plan |
| **CLZ** | Cliff Line Zone of First Workings (approved mining zone under consent SSD_5581) |
| **DP&E** | NSW Department of Planning and Environment (now DPIE) |
| **DPIE** | NSW Department of Planning, Industry and Environment (DPIE) |
| **DOC** | Depth of Cover |
| **ESU** | Environmental Sustainability Unit, formerly within the Division of Resources and Geoscience (DRG), now within the NSW Resources Regulator within NSW DP&E. |
| **EP** | Extraction Plan |
| **EP&A Act** | Environmental Planning and Assessment Act 1979 |
| **EPL** | Environment Protection License |
| **ESU** | Environmental Sustainability Unit (NSW Resources Regulator) |
| **HHMP** | Historic Heritage Management Plan |
| **IEP** | Independent Expert Panel (post-consent) |
| **IRP** | Independent Review Panel (pre-consent) |
| **LCC** | Lithgow City Council |
| **LMP** | Land Management Plan |
| **MEP** | Airly Mine Extension Project |
| **ML** | Mining Lease |
| **MOD** | Modification to Airly Mine's former Development Consent (DA162/91) |
| **NPWS** | NSW National Parks and Wildlife Service |
| **NSW-RR** | NSW Resources Regulator |
| **OEH** | NSW Office of Environment & Heritage |
| **PPMZ** | Panel & Pillar Mining Zone (approved mining zone under consent SSD_5581) |
| **PSMP** | Public Safety Management Plan |
| **SCA** | State Conservation Area |
| **SSD** | State Significant Development |
| **SMP** | Subsidence Monitoring Program |
| **SMZ** | Shallow Mining Zone (approved mining zone under consent SSD_5581) |
| **TARP** | Trigger Action Response Plan |
| **WMP** | Water Management Plan |

# 1 INTRODUCTION

## 1.1 Background

Airly Mine is an existing underground coal mine located approximately 40 kilometres (km) northwest of Lithgow in New South Wales, 170km northwest of Sydney and 4 km to the northeast of Capertee, as illustrated on **Figure 1.1**. The mine is partly located within the Mugii Murum-ban State Conservation Area (SCA). Centennial Airly Pty Limited (Centennial Airly) is the operator of the mine and is a wholly owned subsidiary of Centennial Coal Company Pty Limited (Centennial).

Development Consent for the Airly Mine Extension Project (MEP) was approved on 15 December 2016 subject to the Conditions in Schedule 2 to 6 of State Significant Development 5581 (SSD_5581). The consent allows extraction of 1.8 million tonnes of run-of-mine (ROM) coal per calendar year for a period of 20 years, which is supplied to both domestic and international markets. As per commitments within the Environmental Impact Statement (EIS) for SSD_5581, Airly Mine is implementing a conservative and staged approach to mining, with different mining methods applied in different areas of the mining lease called Mining Zones[2]

The *MW17-18 Panel & Pillar Mining Zone Extraction Plan* as detailed in the *Extraction Plan Main Report (the EP Main Report)* and the supporting component plans, continues the conservative and staged approach to mining being implemented by Airly Mine, with secondary extraction proposed in two miniwall panels (MW17 to MW18). The miniwall panels are located within the *Panel and Pillar Mining Zone* as detailed within SSD_5581.

Airly Mine have undertaken extensive modelling and mine design revisions, with panel (void) and pillar widths specifically designed to reduce subsidence levels to be consistent with EIS predictions (i.e., maximum vertical subsidence <125mm). Conservative setbacks to key sensitive features located within the *Cliff Line Zone of First Workings* will continue to be implemented for the MW17-18 PPMZ Extraction Plan, and extensive monitoring and management measures are proposed to demonstrate the subsidence modelling and effectiveness of the mining. The *Extraction Plan Area (EP Area)* is further defined in **Section 1.3**.

The *EP Main Report* and the supporting component plans have been developed using a risk-based approach and in accordance with:

- Relevant requirements listed under *Condition 7 in Schedule 3* of SSD_5581;
- *Extraction Plan Guideline,* NSW Department of Planning and Environment 2022;
- *Managing Risks of Subsidence Guideline*, NSW Department of Industry, Resources Regulator (NSWRR), 2017; and
- *Consultation with all relevant key stakeholders* (potentially affected by subsidence) and the Independent Expert Panel (IEP) established by NSW Department of Planning and Environment (DPE) for the project.

An Extraction Plan is required to be developed and approved prior to undertaking secondary extraction, including the development of this ***Public Safety Management Plan for MW17-18 (MW17-18 PSMP)***.

2 Airly Mine has five (5) mining zones approved under development consent SSD_5581 as shown in Figure 2 in Appendix 3 of SSD_5581. These zones provide design criteria for different mining methods based on the differing levels of environmental sensitivity of surface features and depth of cover across the Airly mining leases. Section 8 of the Airly Mine EIS (2014) provides further details on the definitions of each of these approved mining zones if required.

## 1.2 Purpose & Scope

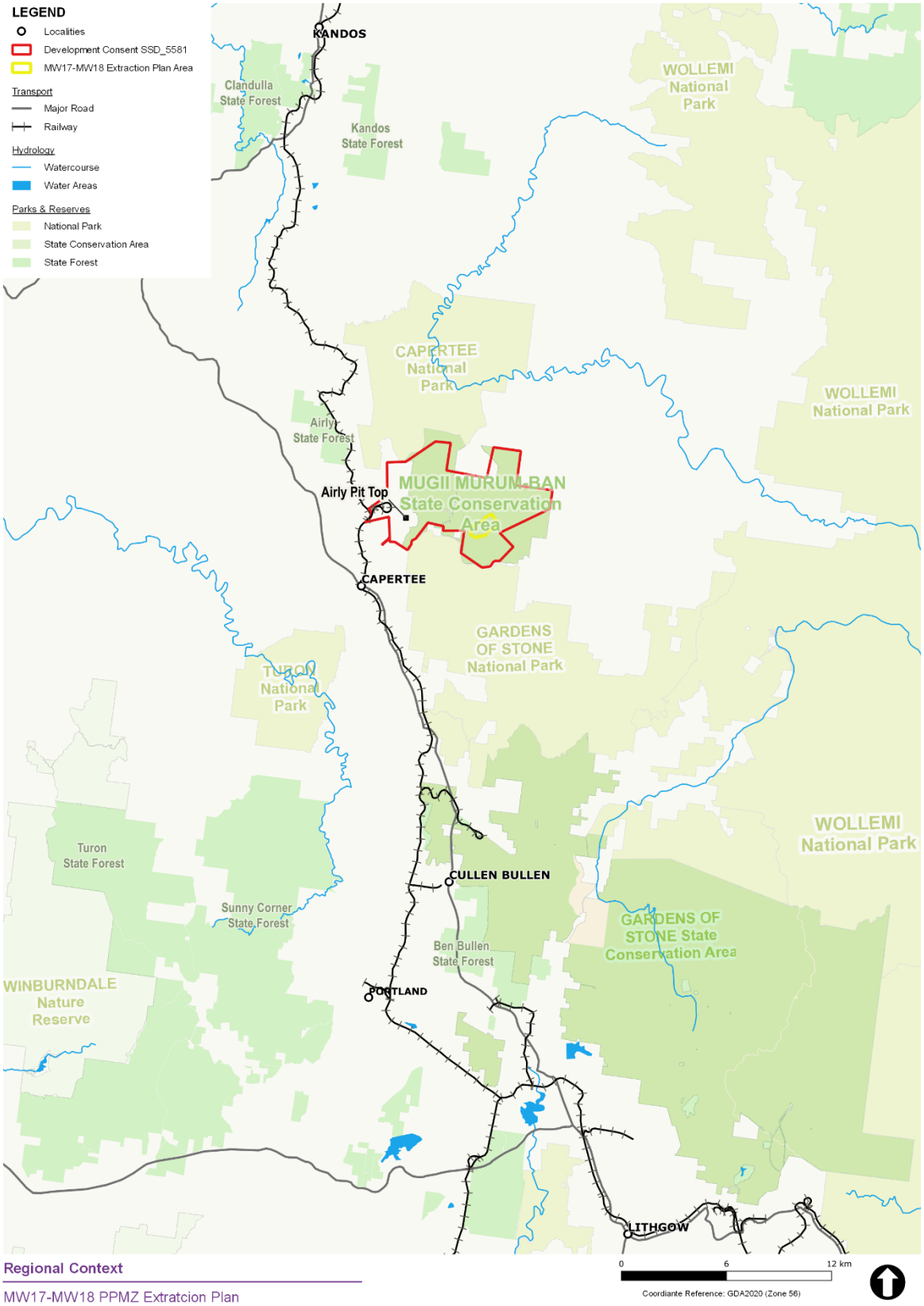
The purpose of this ***MW17-18 PSMP*** is to outline the monitoring and management measures to be implemented to address any potential impacts to public safety (**Section 3.2**) resulting from subsidence associated with secondary extraction via panel and pillar mining within the EP Area (**Section 1.3**).

Void and pillar widths have been specifically designed to support the overlying overburden with minimal subsidence effects. The final pillars left following panel extraction are specifically designed to provide long term stable support to the surface with no surface cracking and minimal ground movement.

Whilst no surface cracking or related impacts have been predicted for panel and pillar mining activities, this management plan importantly continues established monitoring and management frameworks to confirm such for the EP Area, whilst also providing baseline monitoring.

A directly related *Subsidence Monitoring Program for MW17-18 (MW17-18 SMP)* (Appendix 5 of the EP Main Report) has also been specifically developed for the Extraction Plan to address the project performance measures prescribed by consent SSD_5581, supported by a *Master Trigger Action Response Plan for MW17-18 (MW17-18 TARP)* (Appendix 6 of the EP Main Report), including adaptive management measures if required.

## Figure 1.1: Locality Plan




Regional Context

MW17-MW18 PPMZ Extratcion Plan

*The data displayed on this figure has been collected from various sources. The source data may contain inconsistencies or omissions, may not be to scale, may not be current and may present indicative information only. Catalyst Environmental Management does not warrant the accuracy or completeness of the contents of this figure.*

## 1.3 Extraction Plan Area

Two miniwalls are proposed for extraction in the south-eastern area of Genowlan Mountain within the Airly mining leases being miniwalls (MW) 17 and 18. The miniwall panels are located within the *Panel and Pillar Mining Zone* as detailed within SSD 5581. Centennial Airly has applied a 26.5 degree Angle of draw (AoD) around all cliffs mapped within the *Cliff Line Zone of First Workings*. No secondary extraction will occur within the 26.5 degree angle of draw of cliffs within the *Cliff Line Zone of First Workings*.

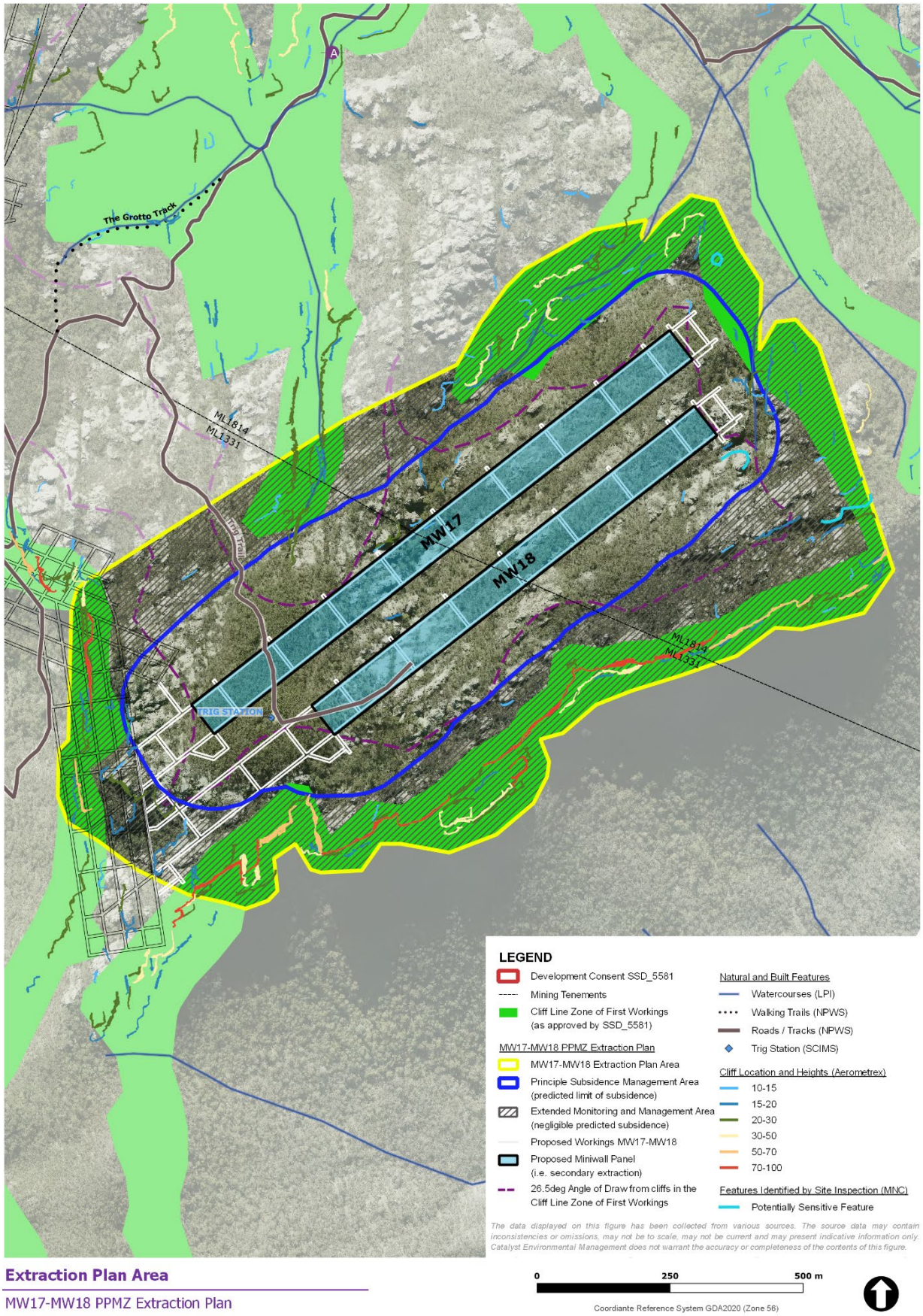
The Extraction Plan Area (EP Area) is comprised of two key components as defined below and illustrated on **Figure 1.2**. The proposed overall EP Area boundary includes an Extended / Far Field Monitoring and Management Area which is beyond the predicted extent of subsidence and involves monitoring and management of sensitive features, primarily the cliffs and pagodas contained within the *Cliff Line Zone of First Workings* surrounding Genowlan Mountain as a precautionary approach to demonstrate the mining methods.

**Table 1-1: MW17-18 Panel & Pillar Mining Zone Extraction Plan Area**

| EP Area Components | Defining Comments |
|---|---|
| **Near-Field / Principal Subsidence Management Area** *(Secondary Extraction Area)* | • Approved area of secondary extraction in accordance with the development consent SSD_5581<br>• The proposed miniwall extraction (second workings) within the **Panel and Pillar Mining Zone** associated with **miniwall panels MW17-MW18**<br>• **No second workings within 26.5 degree setback from the tops of cliffs** located within the Cliff Line Zone of First Workings to **all miniwall panels i.e. MW17-MW18**<br>• **Predicted 20mm limit of vertical subsidence**<br>• Located within parts of both Mining Lease ML1331 and ML1814 |
| **Extended / Far Field Monitoring and Management Area** | • **Monitoring and management area only** for this Extraction Plan, no proposed secondary extraction within this Extraction Plan[3]<br>• This area lies entirely **beyond** the 26.5 degree setback from the tops of cliffs located within the Cliff Line Zone of First Workings to all panels MW17-MW18<br>• Conservatively monitors sensitive features located **beyond** the *Near-field / Principal Subsidence Management Area* for potential subsidence effects further afield<br>• Primarily comprises cliffs and pagodas contained within the Cliff Line Zone of First Workings |

3 Parts of the Extended / Far-field Monitoring and Management Area overlap with the Cliff Line Zone of First Workings. First workings within the Cliff Line Zone of First Workings requires a separate Extraction Plan and any mining undertaken in the Cliff Line Zone of First Workings will be managed in accordance with an approved Extraction Plan.

**Figure 1.2: Extraction Plan Area (EP Area) and Relevant Features within the EP Area**



## 1.4 Relevant Features

The following section provides an overview of the key relevant features managed and monitored in the EP Area as illustrated on **Figure 1.2**. The natural and built features identified within the EP Area include:

- Surface Water
- Groundwater
- Aquatic ecology
- Cliffs, Minor Cliffs and Pagodas
- Mugii Murum-ban SCA General Surface Area, including steep slopes and rock outcrops
- The deeply incised canyons/gorge including an area known as the Grotto
- Tracks and Trails, Fences & Gates
- Habitat
- Threatened Flora & Fauna
- Endangered Ecological Communities (EEC)
- Groundwater Dependent Ecosystems (GDE)
- Public Safety / Safety of 'others' associated with potential for subsidence.
- Publicly accessible sections of the EP Area within Mugii Murum-ban State Conservation Area including tracks and trails and general SCA surface area.

The features identified within the EP Area, and which are subject to this *MW17-18 PSMP* are summarised below and detailed in the following sections :

- **Section 1.4.1** – Public Use of Mugii Murum-ban SCA
- **Section 1.4.2** – Public Access/Primary Thoroughfares
- **Section 1.4.3** – Unsealed roads and tracks

Public safety is primarily managed under this MW17-18 PSMP, however the Land Management Plan for MW17-18 (MW17-18 LMP) is also relevant due to the landscape features which were identified as directly related, potential risk to public safety (particularly cliffs).

### 1.4.1 Public Use of Mugii Murum-ban SCA

The following section provides context for public safety considerations within the EP Area by considering public use of Mugii Murum-ban SCA.

The Mugii Murum-ban SCA provides opportunities for self-reliant recreation including four-wheel driving, nature study and heritage tourism (e.g. ruins of the New Hartley Oil Shale Mine), picnicking, unsupported camping (no facilities), mountain biking, bushwalking and birdwatching. Basic 'bush-camping' (no built facilities, including toilets) can also be undertaken within the SCA. It is noted, horse-riding and motorcycling (dirt bikes) are not permitted in the SCA:

The SCA is a moderately popular destination for four-wheel driving and attracts club and private outings. Many of the existing four-wheel drive routes have tight turns, steep slopes, ruts, and steps and require a high level of proficiency and vehicle capacity. Many trips are undertaken by registered clubs and include overnight camping. This use will continue to be allowed under the draft Plan of Management (POM) for the SCA (OEH, 2015), subject to the planned controlled vehicle access system which will ensure safety during wet weather and prevent damage to park roads and trails (OEH 2015).

Prior to gazettal in 2011(as modified in 2016), the area now encompassing Mugii Murum-ban SCA had no formal visitation management and therefore there are minimal visitor facilities. Information on

park visitation is limited, but the SCA Draft Plan of Management (POM) (OEH 2015) suggests up to 200 four-wheel drive vehicles may enter the park each year. Whilst periods of more intense use occurs (e.g. seasonal influence, group/4WD club use) on average across the year this represents approximately 4 cars a week. [4]

Mugii Murum-ban SCA is not currently a popular destination for adventure recreation activities such as abseiling and rock climbing (POM, 2015), and given opportunities for such in several nearby parks and the relative difficulty in accessing cliff faces within the SCA means its use for adventure recreation is likely to remain minimal (POM, 2015). Adventure activities also have the potential to damage fragile rock formations, particularly pagodas, therefore management of adventure activities will focus on protecting natural features (POM, 2015).

Section 3.7(g) of the POM states that the SCA is also not currently a common destination for commercial tour operators, however, the park has some potential for small-scale, sustainable, self-reliant commercial recreational opportunities (the surrounding Capertee Valley is recognised for tourism and the natural and cultural heritage of the area, including within the SCA, provides a significant contribution to the local tourism market). As with other recreational activities within the SCA, commercial tourism is managed in a regional context, considering opportunities that exist elsewhere in the greater Blue Mountains region. Interest in commercial recreation within the park is anticipated to be low due to the relative ease of access to other nearby locations offering similar recreational activities opportunities (POM, 2015). All commercial activities within the SCA (and all NPWS parks) require an operating licence with conditions that aim to minimise potential adverse impacts.

### 1.4.2 Public Access/Primary Thoroughfares

Due to the rugged nature of the SCA public access is primarily via SCA management trails. The main public entry point to the SCA over the EP Area is via Trig Trail, connected to Genowlan Trail, which is located off Glen Davis Road. Genowlan Trail is an unsealed four wheel drive, dry-weather, gravel road in reasonable condition. In practice, it is understood that maintenance of the road is typically undertaken by the mine and NSW National Parks and Wildlife Service as part of management of the SCA. Genowlan Trail is planned to be gated to control access under the POM (OEH 2015).

All other access to the SCA is on foot and designated walking tracks in the SCA are limited. Therefore access is very limited and difficult beyond the trails mentioned above. Whilst the entire EP area is theoretically accessible, in reality access is difficult and very few individuals venture beyond the formed tracks and trails.

### 1.4.3 Unsealed roads and tracks

Unsealed roads and tracks are located across the Study Area and above MW17-18. These roads/tracks are only accessible by 4WD vehicles. It is noted that no sealed roads are located within the Study Area. It is unlikely that the unsealed road and track surfaces over the South-eastern area of Genowlan Mountain will be adversely impacted by the proposed mini wall extraction, as the Study Area is expected to only be subjected to low levels of subsidence that are no greater than 125mm.

[4] See Section 3.7 of the Draft Plan of Management (OEH 2015) for further details on park uses and constraints.

## 1.5 Land Use and Ownership

The sensitive and rugged terrain above the mine is primarily comprised of the *Mugii Murum-ban State Conservation Area* (SCA) managed by the National Parks and Wildlife Service (NPWS). The EP Area (**Figure 1.2**) is wholly located within the SCA.

Mugii Murum-ban SCA is 3,650 hectares and is bounded to the south by the Glen Davis Road and Gardens of Stone National Park, and to the north by Capertee National Park. Land to the east and west is largely cleared farming land, with some remnant bushland. Lands not included in the SCA include Airly Gap Trail and a number of partially cleared private properties along Airly Gap Trail and at the base of the Genowlan mesa (OEH, 2015).

Mugii Murum-ban SCA is dominated by two prominent mesas which are major visual features of the Capertee Valley – Mt Airly (where panel and pillar mining has been undertaken to date), and Genowlan Mountain, a western portion of which is the subject of the current EP Area. The SCA contains extensive and intricate pagoda clusters, numerous deep gorges, canyons and unusual rock formations. These features combine to create an extremely scenic landscape and is a focal point of environmental protection that requires low impact, non-intrusive monitoring and management.

Mugii Murum-ban SCA lies within the South Eastern Highlands Bioregion. It is part of a large and relatively contiguous system of protected bushland, stretching from the Hunter Valley in the north to the Wollondilly River in the south, and including nearby Capertee, Gardens of Stone and Wollemi national parks (OEH, 2015). The SCA contains a great diversity of ecosystems, supporting several threatened plants and animals. In addition, the SCA contains four relatively pristine sub catchments which are important in maintaining water quality in creek and river systems in the area (OEH, 2015).

The area is of particular significance to the Wiradjuri Aboriginal People and also contains numerous significant historic heritage sites. The SCA also contains important mineral deposits and is recognised in particular as having economically significant deposits of coal (OEH, 2015).

Prior to gazettal, the area now encompassing Mugii Murum-ban SCA had no formal visitation management and therefore there are minimal visitor facilities. The SCA is currently used for four-wheel driving, bushwalking, heritage tourism, picnicking, birdwatching, camping and cycling. Information on SCA visitation is limited but suggests up to 200 four-wheel drive vehicles may enter the SCA each year. The main public entry point to the SCA is via the Airly Gap Trail, a two-wheel drive public road off Glen Davis Road, located west of the current EP Area. Public vehicle access is also provided to the SCA via the four-wheel drive Genowlan Trail (OEH, 2015) which is located within the current EP Area. The SCA is considered most suitable for dispersed, self-reliant, nature-based recreation utilising existing visitor nodes and routes.

In addition to managing the broader SCA, NPWS also currently manage portions of Crown Land (excluding Crown Roads and reserves) under licence from the Division of Crown Lands (NSW DTIRIS), which are in the process of formal transition into the SCA. These are primarily located within Airly gap located to the west of the current EP Area.

## 1.6 Structure of the MW17-18 PSMP

The main text sections of this MW17-18 PSMP include:

**Section 1** Provides an introduction, purpose, scope, extraction plan area, relevant features to public safety and document structure.

**Section 2** Provides the statutory regulatory requirements, risk identification and consultation.

**Section 3** Provides the predicted subsidence impacts assessment and subsidence performance indicators to be used to assess against the relevant subsidence performance measures for public safety.

**Section 4** Outlines the monitoring and management measures in place for the key features in the EP Area.

**Section 5** Summarises the management, mitigation, remediation and reporting measures for this MW17-18 PSMP, including relevant performance measures and indicators, contingency response, adaptive management, reporting and auditing.

**Section 6** Provides an outline of the plan administration and roles and responsibilities for this MW17-18 PSMP.

**Section 7** Provides a historical review of references leading to the development of this MW17-18 PSMP.

# 2 PLAN DEVELOPMENT AND CONSULTATION

## 2.1 Statutory Requirements

Centennial Airly conducts its operations in accordance with:

- The conditions of the Development Consent (SSD_5581);
- Relevant licences and permits, including conditions attached to the Environment Protection Licence (EPL No. 12374) and Mining Leases (i.e. ML 1331 and ML 1814); and
- other relevant State and Commonwealth environmental, planning, mining, safety, and natural resource legislation and guidelines.

Centennial Airly maintains a register of relevant environmental legislative and regulatory requirements in a compliance database.

The relevant statutory requirements applicable to *Miniwall 17-18 Extraction Plan* and this supporting MW17-18 PSMP are presented in the EP Main Report *(refer Section 2.1 and Attachment B)*.

This MW17-18 PSMP is a component of the EP Main Report and has been prepared specifically to address Condition 7(i)(vii) of Schedule 3 which states:

> *(7) Prior to carrying out any first workings within the Cliff Line Zone and Zone of First Workings (refer Figure 2 in Appendix 3), or second workings, the Applicant must prepare an Extraction Plan for the relevant workings to the satisfaction of the Secretary. Each Extraction Plan must:*
>
> *i)…Include a:*
>
> *v) Public Safety Management Plan which has been prepared in consultation with the IEP, Resources Regulator and BCD to ensure public safety and manage access on site.*

This ***MW17-18 PSMP*** has been developed in accordance with Condition 2 in Schedule 6 of SSD_5581 (management plan requirements). **Table 2-1** details where these conditions have been addressed.

**Table 2-1: Public Safety Management Plan Requirements**

| Key Conditions of Development Consent SSD_5581 | Section Addressed |
|---|---|
| **Schedule 6, Condition 2 *(Management Plan Requirements)*** | |
| The Applicant must ensure that the management plans required under this consent are prepared in accordance with any relevant guidelines, and include: | |
| a) Detailed baseline data; | Sections 1.4, 4.2 |
| b) A description of: | |
| • The relevant statutory requirements (including any relevant approval, licence or lease conditions); | EP Main Report (Section 2.1, Attachment B) |
| • Any relevant limits or performance measures/criteria; | Section 5.1 |
| • The specific performance indicators or triggers that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures. | Section 5.4, MW17-18 Master TARP |
| c) A description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria. | Sections 2.1, 5.1, 5.4 |
| d) A program to monitor and report on the: | |
| • Impacts an environmental performance of the development; | Section 4 |
| • Effectiveness of any management measures (see c) above); | Section 5.4, 5.7 |

| Key Conditions of Development Consent SSD_5581 | Section Addressed |
|---|---|
| e) A contingency plan to manage any unpredicted impacts and consequences | Section 5.5 |
| f) A program to investigate and implement ways to improve the environmental performance of the development over time | Section 5 |
| g) A protocol for managing and reporting any:<br>• Incidents;<br>• Complaints;<br>• Non-compliances with statutory requirements; and<br>• Exceedances of the impact assessment criteria and/or performance criteria; and | Section 5.6 |
| h) A protocol for periodic review of the plan. | Section 6.1 |

### 2.1.1 Work, Health and Safety Laws (subsidence related)

Airly Mine operates in accordance with its Safety Management System which integrates plans, policies and procedures that enables a systematic approach to establishing and maintaining effective systems to manage health and safety consistent with WHS laws and relevant standards.

WHS laws[5] have been considered for the Extraction Plan principally within the context of subsidence related risks to public safety, including to public infrastructure and in reference to Managing Risks of Subsidence Guideline (NSW RR, 2017).

An outline of key relevant WHS requirements is provided in the sections below.[6]

**Potential Risks to the Safety of Others**

WHS requirements considered for the Extraction Plan principally are within the context of subsidence related risks to public safety, including to private property and public infrastructure, include:

- Section 19 of the *Work Health and Safety Act 2011* (WHS Act)
  *..all persons conducting a business or undertaking, including mine operators, must ensure, so far as is reasonably practicable,….. that the health and safety of other persons is not put at risk from work carried out as part of the conduct of the business or undertaking*.
- Under section 14(1) of the WHS (Mines and Petroleum) Regulation (2022) *(WHSMP Regulation*),
  *..all persons conducting a business or undertaking at a mine, including the mine operator, must manage risks to health and safety associated with mining operations at the mine in accordance with Part 3.1 of the Work Health and Safety Regulation 2011 (WHS Regulation).*

**Subsidence as a Principal Hazard**

Panel and pillar mining within the EP Area is <u>not</u> considered a *principal hazard* under the above WHS legislation definition, and subsequently a formal PHMP is not required. This PSMP for MW17-18 is intended to manage potential risks from subsidence, particularly within the context of the "safety of others".

[5] WHS laws include the Work Health and Safety Act 2011 (WHS Act), Work Health and Safety Regulation 2017 (WHS Regulation), Work Health and Safety (Mines and Petroleum Sites) Act 2013 (WHSMP Act), and the Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 (WHSMP Regulation)

[6] See Section 2.1.2 in the EP Main Report for further details of the subsidence related WHS requirements

**Assessment for High Risk Activity**

The proposed mining within the EP Area meet the definition of High Risk Activities (HRA) under relevant WHS legislation (in particular Section 5 and Schedule 3 of the WHSMP Regulation):

- Include Secondary extraction (Schedule 3, Section 17) – Proposed Panel and Pillar/miniwall workings are defined by the Development Consent as secondary extraction. Accordingly, Airly Mine have prepared a HRA Notification for Panel and Pillar Mining on Mt Airly for submission to the NSW Resource Regulator (Mines Safety). The HRA proposed workings are entirely consistent with those presented in this Extraction Plan.

**Guidelines for Managing Risks of Subsidence (WHS Legislation)**

This MW17-18 PSMP (and the Extraction Plan Main Report) has been prepared in accordance with the *Managing Risks of Subsidence Guideline* (NSW RR, 2017) which provides practical guidance of key recommended factors to be considered in the management of subsidence risks to 'other persons' (including for Principal Hazard Management Plans) as well as High Risk Activity components.[7]

These have been specifically included in the *Subsidence and Environmental Risk Assessment* undertaken for the Extraction Plan[8], supported by specific technical assessments of these aspects in supporting specialist reports such as those in *Attachment F – Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023)*.

## 2.2 Specialist Assessments

This MW17-18 PSMP has been informed by cliff identification assessments undertaken by Aerometrex (2021) and Michael Nicholson Consulting Pty Ltd (MNC) (2022).

The purpose of the cliff identification assessments was to identify and map the locations of cliffs and other sensitive surface features which can then be used as the basis for determining set back distances to the proposed secondary extraction (within the PPMZ) to minimise risk of surface impacts through appropriate mine layout design to reduce subsidence at sensitive high cliffs and escarpments located on the external parts of the Mount Airly and Genowlan Mountain mesas.

Extensive aerial photogrammetry and cliff identification work was undertaken by Aerometrex (2021). MNC was then engaged to undertake site inspections ("ground truthing") of the cliffs that were identified as being located within the CLZ or the PPMZ on Genowlan Mountain.

The relevant features within the EP Area, including the key cliffs and features identified by these reports, are illustrated on **Figure 1.2**.

MSEC (2023) were engaged to prepare and provide a subsidence prediction and impact assessment report, on the likely impacts of these predicted levels of subsidence on the natural and built features that exist over and near MWs 17 to 18, based on the subsidence modelling work provided by SCT (2023). The subsidence predictions and impact assessment is further discussed below in **Section 3.2** of this PSMP.

[7] See *Attachment B – Relevant Legal and Other Requirements* for key recommended factors to be considered in accordance with the NSWRR guidelines for the management of subsidence risks to 'other persons' (including for Principal Hazard Management Plans as well as HRA components of the guidelines) and where they have been considered for the MW17-18 PSMP (and the Extraction Plan Main Report).

[8] See Section 2.3 Risk Assessment and *Attachment C – Subsidence and Environmental Risk Assessment*

## 2.3 Risk Identification and Assessment

Centennial Airly has undertaken a dedicated ***Subsidence and Environmental Risk Assessment*** *(Stature RA Number: 1001308023[9])* directly in support of this Extraction Plan which provide a risk framework basis for development of the component management plans.

The *Subsidence and Environmental Risk Assessment* was completed on the 13 July 2022 with key staff from the Airly Mine including the Technical Services Manager, Statutory Mine Surveyor, Mining Engineer / Compliance Manager and Environment and Community Officer, as well as the General Manager of Technical Services for Centennial and the Lead Consultant for the EP Project Team from Catalyst Environmental Management. The risk assessment was facilitated by the Mining Engineer / Compliance Manager and has been reviewed by key EP Project Team members for Heritage, Ecology and Subsidence.

Risks were identified and assessed through the review of known surface and sub-surface features within the EP Area. The risk assessment also specifically assessed key heads of consideration required by the Managing Risks of Subsidence Guideline (NSW RR, 2017).

A risk ranking (low, moderate, significant, high or extreme) was assigned to each risk/hazard in consideration of the Maximum Reasonable Consequence (MRC) for the given controls. There were 49 potential risks scenarios assessed during the Risk Assessment; 8 moderate, 41 low and two were assessed as not applicable.

The risk assessment determined that the risk of impact for landscape features (noting the extensive controls identified) was **Low to Moderate** including aspects associated with cliffs and pagodas within the EP Area.

A copy of the risk assessment is included in the EP Main Report (refer Attachment C). Additional details regarding the management and monitoring of subsidence related impacts within the EP Area have been detailed in **Section 4** and **Section 5**.

## 2.4 Consultation

Condition 7 of Schedule 3 under development consent SSD_5581 requires the preparation of this ***MW17-18 PSMP*** in consultation with key relevant stakeholders as detailed below:

- IEP;
- NSW Resources Regulator; and
- NSW Biodiversity Conservation Division (BCD) within the NSW Department of Planning and Environment (DPE).

The outcomes of consultation undertaken for the project is provided in the EP Main Report (refer Attachment D), including copies of relevant correspondence such as project presentations delivered by the mine to key stakeholders and relevant formal correspondence received from key stakeholders.

Stakeholder feedback provided has been reviewed and addressed as necessary as part of the development and review of this Extraction Plan and key component plans.

[9] Centennial Airly has adopted the Stature Risk Assessment Program which was developed to ensure consistency in all risk assessments across the Centennial operations. The Stature Risk Assessment Program sets out a consequences table and risk ranking matrix for managing identified risks consistent with AS/NZS ISO 31000:2009.

# 3 SUBSIDENCE ASSESSMENT

## 3.1 Mine Planning and Design

Mine design is the primary control utilised at Airly Mine for subsidence impact avoidance. Centennial Airly have adopted a conservative mine design to control subsidence to levels predicted in the EIS. Approvals for Panel and Pillar Mining are based on predicted surface subsidence levels of up to 100-125mm.

Void and pillar widths have been specifically designed to support the overburden with minimal subsidence effects at the surface. The final pillars left following panel extraction are specifically designed to provide long term stable support to the surface with no expected surface cracking and minimal ground movement.

The predicted subsidence is not expected to cause adverse impacts on the relevant features covered under this *MW17-18 PSMP*.

Within the EP Area the pillar widths between the miniwall panels have been increased by more than double their original proposed width from 29.5m to 70m. Panel void widths have been slightly increased from 61m to 70.5m.

## 3.2 Subsidence Predictions

Condition 7(g) of Schedule 3 under Development Consent SSD_5581 and the Extraction Plan Guidelines (DPE, 2022) requires revised predictions of potential subsidence effects, subsidence impacts and environmental consequences to be presented within the Extraction Plan for the EP Area, including any relevant information obtained since the EIS and consent, in consultation with the Independent Expert Panel (IEP). A detailed review of the revised subsidence predictions is provided in the *EP Main Report (refer Section 3.2)*.

This Extraction Plan has relied on the most recently updated predictions of subsidence effects, subsidence impacts and environmental consequences. The subsidence assessments undertaken for this Extraction Plan are documented in the following reports:

- *SCT (2023). MW17-18 Pillar and Panel Optimisation Assessment (Airly 5612 dated 8 June 2023).* SCT (2023) were engaged to advise on a revision to the pillar and panel layout to limit the maximum predicted subsidence to a precautionary upper design limit of 95mm (+/-20mm). The proposed revised mining geometry includes two miniwall panels, MW17 and MW18, with panel void widths of 70.5m and 3.0m extraction height separated by a 70m wide barrier pillar. The predicted subsidence effects for the proposed miniwalls 17 to 18 have been provided by SCT (2023). The maximum vertical subsidence for the revised mine layout is predicted to be 88 mm (+/-20mm).

Centennial Airly, then engaged MSEC (2023) to prepare a Subsidence Prediction and Impact Assessment to support the Extraction Plan based on the subsidence prediction work provided by SCT (2023).

The subsidence predictions and impact assessment is documented in the following report:

- *MSEC (2023). Airly Mine MW17 to MW18 – Subsidence Predictions and Impact Assessments for the Natural and Built Features over and near the Proposed MWs 17 to 18 in Support of the Extraction Plan Application (MSEC1351).*

The primary management strategy being implemented by Airly Mine for the Extraction Plan is impact avoidance through the implementation of a conservative mine design, with panel and pillar widths specifically designed to have minimal subsidence effects and prevent subsidence impacts. Conservative setbacks to key sensitive features within the *Cliff Line Zone of First Workings* continue to be implemented for this Extraction Plan (i.e. 26.5 degree Angle of Draw).

The maximum incremental vertical subsidence predictions for the EP Area are shown in **Table 3.1**. The predicted subsidence levels are minimal and well below levels expected to cause damage or any adverse impacts on the relevant features within the EP Area. This includes the extended / far-field subsidence monitoring and management area.

**Table 3-1: Maximum Incremental Subsidence Predictions (SCT, 2023)**

| Miniwall Panel Width | Maximum Predicted Subsidence (mm)[a] |
|---|---|
| **One Miniwall** | -39mm |
| **Two Miniwalls** | -88mm |

*a) SCT (2023) note that a subsidence tolerance of +/-20mm should be applied to the modelled subsidence*

MSEC (2023) have predicted that if the measured subsidence above MW17 to MW18 is less than 125 mm:

- tilts should be less than 2.5 mm/m
- strains should be less than 2 mm/m

The cliff impact assessment for the Extraction Plan was prepared by MSEC (2023) and includes rock fall predictions for key cliffs within the EP Area. The performance measure for public safety requires negligible additional risk, in consultation with the Resources Regulator and BCD (see **Table 5-1**). MSEC (2023) concluded that there should be little chance of exceeding the conditions of approval for identified cliffs over MW 17-18. However, ongoing natural weathering and erosion processed may result in small rockfalls at one of the identified cliff features. At Genowlan Mountain, this occurs naturally every 3 to 4 years on average. If this should occur, MSEC states that based on available data, the size of these types of rock falls would be less than the consent condition that the fall should be less than 2% by area of cliffs.

Furthermore, subsidence impacts on the steep slopes and rock outcrops identified that the predicted level of subsidence and tilts over steep slopes and rock outcrop areas a very low and it is unlikely that these features will be impacted by the proposed mini wall extraction.

Notwithstanding this, appropriate responses have been conservatively developed for unexpected higher than predicted subsidence within a MW17-18 TARP (Appendix 6 of the EP Main Report) developed for the Extraction Plan and this MW17-18 PSMP.

Extensive monitoring and management measures are proposed to demonstrate the subsidence modelling and effectiveness of the mining and monitoring systems. The proposed monitoring approach has been developed in consultation with key stakeholders to minimise further disturbance to the sensitive SCA and builds upon existing management and monitoring practices implemented successfully to date by Centennial Airly.

# 4 MONITORING PROGRAM

## 4.1 Public Safety Monitoring Strategy and Program Summary

Environmental monitoring considerations for public safety are focused on the key sensitive features of cliffs, minor cliffs and pagodas and minor built features within the EP Area including the unsealed roads and tracks. The proposed monitoring program and strategy is developed in consultation with key stakeholders including (but not limited to) the IEP, BCD, NSW Resources Regulator and NPWS, and is detailed within the dedicated MW17-18 SMP (Appendix 5) for the EP Area. The proposed Integrated Subsidence Monitoring Program within the Subsidence Monitoring Program includes:

- **Underground Mining Control** a key focus as noted above (routine survey of workings and inspections by mining officials);
- **Monitoring ground movement** and surface subsidence impacts via the following methods:
    - Global Navigation Satellite System (GNSS) Monitoring Stations / Continually Operating Reference Station (CORS) – Long occupation real time point data base stations;
- **Remote monitoring of the Surface Environment**:
    - LiDAR (High Resolution 40 points per square meter) – for monitoring of vertical subsidence over the EP Area relative to baseline and Performance Measures.
- **Targeted and Trigger-based Surface Inspections** where required (where safely and readily accessible, such as where 4WD trails traverse or are close to the EP Area, and where otherwise triggered by the Master TARP).
- **Data Analysis** data analysis and reporting will monitor specifically for change and target:
    - Any areas detected for significant change by remote monitoring (LiDAR acquisition) results (including pre and post mining areas), triggering further detailed analysis under the Master TARP, including a process for determining natural or mining-induced rock fall.
    - The process for this detection is detailed further in the Subsidence Monitoring Program and Master TARP respectively. Data for natural rock falls in areas yet to be mined will also provide additional data to the baseline data set.

Airly Mine will implement the monitoring program applicable to public safety as specified in **Table 4-1** and shown on **Figure 4.1** to monitor the development of possible subsidence related environmental impacts. It is noted that the table is reproduced from the original within the *Subsidence Monitoring Program for MW17-18*, therefore refer to the MW17-18 SMP for full details.

A contingency plan has been developed as a component of this MW17-18 PSMP to outline management measures that will be implemented if predicted consequences are exceeded (**Section 5.1**).

**Table 4-1: Public Safety Features Subsidence Monitoring Program Summary**

| Monitoring Component / Feature | Purpose/Parameter | Monitoring Method | Frequency & Duration |
|---|---|---|---|
| **Cliffs, Minor Cliffs & Pagodas** | Presence/absence of mine-induced damage or change to features (significant rock falls and surface cracking)<br>Various Parameters relevant to each method | LiDAR | Remote aerial monitoring is undertaken at approximately six-month intervals. At least 2 surveys will have been undertaken prior to miniwall extraction. At least one survey throughout extraction MW17-MW18 and at least one survey will be undertaken following completion of panels MW17-MW18. No further detailed analysis after post mining survey has indicated negligible impacts (in the undermined area). |
| | | Targeted GNSS Monitoring Stations | Installed prior to commencement, continuous data from installation, throughout extraction of MW17-MW18 and will remain in-situ until consistent results are obtained demonstrating completion of major subsidence movement (i.e. within survey error) following completion of panels MW17-MW18 |
| | | Targeted visual surface inspections | Only if triggered as per MW17-18 Master TARP triggers |
| **General Land Surface (excl. cliffs and pagodas)** | Evidence of subsidence impacts compared to baseline records | LiDAR | Remote aerial monitoring is undertaken at approximately six-month intervals. At least 2 surveys will have been undertaken prior to miniwall extraction. At least one survey throughout extraction MW17-MW18 and at least one survey will be undertaken following completion of panels MW17-MW18. No further detailed analysis after post mining survey has indicated negligible impacts (in the undermined area). |
| | | Targeted GNSS Monitoring Stations | Installed prior to commencement, continuous data from installation, throughout extraction of MW17-MW18 and will remain in-situ until consistent results are obtained demonstrating completion of major subsidence movement (i.e. within survey error) following completion of panels MW17-MW18 |
| | | Targeted visual surface inspections | Only if triggered as per MW17-18 Master TARP triggers |
| **Walking and 4WD tracks** | Evidence of subsidence impacts compared to baseline records | LiDAR | Remote aerial monitoring is undertaken at approximately six-month intervals. At least 2 surveys will have been undertaken prior to miniwall extraction. At least one survey throughout extraction MW17-MW18 and at least one survey will be undertaken following completion of panels MW17-MW18. No further detailed analysis after post mining survey has indicated negligible impacts (in the undermined area). |
| | | Targeted visual surface inspections | Only if triggered as per MW17-18 Master TARP triggers |

## 4.2 Baseline Monitoring

Baseline monitoring of natural and built features as they relate to public safety within the EP Area has commenced and will be obtained by using a combination of the following methods:

- **Landscape Features** (including cliffs and pagodas) using both monitoring ground movement and remote monitoring methods;[10]
    - The installation of the GNSS network is scheduled for completion prior to commencement of development workings with baseline continuous data from installation through to commencement of secondary extraction of nearest panel of MW17. [11]
    - LiDAR baseline flown in December 2022 and June 2023, an additional survey will potentially be flown prior to secondary extraction commencing in MW17.
    - High resolution stereo vertical and 3D oblique photogrammetry baseline flown in May 2020, November 2020, May 2021, May 2022 and December 2022.[12]

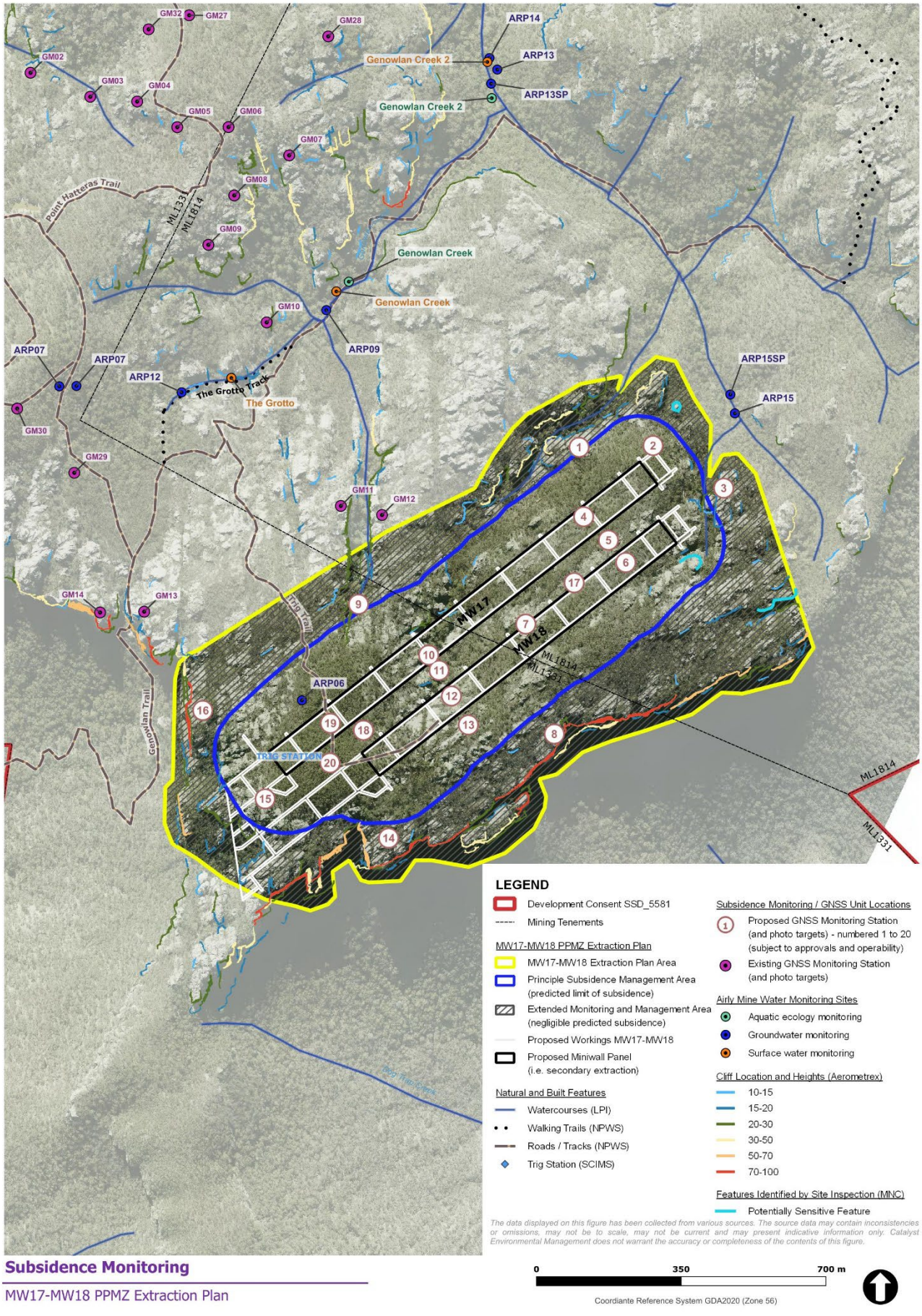
Further details including methodologies, locations, parameters, frequencies and duration of monitoring is provided in the *MW17-18* SMP (Appendix 7 of the EP Main Report) and the Land Management Plan *MW17-18* LMP (Appendix 2 of the EP Main Report).

[10] See Section 4.3.1 and 4.3.2 in the Subsidence Monitoring Program for MW17-18 (Appendix 7 of the EP Main Report) for further details.

[11] Installation of this monitoring equipment is subject to a Review of Environmental Factors and subsequent approval from NPWS.

[12] Note, stereo vertical and 3D oblique photogrammetry is proposed to be replaced by routine LiDAR survey, however the baseline photogrammetry data may be used for data analysis or comparison against future stereo vertical and 3D oblique photogrammetry if required.

**Figure 4.1: Subsidence Monitoring**



# 5 MANAGEMENT, MITIGATION, REMEDIATION AND REPORTING MEASURES

## 5.1 Performance Measures and Indicators

The approved subsidence impact performance measures are specified under Condition 3 in Schedule 3 of SSD_5581. The performance measures relating to potential subsidence impacts (as they relate to this *MW17-18 PSMP*) are outlined in **Table 5-1**[13].

**Table 5-1: Relevant Subsidence Impact Performance Measures for Public Safety**

| Public Safety | Performance Measure | Performance Indicator | Applicability to this EP Area |
|---|---|---|---|
| Public Safety | Negligible additional risk, in consultation with the Resources Regulator and BCD | Presence/absence of mine-induced damage or change to features (significant rock falls and surface cracking)<br>Various Parameters relevant to each method | Applicable |

Additional internal performance measures set by Centennial Airly for the mine design (to be monitored by the underground components of the Subsidence Monitoring Program) are detailed in the MW17-18 SMP (Appendix 5 of the EP Main Report) and have been reflected within the MW17-18 Master TARP (Appendix 6 of the EP Main Report).

To establish compliance with the performance measures, Airly Mine has developed a monitoring program with several integrated components (see **Section 4**) and an associated MW17-18 Master TARP (Appendix 6 of the EP Main Report).

These documents establish appropriate monitoring elements, parameters, and associated trigger levels to demonstrate that the environmental performance satisfies the criteria in Section 5.1 of the EP Main Report.

**Table 5-2** contains the performance indicators which have been established for key monitoring aspects with allocated trigger values to define the following key performance scenarios within the MW17-18 TARP (Appendix 8 of the EP Main Report).

**Table 5-2: Performance Indicators & TARP Risk Management Scenarios**

| Performance Indicator | General Description | Action / Response |
|---|---|---|
| **Level 1: Condition Green** | **Operations within predictions, and within approved impacts**. | Continued operations and monitoring as normal. |
| **Level 2: Condition Amber** | **Operations within approved impacts but potentially exceed / exceed predictions**. | Review and investigation processes are engaged, with adaptive management as required. |
| **Level 3: Condition Red** | **Operations exceed approved impact.**<br>*The approved Performance Measures (criteria thresholds) of Development Consent (and any other relevant approvals) are listed in Condition Red.* | Adaptive Management measures are fully engaged as per the TARP and relevant sections of the Extraction Plan and the SMP. |

[13] extracts from Tables 1 and 2, under Condition 2 in Schedule 3 of Development Consent SSD_5581

## 5.2 Management and Mitigation Measures

As described in **Section 3.2**, the predicted subsidence levels in the EP Area[14] are minimal and well below levels expected to cause damage or any adverse impacts on the natural features. This includes the extended / far-field subsidence monitoring and management area.

The *Subsidence and Environmental* risk assessment (**Section 2.3**) determined that the risk of impact for public safety was **Low to Moderate** including aspects associated with potential instabilities for cliffs and pagodas within the EP Area. There are two main management aspects of this MW17-18 PSMP, including:

- Mine design to avoid impacts (**Sections 3.1 and 3.2**);
    - The primary management strategy being implemented is impact avoidance through the implementation of a conservative mine design. Mining methods which limit void widths are designed to leave sufficiently large and long term stable final pillars, and hence have minimal subsidence effects and prevent subsidence impacts, and
- Monitoring and management measures (**Section 4**).
    - Monitoring to ensure the mine design is strictly implemented as designed through underground mining controls and monitoring of key landscape features for change (particularly cliffs and pagodas) will be undertaken to confirm that the mine design measures to prevent impact are adequate and remain within consent.

It is noted that management measures associated with public safety aspects of the EP Area are addressed separately within the *PSMP (MW17-18 PSMP)*.

The EP Area is located in rugged, largely inaccessible, terrain within the Mugii Murum-ban SCA which offers opportunities for self-reliant recreation including four-wheel driving, nature study, camping, mountain biking, bushwalking and birdwatching.

The overall management of Mugii Murum-ban SCA is the responsibility of the NPWS. In consultation with the NPWS, IEP, BCD and NSW Resources Regulator, Airly mine has committed to the following monitoring and management measures, as they related to land in the EP Area, including:

- Develop and install subsidence monitoring equipment prior to mining MW17 for baseline data and maintained for the required period post mining with the Subsidence Monitoring Program (SMP) (**Section 4.1**) (for further details refer to Section 4 of the EP Main Report and the Subsidence Monitoring Program (MW17-18 SMP) (Appendix 7);
- Develop an Integrated Subsidence Monitoring Program within the Subsidence Monitoring Program (MW17-18 SMP) that will provide data for trend analysis, that will inform adaptive management if required (**Section 5.2**) (for further details refer to Section 4 of the EP Main Report and MW17-18 SMP (Appendix 7);
- In consultation with NPWS, consideration of safety warning signage for placement prior to mining in the vicinity of key areas such as Genowlan Mountain.

Therefore, it is expected with the above controls in place, the subsidence performance measures for land will be achieved. Noting, as detailed by MSEC (2023) and Section 3.2 of the EP Main Report, that

[14] For important context to the current EP Area, it is noted that the external cliffs of the mountain complex are located in the far-field / extended subsidence management and monitoring area (this is the same as the previously approved Cliff Line Zone of First Workings). There is predicted to be negligible subsidence beyond the near field / principal subsidence area, and no surface cracking within or beyond the EP Area.

cliff formations do experience rock falls naturally at a relatively rapid rate which is why they exist in the landform[15].

Notwithstanding this, appropriate responses have been conservatively developed for unexpected/higher than predicted subsidence within a ***Master Trigger Action Response Plan (TARP)*** developed for the Extraction Plan and this MW17-18 *PSMP* , which include:

- Condition Amber: controlling access to the public in around the EP zone until the area is inspected and geotechnical risk assessment is complete; and
- Condition Red: barricade the area until miniwall extraction has ceased and the entire area is inspected and geotechnical risk assessment is complete.

If triggered, any changes to public access or potential use barricading will be implemented in consultation with NPWS.

## 5.3 Remediation and Rehabilitation Measures

Due to the minimal subsidence expected the need to implement remediation/rehabilitation measures for potential impacts are considered unlikely. However, if remediation is required, Airly Mine will undertake remediation in accordance with:

- Conditions 7a)-7c) in Schedule 6 of SSD_5581, noting in particular the requirement to submit a report to DPE describing remediation options and any preferred remediation measures or other course of action;
- Any relevant actions prescribed in the MW17-18 TARP developed for the Extraction Plan;
- The current Mining Operations Plan and Rehabilitation Management Plan; and
- In consultation with key stakeholders including any affected land holders and relevant government agencies.

A Response Strategy will be adopted if a significant impact is detected as a result of mining activities within the Extraction Plan area.

## 5.4 Trigger Action Response Plan

A detailed MW17-18 TARP (Appendix 6 of the EP Main Report) has been developed for the Extraction Plan to reflect the commitments of this MW17-18 PSMP and other related aspects. Whilst impacts are not predicted nor expected, the MW17-18 TARP provides a process of tiered and/or escalating trigger levels for contingency measures should subsidence and impacts be greater than predicted/approved. The MW17-18 TARP applies only to the EP Area (separate TARPs apply to other established EP Areas in various approved mining zones).

Given the mine has been designed specifically to avoid impacts, the MW17-18 TARP includes detailed measures for Underground Mining Controls to ensure that the mining geometry is formed as per the approved design specifications that determine the predicted subsidence movements and impacts.

The MW17-18 TARP includes detailed performance indicators for public safety management. The contingency plan where a performance indictor has been exceeded is outlined in the TARP. A trigger will result in additional investigations to determine if the exceedance is related to non-mining-factors

[15] See Section 1.1 of '*MSEC1270 Subsidence Predictions and Impact Assessments for the Natural and Built Features over and near the proposed MWs 17 to 18 in support of the Extraction Plan Area*'

or is a consequence of mining activity. The response to these exceedances will follow the TARP. Management / corrective actions can be implemented where required to remedy these non-conformities and report accordingly.

## 5.5 Adaptive Management and Contingency Planning

An Adaptive Management Framework provides for flexible decision making, adjusted to consider uncertainties as management outcomes are understood. The adaptive management approach at Airly Mine is detailed in the EP Main Report *(refer Section 5.2)*.

In summary, adaptive management at Airly Mine involves monitoring and evaluation against performance measures and associated indicators in the MW17-18 TARP established for the extraction plan and supporting management plans. Where performance indicators indicate increasing levels of risk (i.e., where relevant thresholds of conditions green, amber or red are being exceeded), escalating adaptive management measures are engaged in accordance with the MW17-18 TARP. The process has been successfully implemented in existing Extraction Plan areas at Airly Mine and has been updated to reflect EIS commitments and consent requirements for the Airly Mine Extension Project, including specific performance measures.

## 5.6 Incidents, Complaints, Exceedances and Non-Compliances

Incidents, complaints, exceedances and non-compliances are managed accordance with the requirements of relevant approvals and licences including SSD_5581, EPL12374 and EPBC 2013/.7076, relevant legislation and regulations, and generally in accordance with the *Extraction Plan Guideline* (DPE, 2022). A detailed review of the notification requirements relevant to the Extraction Plan, including this MW17-18 PSMP, is provided in the EP Main Report *(refer Section 5.7.1)*, including requirements for:

- Incident or non-compliance reporting in accordance with:
    - Consent condition 9 (Schedule 6) of SSD_5581.
    - EPBC 2013/7076 Condition 1, or as triggered by the TARP (reporting incidents under Management Plans as per Schedule 6, Condition 2 of SSD_5581).
    - EPL12374 condition R2
    - WHS Regulation (Mines and Petroleum Sites, 2022) Clause 124 - Duty to notify regulator of certain incidents
    - Section 6 of the Guidelines for Managing Risks of Subsidence (WHS (Mines and Petroleum Sites), February 2017
- Managing complaints.

Incidents, complaints, exceedances and non-compliances will be managed in accordance with the requirements detailed in the EP Main Report *(refer Section 5.6).*

## 5.7 Reporting and Auditing

### 5.7.1 Reporting

Reporting is undertaken in accordance with the requirements of specific requirements of relevant approvals and licences including SSD_5581, EPL12374 and EPBC 2013/7076, and generally in accordance with the *Extraction Plan Guideline* (DPE, 2022). Additionally, high potential incident

notifications for unexpected subsidence events in relation to the safety of other persons under WHS legislation has also been included.

A detailed review of the reporting and notification requirements relevant to the Extraction Plan, including this MW17-18 PSMP, is provided in the EP Main Report *(refer Section 5.7.1*, including requirements for:

- Regular reporting of impacts and environmental monitoring results in accordance with Condition 10 of Schedule 6 under SSD_5581;
- Annual reporting required in accordance with condition 11 of Schedule 6 under SSD_5581 and separately under EPBC 2013 / 7076;

Reporting and notifications will be undertaken in accordance with the requirements detailed in the EP Main Report *(refer Section 5.7.1)*.

### 5.7.2 Periodic Auditing

Comprehensive Independent Environmental Audits of the entire approved development under development consent SSD_5581 are undertaken within 1 year of commencement and every 3 years thereafter (unless directed otherwise) in accordance with Conditions 12 and 13 of SSD_5581.

Auditing of any rehabilitation undertaken for the mine (including for subsidence if triggered) is undertaken in accordance with the Mining Operations Plan / Rehabilitation Management Plan under Condition 27 in Schedule 4 of development consent SSD_5581.

Additionally, in accordance with section20(c) of the WHSMP Regulation (2022), auditing will be undertaken in accordance with the Airly Mine Safety Management System (SMS), against the performance standards for measuring the effectiveness of all aspects of the SMS, including the methods, frequency and results of the audit process. The audit should also consider the following matters:

(1) competency of the auditor,

(2) the person responsible for ensuring the audit is conducted, and

(3) the person responsible for implementing the results of the audit.

# 6 PLAN ADMINISTRATION AND RESPONSIBILITIES

## 6.1 Review

In accordance with the requirements under Condition 3 in Schedule 6 of Development Consent SSD_5581, as a minimum Centennial Airly will review this Plan within three months of the following:

a) Submission of an incident report;

b) Submission of an Annual Review (required 31 March annually);

c) Submission of an Independent Environmental Audit; or

d) Any modification to the conditions of SSD_5581.

Where this leads to revisions of the document, within four (4) weeks of the review the revised document must be submitted to DPE for the approval of the Secretary. Continual improvement shall be achieved through monitoring, internal and external communication with stakeholders, implementation of corrective and preventative actions and through monitoring progress against the objectives included in the environmental management plans. The reporting framework (refer **Section 5.7**) will document the effectiveness of this document (and the related Extraction Plan) through comparison of the predicted negligible impacts of subsidence against actual outcomes.

Each variation to this Plan will be identified in the Document Control Table at the beginning of this document.

Additionally, to maintain consistency with existing management plans and previous Extraction Plans at the mine, this MW17-18 PSMP will also be reviewed in the event that the following occur:

- Stakeholders raise issues that necessitate a review;
- There are other changes to management requirements (e.g. changes to other related approvals besides consent, such as Mining Lease and/or EPL conditions);
- Where unpredicted impacts or consequences have required implementation of contingency actions under this plan;
- Monitoring or audit processes demonstrate that a review is warranted;
- Where otherwise triggered by the MW17-18 TARP;
- Where triggered by (or for) review of other related management plans (if applicable); or
- Every three (3) years as a minimum (where not already triggered above).

Any amendments to the MW17-18 PSMP will be undertaken in accordance with Consent/relevant approvals and in consultation with key relevant stakeholders where required. Following any significant changes, a copy of the amended MW17-18 PSMP will be forwarded to all relevant stakeholders.

In addition to planning development consent requirements, Airly Mine must review and as necessary revise the risk control measures implemented for subsidence in accordance with Section 15 of the *WHSMP Regulation (2022)*. Any review triggered by WHS Legislation Requirements will be addressed via the process identified in the EP Main Report *(refer Section 5.5)* and this MW17-18 PSMP.

## 6.2 Roles and Responsibilities

The responsibility for implementation, monitoring and review of the MW17-18 PSMP lies with the Superintendent Environment and Community. The ultimate responsibility for the implementation of the MW17-18 PSMP lies with the Mine Manager, who shall make appropriate resources available. The roles and responsibilities for this MW17-18 PSMP are outlined in **Table 6-1.**

**Table 6-1: Key Personnel and Accountabilities**

| Position | Responsibility |
|---|---|
| Mine Manager | • Ensuring that sufficient resources are available to implement and execute the requirements of this Plan; and<br>• Reporting triggers/non-conformances to external stakeholders. |
| Technical Services Manager | • Coordinate underground inspections and subsidence monitoring program associated with this MW17-18 PSMP;<br>• Coordinate implementation of the mine design and MW17-18 TARP.<br>• Reporting triggers/non-conformances internally to the mine manager as appropriate.<br>• Reporting to DPE and NSW RR of subsidence and pillar system performance upon completion of specified monitoring intervals. |
| Production Manager | • Implement mine design<br>• Establish and maintain underground monitoring and inspections program;<br>• Auditing as required |
| Mine Surveyor | • Survey as built initial development pillars<br>• Establish and maintain subsidence monitoring program;<br>• Internal reporting as required.<br>• Mark up centre lines for driveage in pillars<br>• Produce final mining plan for extraction workings to be carried out in consultation with the Technical Services Manager. |
| Superintendent Environment and Community | Implementation, monitoring and review of this plan, including:<br>• The carrying out of targeted inspections;<br>• The installation and maintenance of signage where required;<br>• Reporting triggers/non-conformances internally to the Mine Manager as appropriate;<br>• Consulting with land owners, landholders and managers regarding any land management issues arising from subsidence within the EP Area. This includes (but may not be limited to) NPWS, Office of Crown Lands and private landowners within the EP Area (if and as applicable);<br>• Reviewing this MW17-18 PSMP, including consultation during the review process with relevant stakeholders;<br>• Coordinating any remediation work as required;<br>• Inspecting targeted accessible areas susceptible to tensile and compressive strains and potential cracking as required (e.g. accessible tracks and trails); and<br>• Co-ordinating the generation and submission of formal reporting requirements outlined in this Plan. |

# 7 REFERENCES

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# APPENDIX 5Subsidence Monitoring Program for MW17-18

# Subsidence Monitoring Program (MW17-18 SMP)

## MW17-18 Panel & Pillar Mining Zone Extraction Plan

**Airly Mine (SSD_5581)**

**November 2023**

# DOCUMENT CONTROL / TITLE BLOCK

| | | |
|---|---|---|
| **EXTRACTION PLAN DETAILS** | **Title:** | Subsidence Monitoring Program: MW17-18 Panel & Pillar Mining Zone Extraction Plan |
| | **Applicant:** | Centennial Airly Mine |
| | **Revision No.:** | MW17-18 SMP_Rev_3[1] |

# REVISION

| | **Revision No.** | **Details of Revision** | **Date Sent** |
|---|---|---|---|
| **REVISION DETAILS** | Rev_0 | Draft for external consultation | 21/02/2023 |
| | Rev_1 | Updated following external consultation to incorporate a revision of mine design (reduction in miniwall panels) and accompanying pillar width modelling and subsidence predictions and impact assessments | 11/07/2023 |
| | Rev_2 | Updated following external consultation to include requirement to regularly provide GNSS subsidence monitoring data to NPWS | 23/08/2023 |
| | Rev_3 | Updated subsidence monitoring layout with two additional GNSS units | 7/11/2023 |
| | | | |
| | | | |

[1] An integrated Document Control Procedure is incorporated into Centennial Airly Mine's Safety Management System (SMS). Documents, data and records pertaining to this plan will be managed according to ***Airly Mine Document and Data Control Management Plan (AIR-MP-1034)***.

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# Other Relevant Information
## *(refer to EP Main Report)*

ATTACHMENT A – IDENTIFICATION OF NATURAL AND BUILT FEATURES CHECKLIST

ATTACHMENT B – RELEVANT LEGAL AND OTHER REQUIREMENTS

ATTACHMENT C – SUBSIDENCE AND ENVIRONMENTAL RISK ASSESSMENT (EP AREA)

ATTACHMENT D – STAKEHOLDER CONSULTATION

ATTACHMENT E – TECHNICAL REPORT: PILLAR WIDTH MODELLING (SCT, 2023)

ATTACHMENT F – TECHNICAL REPORT: SUBSIDENCE PREDICTIONS AND IMPACT ASSESSMENT REPORT (MSEC, 2023)

ATTACHMENT G – TECHNICAL REPORT: BASELINE BIODIVERSITY ASSESSMENT (RPS, 2023)

ATTACHMENT H – TECHNICAL REPORT: BASELINE HISTORIC HERITAGE ASSESSMENT (RPS, 2022A)

ATTACHMENT I – TECHNICAL REPORT: BASELINE ABORIGINAL HERITAGE ASSESSMENT (RPS, 2022B)

# Abbreviations

| | |
|---|---|
| **BMP** | Biodiversity Management Plan |
| **CLZ** | Cliff Line Zone of First Workings (approved Mining Zone of consent SSD_5581) |
| **DP&E** | NSW Department of Planning and Environment |
| **DOC** | Depth of Cover |
| **EP** | Extraction Plan |
| **EP&A Act** | Environmental Planning and Assessment Act 1979 |
| **EPL** | Environment Protection Licence |
| **HHMP** | Historic Heritage Management Plan |
| **LiDAR** | Light Detection And Ranging |
| **LMP** | Land Management Plan |
| **MEP** | Airly Mine Extension Project |
| **ML** | Mining Lease |
| **MODx** | Airly DA162/91 Modifications (e.g. MOD3, MOD, MOD5) |
| **Mtpa** | Million tonnes per annum |
| **NPWS** | NSW National Parks and Wildlife Service |
| **OEH** | NSW Office of Environment & Heritage |
| **PSE** | Principal Subsidence Engineer |
| **PSMP** | Public Safety Management Plan |
| **SCA** | State Conservation Area |
| **SMP** | Subsidence Monitoring Program |
| **TARP** | Trigger Action Response Plan |

# 1 INTRODUCTION

## 1.1 Background

Airly Mine is an existing underground coal mine located approximately 40 kilometres (km) northwest of Lithgow in New South Wales, 170km northwest of Sydney and 4 km to the northeast of Capertee, as illustrated on **Figure 1.1**. The mine is partly located within the Mugii Murum-ban State Conservation Area (SCA). Centennial Airly Pty Limited (Centennial Airly) is the operator of the mine and is a wholly owned subsidiary of Centennial Coal Company Pty Limited (Centennial).

Development Consent for the Airly Mine Extension Project (MEP) was approved on 15 December 2016 subject to the Conditions in Schedule 2 to 6 of State Significant Development 5581 (SSD_5581). The consent allows extraction of 1.8 million tonnes of run-of-mine (ROM) coal per calendar year for a period of 20 years, which is supplied to both domestic and international markets. As per commitments within the Environmental Impact Statement (EIS) for SSD_5581, Airly Mine is implementing a conservative and staged approach to mining, with different mining methods applied in different areas of the mining lease called Mining Zones[2].

The *MW17-18 Panel & Pillar Mining Zone Extraction Plan* as detailed in the *Extraction Plan Main Report (the EP Main Report)* and the supporting component plans, continues the conservative and staged approach to mining being implemented by Airly Mine, with secondary extraction proposed in two miniwall panels (MW17 to MW18). The miniwall panels are located within the *Panel and Pillar Mining Zone* as detailed within SSD_5581.

Airly Mine have undertaken extensive modelling and mine design revisions, with panel (void) and pillar widths specifically designed to reduce subsidence levels to be consistent with EIS predictions (i.e., maximum vertical subsidence <125mm). Conservative setbacks to key sensitive features located within the *Cliff Line Zone of First Workings* will continue to be implemented for the MW17-18 PPMZ Extraction Plan, and extensive monitoring and management measures are proposed to demonstrate the subsidence modelling and effectiveness of the mining. The *Extraction Plan Area (EP Area)* is further defined in **Section 1.3**.

The design of this subsidence monitoring program is the progressive result of extensive and ongoing stakeholder consultation, risk assessments and feedback since the Airly MEP EIS (pre 2014) and continuing throughout previously approved Extraction Plans through to the present, including with the IEP, National Parks & Wildlife Service (NPWS), Biodiversity Conservation Division (BCD), DPE and NSWRR.

The *EP Main Report* and the supporting component plans have been developed using a risk-based approach and in accordance with:

- Relevant requirements listed under *Condition 7 in Schedule 3* of SSD_5581;
- *Extraction Plan Guideline,* NSW Department of Planning and Environment 2022;
- *Managing Risks of Subsidence Guideline*, NSW Department of Industry, Resources Regulator (NSWRR), 2017; and
- *Consultation with all relevant key stakeholders* (potentially affected by subsidence) and the Independent Expert Panel (IEP) established by NSW Department of Planning and Environment (DPE) for the project.

An Extraction Plan is required to be developed and approved prior to undertaking secondary extraction, including the development of this ***Subsidence Monitoring Program for MW17-18 (MW17-18 SMP)***.

[2] Airly Mine has five (5) mining zones approved under development consent SSD_5581 as shown in Figure 2 in Appendix 3 of SSD_5581. These zones provide design criteria for different mining methods based on the differing levels of environmental sensitivity of surface features and depth of cover across the Airly mining leases. Section 8 of the Airly Mine EIS (2014) provides further details on the definitions of each of these approved mining zones if required.

## 1.2 Purpose & Scope

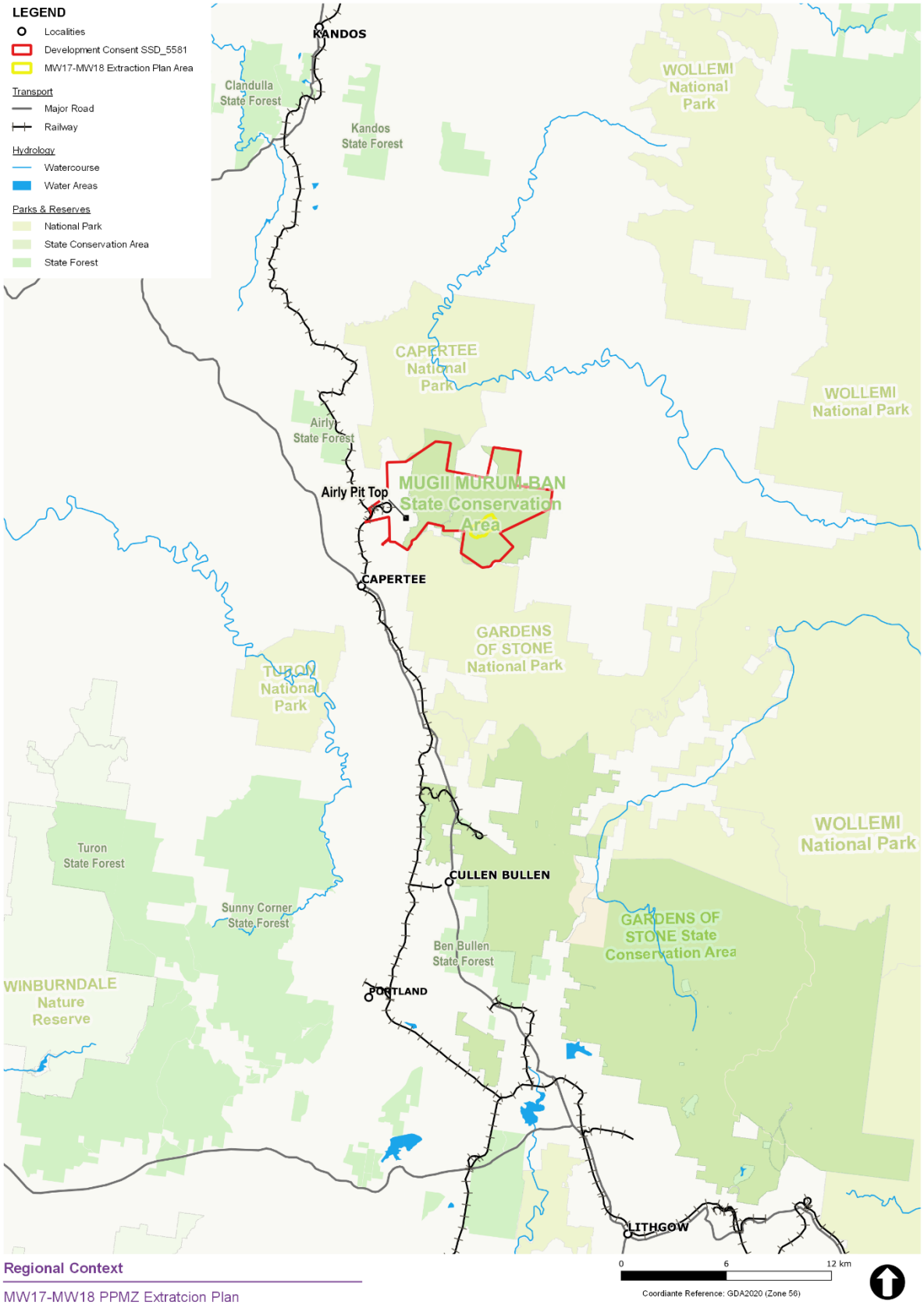
The purpose of this MW17-18 SMP is to outline the monitoring and management measures to be implemented to address any potential impacts (**Section 3.2**) resulting from subsidence associated with secondary extraction via panel and pillar mining within the EP Area (**Section 1.3**).

Void and pillar widths have been specifically designed to support the overlying overburden with minimal subsidence effects. The final pillars left following panel extraction are specifically designed to provide long term stable support to the surface with no surface cracking and minimal ground movement.

Whilst no surface cracking or related impacts have been predicted for panel and pillar mining activities, this management plan importantly continues established monitoring and management frameworks to confirm such for the EP Area, whilst also providing baseline monitoring.

This MW17-18 SMP is supported by a *Master Trigger Action Response Plan for MW17-18 (MW17-18 TARP)* (Appendix 6 of the EP Main Report), including adaptive management measures if required.

**Figure 1.1: Locality Plan**




Regional Context

MW17-MW18 PPMZ Extratcion Plan

*The data displayed on this figure has been collected from various sources. The source data may contain inconsistencies or omissions, may not be to scale, may not be current and may present indicative information only. Catalyst Environmental Management does not warrant the accuracy or completeness of the contents of this figure.*

## 1.3 Extraction Plan Area

Two miniwalls are proposed for extraction in the south-eastern area of Genowlan Mountain within the Airly mining leases being miniwalls (MW) 17 and 18. The miniwall panels are located within the *Panel and Pillar Mining Zone* as detailed within SSD 5581. Centennial Airly has applied a 26.5 degree Angle of draw (AoD) around all cliffs mapped within the *Cliff Line Zone of First Workings*. No secondary extraction will occur within the 26.5 degree angle of draw of cliffs within the *Cliff Line Zone of First Workings*.

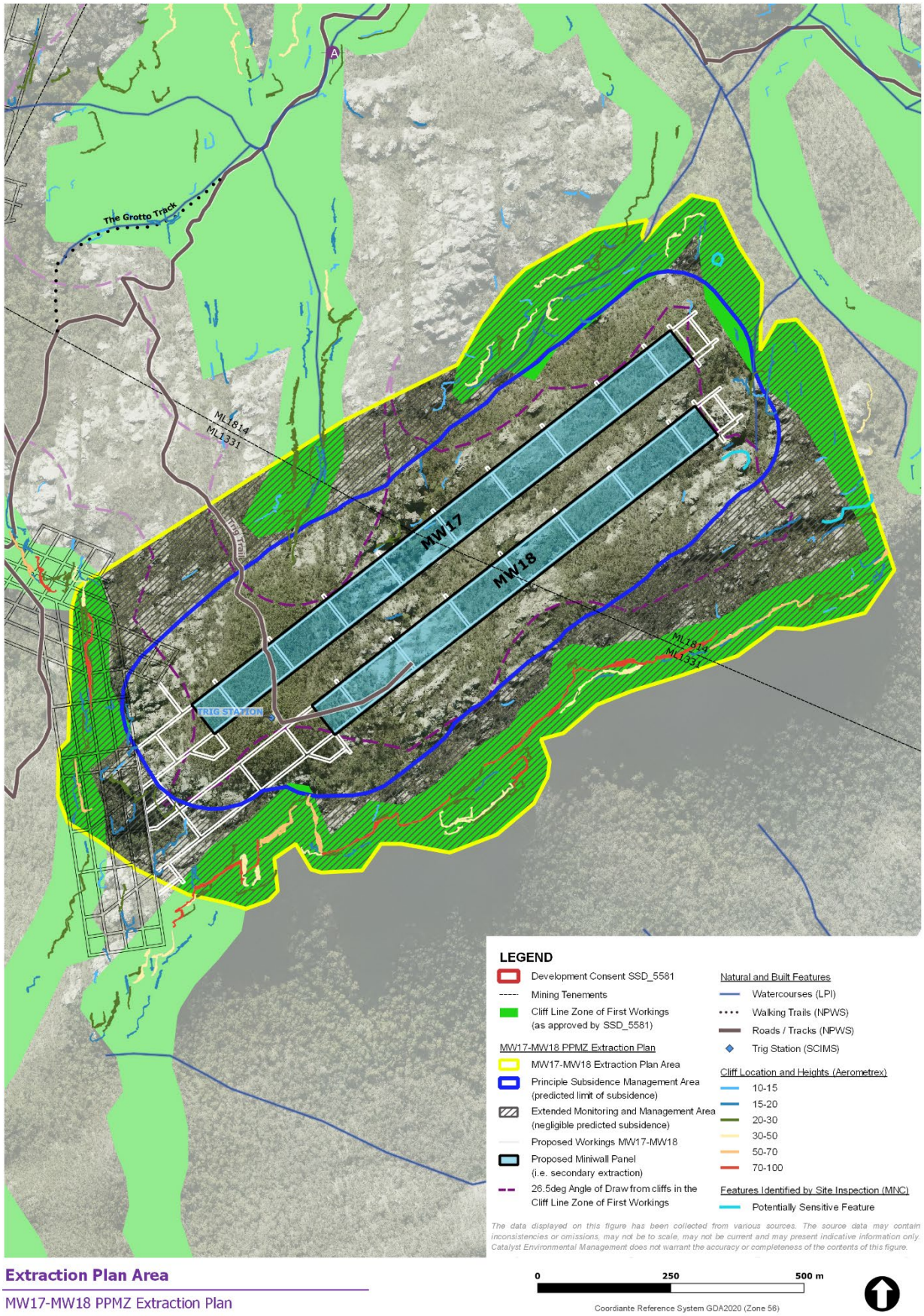
The Extraction Plan Area (EP Area) is comprised of two key components as defined below and illustrated on **Figure 1.2**. The proposed overall EP Area boundary includes an Extended / Far Field Monitoring and Management Area which is beyond the predicted extent of subsidence and involves monitoring and management of sensitive features, primarily the cliffs and pagodas contained within the *Cliff Line Zone of First Workings* surrounding Genowlan Mountain as a precautionary approach to demonstrate the mining methods.

**Table 1-1: MW17-18 Panel & Pillar Mining Zone Extraction Plan Area**

| EP Area Components | Defining Comments |
|---|---|
| **Near-Field / Principal Subsidence Management Area** *(Secondary Extraction Area)* | • Approved area of secondary extraction in accordance with the development consent SSD_5581<br>• The proposed miniwall extraction (second workings) within the **Panel and Pillar Mining Zone** associated with **miniwall panels MW17-MW18**<br>• **No second workings within 26.5 degree setback from the tops of cliffs** located within the Cliff Line Zone of First Workings to **all miniwall panels i.e. MW17-MW18**<br>• **Predicted 20mm limit of vertical subsidence**<br>• Located within parts of both Mining Lease ML1331 and ML1814 |
| **Extended / Far Field Monitoring and Management Area** | • **Monitoring and management area only** for this Extraction Plan, no proposed secondary extraction within this Extraction Plan[3]<br>• This area lies entirely **beyond** the 26.5 degree setback from the tops of cliffs located within the Cliff Line Zone of First Workings to all panels MW17-MW18<br>• Conservatively monitors sensitive features located **beyond** the *Near-field / Principal Subsidence Management Area* for potential subsidence effects further afield<br>• Primarily comprises cliffs and pagodas contained within the Cliff Line Zone of First Workings |

3 Parts of the Extended / Far-field Monitoring and Management Area overlap with the Cliff Line Zone of First Workings. First workings within the Cliff Line Zone of First Workings requires a separate Extraction Plan and any mining undertaken in the Cliff Line Zone of First Workings will be managed in accordance with an approved Extraction Plan.

**Figure 1.2: Extraction Plan Area (EP Area) and Relevant Features within the EP Area**



## 1.4 Relevant Features

The following section provides an overview of the key relevant features in the EP Area as illustrated on **Figure 1.2**. The natural and built features identified within the EP Area include:

- Surface Water
- Groundwater
- Aquatic ecology
- Cliffs, Minor Cliffs and Pagodas
- Mugii Murum-ban SCA General Surface Area, including steep slopes and rock outcrops
- The deeply incised canyons/gorge including an area known as the Grotto
- Tracks and Trails, Fences & Gates
- Habitat
- Threatened Flora & Fauna
- Potential Endangered Ecological Communities (EEC) and Groundwater Dependent Ecosystems (GDE) (including facultative)
- Public Safety / Safety of 'others' associated with potential for subsidence.
- Publicly accessible sections of the EP Area within Mugii Murum-ban State Conservation Area including tracks and trails and general SCA surface area.

The natural and built features relevant to the MW17-18 PPMZ Extraction Plan are identified in the checklist provided in the EP Main Report (refer *Attachment A – Identification of Natural and Built Features Checklist)*.

## 1.5 Structure of the MW17-18 SMP

This *MW17-18 SMP* provides details of the monitoring and management strategies and methodologies of the current program which has been designed to address the key risks identified by the ongoing risk assessment and stakeholder consultation process.

The main text sections of this *MW17-18 SMP* include:

**Section 1** Provides an introduction, purpose, scope, extraction plan area, relevant features and document structure.

**Section 2** Provides the statutory regulatory requirements, risk identification and consultation.

**Section 3** Provides the predicted subsidence impacts assessment and subsidence performance indicators to be used to assess against the relevant subsidence performance measures.

**Section 4** Outlines the monitoring and management measures in place for the key features in the EP Area.

**Section 5** Summarises the management, mitigation, remediation and reporting measures for the MW17-18 PPMZ Extraction Plan, including relevant performance measures and indicators, contingency response, adaptive management, reporting and auditing.

**Section 6** Provides an outline of the plan administration and roles and responsibilities for this *MW17-18 SMP*.

**Section 7** Provides a historical review of references leading to the development of this *MW17-18 SMP*.

## 1.6 Related Management and Monitoring Plans

**Table 1-2** provides a summary of the natural and built features within the EP Area along with the related Component Plan that the respective features are managed through. The scope of management plans for the Extraction Plan was developed in consultation with DPE.

Related monitoring programs detailed in these documents have been outlined in **Section 4** and are summarised in **Table 4-1** (*Subsidence Movements and Effects Monitoring Program Summary)* and **Table 4-2** *(Natural and Built Features Monitoring Program Summary)*.

**Table 1-2: Relevant Features within the EP Area and Related Management Plans**

| Key Features Managed and Monitored | Section | Component Plan |
|---|---|---|
| Surface Water (quality, flow and stream stability, erosion & sediment control)<br>Groundwater (including downstream alluvial and facultative ecosystems)<br>Monitoring of aquatic ecology | 4.3.5<br>4.3.6<br>4.3.8 | Airly Mine Water Management Plan (WMP) *(whole of site/consent area) – refer Appendix 1* |
| Cliffs, Minor Cliffs and Pagodas<br>Mugii Murum-ban SCA General Surface Area, including steep slopes and rock outcrops<br>The deeply incised canyons/gorge including the Grotto<br>Tracks and Trails, Fences & Gates | 4.3.1<br>4.3.2<br>4.3.4 | Land Management Plan for MW17-18 (MW17-18 LMP) – *refer Appendix 2* |
| Habitat<br>Threatened flora and fauna<br>Endangered Ecological Communities (EEC)<br>Groundwater Dependent Ecosystems (GDE)<br>Aquatic ecosystems | 4.3.7 | Biodiversity Management Plan for MW17-18 (MW17-18 BMP) – *refer Appendix 3* |
| Public Safety / Safety of 'others' associated with *potential* for subsidence.<br>Publicly accessible sections of the EP Area within Mugii Murum-ban State Conservation Area including tracks and trails and general SCA surface area. | *MW17-18 PSMP* | Public Safety Management Plan for MW17-18 (MW17-18 PSMP) – *refer Appendix 6* |
| Details the monitoring program for the EP Area for all Key Features<br>Includes baseline monitoring, as well as during and post mining requirements | 4 | Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) – *this document* |

# 2 PLAN DEVELOPMENT AND CONSULTATION

## 2.1 Statutory Requirements

### 2.1.1 Development Consent and Statement of Commitments

Centennial Airly conducts its operations in accordance with:

- The conditions of the Development Consent (SSD_5581);
- Relevant licences and permits, including conditions attached to the Environment Protection Licence (EPL No. 12374) and Mining Leases (i.e. ML 1331 and ML 1814); and
- other relevant State and Commonwealth environmental, planning, mining, safety, and natural resource legislation and guidelines.

Centennial Airly maintains a register of relevant environmental legislative and regulatory requirements in a compliance database.

The relevant statutory requirements applicable to the *MW17-18 PPMZ Extraction Plan* and this supporting *MW17-18 SMP* are presented in the EP Main Report *(refer Section 2.1 and Attachment B)*.

This *MW17-18 SMP* is a component of the EP Main Report and has been prepared specifically to address Condition 7(i)(i) of Schedule 3 which states:

> *(7) Prior to carrying out any first workings within the Cliff Line Zone and Zone of First Workings (refer to Figure 2 in Appendix 3) or second workings, the Applicant must prepare an Extraction Plan for the relevant workings to the satisfaction of the Secretary. Each Extraction Plan must:*
>
> *(i)…include a:*
>
> *(i) Subsidence Monitoring Program which has been prepared in consultation with the IEP, Resources Regulator and BCD, to:*
>
> - *monitor the subsidence effects and subsidence effects of the development;*
> - *develop effective remote monitoring techniques for the development;*
> - *monitor pillar loads underground to develop an understanding of the loading conditions on pillars in the vicinity of cliff lines, pagodas and steep slopes;*
> - *provide data to assist with the management of 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;*

This ***MW17-18 SMP*** has been developed in accordance with Condition 2 in Schedule 6 of SSD_5581 (management plan requirements). **Table 2-1** details where these conditions have been addressed.

**Table 2-1: Development Consent SSD_5581 Management Plan Requirements**

| Condition | Requirement | Section |
|---|---|---|
| Schedule 6, Condition 2 *(Management Plan Requirements)* | The Applicant must ensure that the management plans required under this consent are prepared in accordance with any relevant guidelines, and include: | |
| | a) Detailed baseline data; | Section 4.2 and 4.3 |
| | b) A description of:<br>• The relevant statutory requirements (including any relevant approval, licence or lease conditions);<br>• Any relevant limits or performance measures/criteria;<br>• The specific performance indicators or triggers that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures. | EP Main Report (Section 2.1, Attachment B)<br>Section 5.1<br>EP Main Report (Section 5.1), MW17-18 Master TARP |
| | c) A description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria. | Section 4 and related management plans |
| | d) A program to monitor and report on the:<br>• Impacts an environmental performance of the development;<br>• Effectiveness of any management measures (see c) above); | Section 4 |
| | e) A contingency plan to manage any unpredicted impacts and consequences | Section 5.4 |
| | f) A program to investigate and implement ways to improve the environmental performance of the development over time | Section 5.4, 5.5 and 5.6 |
| | g) A protocol for managing and reporting any:<br>• Incidents;<br>• Complaints;<br>• Non-compliances with statutory requirements; and<br>• Exceedances of the impact assessment criteria and/or performance criteria; and | Section 5.5 |
| | h) A protocol for periodic review of the plan. | Section 6.1 |

### 2.1.2 WHS (Mines and Petroleum) Legislation

The NSW *Work Health and Safety (Mines and Petroleum Sites) Regulation 2022* (WHSMP Regulation) under the NSW Work Health and Safety Act (2011) requires the mine operator of an underground coal mine to ensure that:

- Monitoring of subsidence is conducted, including monitoring of its effects on relevant surface and subsurface features (Section 70(2)(b); and
- All subsidence monitoring data is provided to the regulator in the manner and form and at the times required by the regulator (Section 70(2) (d)).

**Table 2-2** below lists recommended factors to be considered in the development of subsidence monitoring programs in accordance with the *Managing Risks of Subsidence Guideline*, NSW Department of Industry, Resources Regulator (NSWRR), 2017.[4]

[4] Table 2.2 is a summary of aspects specifically related to subsidence monitoring.

**Table 2-2: Recommended factors in development of Subsidence Monitoring Programs**

| Referenced Section | Requirement | Section |
|---|---|---|
| Primary Duty of Care (s1.2, s2.1) | Under Section 19 of the Work Health and Safety Act 2011 (WHS Act) all persons conducting a business or undertaking (PCBUs), including mine operators, must ensure, so far as is reasonably practicable,….. that the health and safety of **other persons** is not put at risk from work carried out as part of the conduct of the business or undertaking. | MW17-18 PSMP Section 2.2<br>EP Main Report – Attachment C |
| Managing Risks of Subsidence (Overview) (s2.1) | Under section 70(1) of the WHSMP Regulation (2022), the operator of an underground coal mine must…… manage risks to health and safety associated with subsidence at the mine. Section 70(2) sets out specific requirements in relation to subsidence.<br>***Note**: Section 3 of the Guidelines provides further details for risk identification, assessment and management for principal hazards which are described further in the PSMP (refer for full details if required).* | MW17-18 PSMP Section 2.2<br>EP Main Report – Attachment C |
| Objectives of Subsidence Monitoring (s2.9.1.1) | In undertaking subsidence monitoring, the mine operator should determine how the monitoring data is to be captured, recorded, communicated and, importantly, acted upon, for the purpose of: | Section 4 |
| | (1) ensuring that the mine operator has a current and correct understanding of the hazards of subsidence | Section 2.2 |
| | (2) ensuring that the risk control measures are maintained so that they remain effective, | Section 4, 6.2 |
| | (3) avoiding unplanned events. | Section 5.3 |
| | (4) detecting early warnings of changes from the results of risk assessments to facilitate corrective or proactive management actions or the commencement of emergency procedures, | Section 4, 5.3, MW17-18 Master TARP |
| | (5) identifying emerging new risks of subsidence, and | Section 4, 5.3 |
| | (6) informing the continual improvement and change management. | Section 5.6.2 |
| Scope of Subsidence Monitoring (s2.9.1.2) | The scope of subsidence monitoring must include: | |
| | (1) Monitoring of subsidence | Section 4 |
| | (2) Monitoring of the effects of subsidence on relevant surface or subsurface features | Section 4 |
| | (3) Monitoring the risk control measures to ensure they remain effective | Section 4 |
| Design, implementation and maintenance of Subsidence Monitoring (s2.9.1.3) | When designing, implementing and maintaining a subsidence monitoring program, the mine operator of an underground coal mine should:<br>(1) address the objective and scope of the subsidence monitoring program (refer to sections 2.9.1.1 and 2.9.1.2 above) | This document |
| | (2) consider the outcomes of subsidence hazard identification, investigation and analysis (refer to section 2.3.4 above). In particular, the subsidence monitoring program should be designed and implemented to assist with:<br>(a) the verification of the risk assessments previously conducted,<br>(b) the verification of the assumptions used during the investigations, analyses or risk assessments previously conducted;<br>(c) the management of uncertainty and abnormal subsidence, | Section 2.2, 4,<br>EP Main Report – Attachment C |
| | (3) consider the results of stakeholder consultation | EP Main Report – Attachment D |
| | (4) ensure that the monitoring activities are carried out by a competent person | Section 6.2 |
| | The subsidence monitoring program should specify:<br>(1) the individual monitoring activities of the subsidence monitoring program, | Section 4 |
| | (2) the information to be captured from each of the individual monitoring activities | Section 4 |

| Referenced Section | Requirement | Section |
|---|---|---|
| | (3) the locations and area where each of the individual monitoring activities will be undertaken, in particular, the layout and/or locations of instrumentation, monitoring points and inspections, | Section 4 |
| | (4) the timing, frequency and duration of monitoring activities and reporting | Section 4 |
| | (5) the monitoring methods, technologies, industry standards and codes of practice that apply when undertaking the monitoring activities | Section 4 |
| | (6) the measures and procedures for quality assurance | Section 4 |
| | (7) the measures and procedures for detecting emerging new risks or early warnings of changes from the results of risk assessments | Section 4, 5.3, MW17-18 Master TARP |
| | (8) the measures and procedures for recording and reporting monitoring results to the regulator and stakeholders | Section 5.6.1 |
| | (9) the measures and procedures for rectifying any disturbances to or malfunctions of the implemented monitoring device in a timely manner so that the subsidence monitoring program remains effective | Section 4, 5.3, MW17-18 Master TARP |
| | (10) a set of criteria, which if satisfied, enables a competent person to vary the implemented subsidence monitoring program (e.g. timing, frequency or duration of subsidence monitoring or reporting) | Section 2.2, 4, 5.1 |
| | (11) any necessary "redundancies", that is, different monitoring technologies or procedures that are to be used to monitor the same subsidence hazard. "Redundancies" should be considered where the subsidence hazard may have potentially severe health and safety consequences | Section 2.2, 4 |
| | (12) Relevant details of a proposed subsidence monitoring program should be demonstrated on a graphical plan (i.e. Plan 7) that is part of the HRA notification (refer to the NSW Department of Industry WHS guideline "Notifying the regulator of a high risk activity"). | Refer HRA Application |
| Baseline Subsidence Data (s2.9.1.4) | Prior to the development of subsidence, the mine operator should complete:<br>(1) the design and implementation of the subsidence monitoring program in accordance with section 2.9.1.3 above | This document |
| | (2) the collection of base-line subsidence data in accordance with the subsidence monitoring program | Section 4 |
| Review (s2.9.2) | The mine operator must ensure that any interpretation of subsidence information (e.g. reviewing the risk control measures for subsidence) is carried out only by a competent person | Section 6.2 |
| | The mine operator must review and as necessary revise the risk control measures implemented for subsidence in accordance with section 15 of the WHSMP Regulation | Section 6.1 |
| | In undertaking the reviews, the stakeholders must, so far as is reasonably practicable, be consulted and the following questions should be addressed"<br>(1) have all subsidence hazards been identified?<br>(2) is the mine operator's understanding of subsidence hazards still current and correct?<br>(3) have the implemented risk control measures been working effectively?<br>(4) are the risks of subsidence being adequately managed?<br>(5) have there been any early warnings of changes from the results of risk assessments, which warrant corrective or proactive management actions or the commencement of emergency procedures?<br>(6) have any incidents of subsidence occurred and what is the learning from the investigations of these incidents?<br>(7) should the implemented risk control measures be revised according to the results of subsidence monitoring and review? | Section 6.1 |

## 2.2 Risk-based development of Monitoring Strategy

Centennial Airly has undertaken a dedicated ***Subsidence and Environmental Risk Assessment*** *(Stature RA Number: 1001308023[5])* directly in support of this Extraction Plan which provide a risk framework basis for development of the component management plans.

The *Subsidence and Environmental risk assessment* was completed on the 13 July 2022 with key staff from the Airly Mine including the Technical Services Manager, Statutory Mine Surveyor, Mining Engineer / Compliance Manager and Environment and Community Officer, as well as the General Manager of Technical Services for Centennial and the Lead Consultant for the EP Project Team from Catalyst Environmental Management. The risk assessment was facilitated by the Mining Engineer / Compliance Manager and has been reviewed by key EP Project Team members for Heritage, Ecology and Subsidence.

Risks were identified and assessed through the review of known surface and sub-surface features within the EP Area. The risk assessment also specifically assessed key heads of consideration required by the Managing Risks of Subsidence Guideline (NSW RR, 2017).

A risk ranking (low, moderate, significant, high or extreme) was assigned to each risk/hazard in consideration of the Maximum Reasonable Consequence (MRC) for the given controls. There were 49 potential risks scenarios assessed during the Risk Assessment; 8 moderate, 41 low and two were assessed as not applicable.

The risk assessment determined that the risk of impact for the relevant features within the EP Area (noting the extensive controls identified) was **Low to Moderate** including aspects associated with cliffs and pagodas.

A copy of the risk assessment is included in the EP Main Report (refer Attachment C). Additional details regarding the management and monitoring of subsidence related impacts to land within the EP Area have been detailed in **Section 4.**

## 2.3 Consultation

Condition 7 of Schedule 3 under development consent SSD_5581 requires the preparation of this ***MW17-18 SMP*** in consultation with key relevant stakeholders as detailed below:

- IEP;
- NSW Resources Regulator; and
- NSW Biodiversity Conservation Division (BCD).

The outcomes of consultation undertaken for the project is provided in the EP Main Report (refer Attachment D), including copies of relevant correspondence such as project presentations delivered by the mine to key stakeholders and relevant formal correspondence received from key stakeholders.

Stakeholder feedback provided has been reviewed and addressed as necessary as part of the development and review of this Extraction Plan and key component plans.

[5] Centennial Airly has adopted the Stature Risk Assessment Program which was developed to ensure consistency in all risk assessments across the Centennial operations. The Stature Risk Assessment Program sets out a consequences table and risk ranking matrix for managing identified risks consistent with AS/NZS ISO 31000:2009.

# 3 SUBSIDENCE ASSESSMENT

## 3.1 Mine Planning and Design

Mine design is the primary control utilised at Airly Mine for subsidence impact avoidance. Centennial Airly have adopted a conservative mine design to control subsidence to levels predicted in the EIS. Approvals for Panel and Pillar Mining are based on predicted surface subsidence levels of up to 100-125mm.

Void and pillar widths have been specifically designed to support the overburden with minimal subsidence effects at the surface. The final pillars left following panel extraction are specifically designed to provide long term stable support to the surface with no expected surface cracking and minimal ground movement.

The predicted subsidence is not expected to cause adverse impacts on the relevant features covered under this *MW17-18 SMP*.

Within the EP Area the pillar widths between the miniwall panels have been increased by more than double their original proposed width from 29.5m to 70m. Panel void widths have been slightly increased from 61m to 70.5m.

## 3.2 Subsidence Predictions

Condition 7(g) of Schedule 3 under Development Consent SSD_5581 and the Extraction Plan Guidelines (DPE, 2022) requires revised predictions of potential subsidence effects, subsidence impacts and environmental consequences to be presented within the Extraction Plan for the EP Area, including any relevant information obtained since the EIS and consent, in consultation with the Independent Expert Panel (IEP). A detailed review of the revised subsidence predictions is provided in the *EP Main Report (refer Section 3.2)*.

This Extraction Plan has relied on the most recently updated predictions of subsidence effects, subsidence impacts and environmental consequences. The subsidence assessments undertaken for this Extraction Plan are documented in the following reports:

- *SCT (2023). MW17-18 Pillar and Panel Optimisation Assessment (Airly 5612 dated 8 June 2023).* SCT (2023) were engaged to advise on a revision to the pillar and panel layout to limit the maximum predicted subsidence to a precautionary upper design limit of 95mm (+/-20mm). The proposed revised mining geometry includes two miniwall panels, MW17 and MW18, with panel void widths of 70.5m and 3.0m extraction height separated by a 70m wide barrier pillar. The predicted subsidence effects for the proposed miniwalls 17 to 18 have been provided by SCT (2023). The maximum vertical subsidence for the revised mine layout is predicted to be 88 mm (+/-20mm).

Centennial Airly, then engaged MSEC (2023) to prepare a Subsidence Prediction and Impact Assessment to support the Extraction Plan based on the subsidence prediction work provided by SCT (2023). The subsidence predictions and impact assessment is documented in the following report:

- *MSEC (2023). Airly Mine MW17 to MW18 – Subsidence Predictions and Impact Assessments for the Natural and Built Features over and near the Proposed MWs 17 to 18 in Support of the Extraction Plan Application (MSEC1351).*

The primary management strategy being implemented by Airly Mine for the Extraction Plan is impact avoidance through the implementation of a conservative mine design, with panel and pillar widths specifically designed to have minimal subsidence effects and prevent subsidence impacts. Conservative setbacks to key sensitive features within the *Cliff Line Zone of First Workings* continue to be implemented for this Extraction Plan (i.e. 26.5 degree Angle of Draw).

The maximum incremental vertical subsidence predictions for the EP Area are shown in **Table 3-1**. The predicted subsidence levels are minimal and well below levels expected to cause damage or any adverse

impacts on the relevant features within the EP Area. This includes the extended / far-field subsidence monitoring and management area.

**Table 3-1: Maximum Incremental Subsidence Predictions (SCT, 2023)**

| Miniwall Panel Width | Maximum Predicted Subsidence (mm)[a] |
|---|---|
| **One Miniwall** | -39mm |
| **Two Miniwalls** | -88mm |

*a) SCT (2023) note that a subsidence tolerance/natural variability of +/-20mm should be applied to the modelled subsidence*

MSEC (2023) have predicted that if the measured subsidence above MW17 to MW18 is less than 125 mm:

- tilts should be less than 2.5 mm/m
- strains should be less than 2 mm/m

Notwithstanding this, appropriate responses have been conservatively developed for unexpected higher than predicted subsidence within a MW17-18 TARP (Appendix 6 of the EP Main Report) developed for the Extraction Plan and this MW17-18 SMP.

Extensive monitoring and management measures are proposed to demonstrate the subsidence modelling and effectiveness of the mining and monitoring systems. The proposed monitoring approach has been developed in consultation with key stakeholders to minimise further disturbance to the sensitive SCA and builds upon existing management and monitoring practices implemented successfully to date by Centennial Airly.

# 4 SUBSIDENCE MONITORING AND MANAGEMENT

## 4.1 Monitoring Strategy and Program Summary

### 4.1.1 Monitoring Strategy

The proposed monitoring strategy for the EP Area reflects a number of important considerations. An integrated approach to monitoring and inspections has been developed as a continuation of previously approved methodologies for existing Extraction Plans, in order to address the following:

- Demonstrate mining is undertaken as per the approved designs (as the basis of impact avoidance predictions);
- Provide information to demonstrate statutory performance criteria and obligations are satisfied, as detailed in **Section 5.1**;
- Target monitoring of potential changes/impact to key sensitive surface features within the EP Area (primarily cliffs, minor cliffs and pagodas);
- Recognises that the predicted subsidence levels are minimal and well below levels expected to cause damage.
- Validate the mine design and provide ongoing basis for future monitoring systems and staged Extraction Plans for other approved mining zones within the lease;
- Address stakeholder requirements to minimise environmental impact of monitoring in the SCA, recognising environmental sensitivity and accessibility. This includes limiting clearing and disturbance from general access requirements by personnel wherever possible;
- Where triggers are exceeded, provide data to demonstrate the effectiveness of adaptive management strategies; and
- Provide appropriate information required to assess against triggers within the Master TARP, including data for trend analysis to inform adaptive management (refer **Section 5.1 and 5.4**).

Given the above considerations (noting surface access restrictions), an integrated system of underground monitoring, ground movement survey, detailed aerial remote monitoring and targeted and triggered surface monitoring has been developed for the current EP, using escalating triggers and levels of investigation where required in accordance with the *MW17-18 Master TARP*.

### 4.1.2 Integrated Subsidence Monitoring Program

The proposed monitoring program and strategy for the EP Area is developed in consultation with key stakeholders including (but not limited to) the IEP, BCD, NSW Resources Regulator and NPWS. The proposed *Integrated Subsidence Monitoring Program* includes:

- **Underground Mining Control** -a key focus as noted above (routine survey of workings and inspections by mining officials);
- **Monitoring ground movement** and surface subsidence impacts via Global Navigation Satellite System (GNSS) Monitoring Stations / Continually Operating Reference Station (CORS) – Long occupation real time point data base stations;
- **Remote monitoring of the Surface Environment**:
    - LiDAR (High Resolution 40 points per square meter) – for monitoring of vertical subsidence over the EP Area relative to baseline and Performance Measures.

- **Trigger-based Targeted Surface Inspections** where required (where safely and readily accessible, such as where 4WD trails traverse or are close to the EP Area, and where otherwise triggered by the Master TARP).
- **Data Analysis** and reporting will monitor specifically for change and target:
    - Any areas detected for significant change by remote monitoring results (including pre and post mining areas), triggering further detailed analysis under the Master TARP, including a process for determining natural or mining-induced rock fall.
    - The process for this detection is detailed further in the Subsidence Monitoring Program and Master TARP respectively. Data for natural rock falls in areas yet to be mined will also provide additional data to the baseline data set.

### 4.1.3 Monitoring Program Summary

The monitoring program to monitor the development of possible subsidence related environmental impacts is detailed in **Section 4.2 and 4.3** and summarised in **Table 4-1** (*Subsidence Movements and Effects Monitoring Program Summary)* and **Table 4-2** *(Natural and Built Features Monitoring Program Summary)*.

A contingency plan has been developed as a component of this MW17-18 SMP to outline management measures that will be implemented in the event that predicted outcomes are exceeded (**Section 5.1**).

**Table 4-1: Subsidence Movements and Effects Monitoring Program Summary**

| Type | Location | Purpose | Monitoring Methods / Standards and Accuracy | Parameter | Frequency and Duration |
|---|---|---|---|---|---|
| ***Underground Mine Control:***<br>Panel Width/Height / Chain Pillar Size / Rib Condition | *Near-Field / Active Extraction Area:*<br>• Active Panel<br>• Completed first workings during panel development<br>• Planned final pillars after mining. | Confirm that formation of underground workings for development and extraction is implemented as per approved designs. | • Conventional underground survey of chain pillar / workings as completed in the active panel.<br>• Visual Inspection<br>• Overlay of 'as built' pillars (as surveyed) against designed pillars of mine plan by Mine Surveyor to confirm appropriate final chain pillar sizes and panel system FOS has been achieved. | • Roadway width<br>• Roadway height<br>• Max void width<br>• Final chain pillar area,<br>• Final width to height ratio,<br>• Final Pillar System FOS as formed<br>• Presence & depth of rib spalling (m)<br>• Presence of geological structure in final pillars.<br>• Off line driveage | <u>During Mining:</u><br>• Development: Weekly in active working areas during first workings, undertaken by mining official.<br>• Second workings – statutory shift inspections of chain pillar ribs in accessible areas.<br>• Survey of chain pillars in active panel updated weekly by mining official deputy / undermanager.<br>• Accessible pillars in the Extended Monitoring and Management Area (Cliff Line Zone of First Workings) inspected once following second workings within the near-field EP Area.<br><u>Post Mining</u>:<br>• Final inspection at of chain pillars. At completion of active panel.<br>• Accessible pillars in the Extended Monitoring and Management Area (Cliff Line Zone of First Workings) e.g. mains panels inspected at 3months and 12months following completion of each panel MW17 and MW18. |
| ***Airly Mine GNSS Monitoring Stations*** | ***20*** *Targeted GNSS Monitoring Stations located in both Near-Field / Active Extraction Area and Extended / Far Field Monitoring Area* | • Monitor vertical and horizontal movements from secondary extraction to ensure within modelled predictions.<br>• Continuous occupation monitoring, including for baseline, at key locations / surface features (e.g. large cliffs, public access areas, pseudo 'transverse' and 'longitudinal' lines)<br>• Provide continually operating reference points for stereo vertical photogrammetry<br>• Provide notifications to key site personnel in accordance with trigger thresholds presented in the Master TARP | • **Continuous near real time** point data (raw data set at 10 second intervals)<br>• Global Navigation Satellite System (GNSS) Stations<br>• <+/-5mm rolling 7-day average<br>• Co-located with photogrammetry geo-reference markers | • Vertical subsidence (mm)<br>• Horizontal displacement (mm) | <u>Baseline</u>: Installed prior to commencement of secondary extraction, continuous data from installation through to commencement of secondary extraction of nearest panel (i.e. some stations far from MW17 will continue to provide baseline until mining comes nearer)<br><u>During mining</u>: Continuous throughout extraction MW17-MW18<br><u>Post Mining</u>: GNSS stations will remain in-situ until consistent results are obtained demonstrating completion of major subsidence movement (i.e. within survey error) following completion of panels MW17-MW18 |
| ***LiDAR*** | **Entire EP Area** (including pre-mining baseline areas and post mining areas) | • Differential subsidence measure between each monitoring event ('epochs') across large areas.<br>• Reporting of observed subsidence between each epoch – heat map and cross sections are available.<br>• Ability to assess thousands of points and potentially provide whole of area monitoring. | • High Resolution LiDAR georeferenced to GNSS monitoring stations.<br>• 40pts per square meter<br>• Capable of detecting 50mm subsidence movements at very high confidence levels. Smaller movements can also be detected at lower confidence levels. | • Vertical subsidence movements monitoring of 'broad-area' (typically >50mm at high confidence levels) relative to previous monitoring events ('epochs'). | <u>Baseline:</u> At least two surveys undertaken prior to miniwall extraction (December 2022 and June 2023). Potential for a third baseline survey around December 2023.<br><u>During mining</u>: At least one survey will be undertaken during extraction of MW17-MW18<br><u>Post Mining</u>: Survey will be undertaken following completion of panels MW17-MW18. No further detailed analysis after post mining survey has indicated negligible impacts (in the undermined area). |
| ***Targeted Surface Inspection*** | **Near-field / active panel area** (and extended monitoring area where applicable) if issues are identified from monitoring as per Master TARP triggers. | Complementary monitoring supporting | Visual inspection of relevant area/location where safely accessible. | Presence/absence of mine-induced damage or change to features (e.g. rock falls or surface cracking) | Triggered targeted visual ground inspection will be undertaken if issues are identified from subsidence monitoring program as per Master TARP triggers |

## Table 4-2: Natural and Built Features Monitoring Program Summary

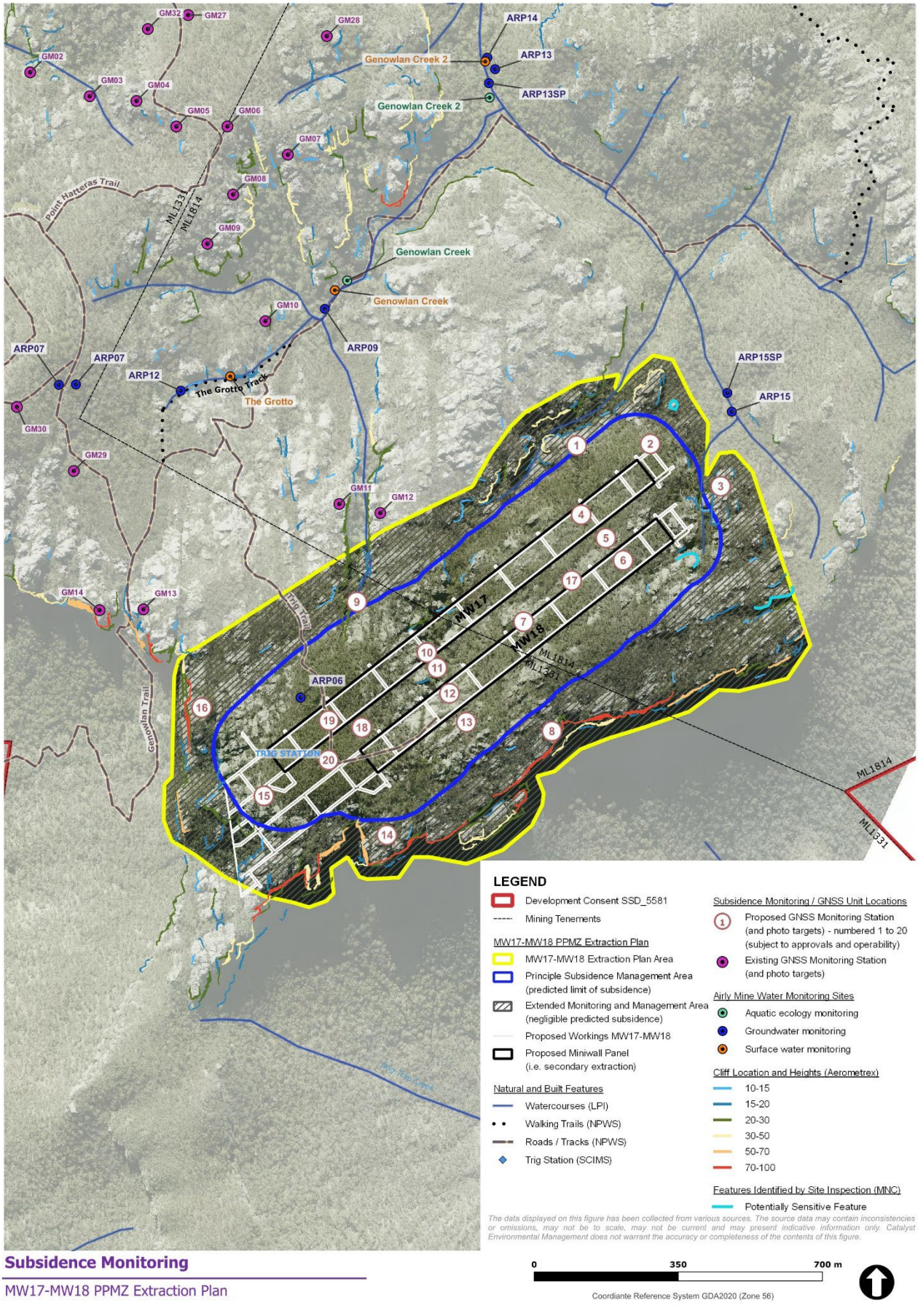
| Aspect | Location | Monitoring Method | Parameter | Frequency and Duration |
|---|---|---|---|---|
| **Land** | | | | |
| **Cliffs, Minor Cliffs & Pagodas.** | *Entire EP Area*<br>• LiDAR for entire EP Area (including pre-mining baseline areas and post mining areas)[1]<br>• Reporting by exception (significant change) and for areas mined within each reporting period (refer Subsidence Monitoring Program for details). | • LiDAR (40pts/m$^2$)<br>• Triggered targeted visual ground inspection in relevant areas if issues are identified from integrated monitoring network as per TARP triggers (see Appendix 6) | Presence/absence of mine-induced damage or change to features (significant rock falls and surface cracking). Various Parameters relevant to each method. | Baseline: At least two prior to extraction.<br>During mining (secondary extraction): Approximately six monthly surveys during mining for change relative to baseline and Performance Measures.<br>Post Mining: No further detailed analysis once post mining survey has indicated negligible impacts (in the undermined area)[1]. Six monthly surveys continue with a focus on the next active mining area.<br>*Triggered targeted visual ground inspection will be undertaken if issues are identified from aerial / underground monitoring as per MW17-18 Master TARP triggers (Appendix 6 of the EP Main Report).* |
| **General Land Surface** (excl. cliffs and pagodas) | *Entire EP Area*<br>• Baseline – Entire EP Area<br>• Routine Survey data for entire EP Area (including pre-mining areas and post mining areas)[1]<br>• Reporting by exception (significant change) and for areas mined within each reporting period (refer Subsidence Monitoring Program for details). | As above | Presence/absence of damage or change to land surface (including topography, sinkholes, rock features, soil cover, vegetation cover, etc.) | Baseline: At least two prior to extraction.<br>During mining (secondary extraction): Approximately six monthly surveys during mining for change relative to baseline and Performance Measures.<br>Post Mining: No further detailed analysis once post mining survey has indicated negligible impacts (in the undermined area)[1]. Six monthly surveys continue with a focus on the next active mining area.<br>*Triggered targeted visual ground inspection will be undertaken if issues are identified from aerial / underground monitoring as per MW17-18 Master TARP triggers (Appendix 6 of the EP Main Report).* |
| **SCA Management Trails** (Trig Trail and other linked trails) | *Near-field Monitoring and Management Area* (i.e. Trig Trail):<br>• Sections traversing extraction plan area during undermining of any marked trail/track where the trail or track is within half depth of cover from the workings. | Targeted trigger-based visual Inspection (including photos as required) | Surface cracking and drainage change.<br>(Note: sections of cliffs and pagodas that are visible during surface inspections would also be assessed for any observed rock fall to support aerial monitoring of those aspects). | Triggered targeted visual ground inspection will be undertaken if issues are identified from aerial / underground monitoring as per *MW17-18 Master TARP triggers (Appendix 6 of the EP Main Report).* |
| **Permanent Survey Marks** | *Near-field Monitoring and Management Area:*<br>• Genowlan [P] Trig Station (TS 7138) – located near finishing end of MW18. | As per requirements advised by the Surveyor General. | • As per requirements advised by the Surveyor General. | Baseline: Position as per formal government records held by Surveyor General<br>During Mining: Nil (not applicable).<br>Post-Mining: As per requirements advised by the Surveyor General. |
| **Note: The monitoring outlined below presents site-wide monitoring undertaken for 'whole-of-mine' environmental management plans required separately to the Extraction Plan, but which may assist in assessing for potential unexpected impacts (e.g. downstream watercourses). As live EMS documents, refer each management plan for full and current details.** | | | | |
| **Surface Water** | | | | |
| **Gap Creek**<br>**Genowlan Creek**<br>**Airly Creek**<br>*including discharge monitoring and onsite locations (Airly Mine surface operations area)*<br>*(see Site Water Management Plan (s4.2, 4.3))* | • Gap Creek Water Quality & Flow Monitoring Station<br>• Genowlan Creek Flow Monitoring Station<br>• Genowlan Creek 2 Water Quality & Flow Station<br>• The Grotto Water Quality Monitoring Station<br>• Airly Creek Water Quality Monitoring Station<br>• Airly Creek Upstream Water Quality Monitoring Station<br>• 5 onsite dams. | • Flow monitoring<br>• Water Quality Monitoring<br>• Water quality in onsite dams as per s4.2 of WMP)<br>• Visual Inspection of mine water dams by Airly Mine ECC. | • Volumetric Flow.<br>• Water Quality (WQ) -monthly screening suite and annual full ANZECC suite. See WMP for parameter details.<br>• Water quality suites for onsite dams as per s4.2 of WMP (including EPL requirements). Visual inspection of mine dams | • Continuous flow monitoring at Gap, Genowlan Creek and Genowlan Creek 2 site (data logged).<br>• Monthly routine WQ screening samples during mining.<br>• Annually- Full WQ sampling suite on Gap Creek, the Grotto, Genowlan Creek 2.<br>• Weekly inspections of mine water dams and event based (20mm in 24hrs). Monthly and annual sampling of onsite dams as per s4.2 of WMP.<br>• Refer site WMP for details including completion of monitoring. |
| **Groundwater** | | | | |
| **Groundwater Bores**,<br>**Village Spring - Flow monitoring of seepage**<br>**Transfers from Underground Workings**<br>*(refer Site Water Management Plan (s4.4))* | • Vibrating wire piezometer (VWPs) and standpipe monitoring bore network across ML1331, monitoring various strata as per WMP.<br>• Village spring seepage from old shale mine workings<br>• Underground workings | • All VWPs and standpipe bores continuously logged for piezometric head and groundwater levels. Groundwater Quality Monitoring as detailed in s4.4.2 of the WMP.<br>• Village spring seepage flow by logged pressure transducer.<br>• In-line flow metering of underground transfers | • Water Level (mAHD)<br>• Water quality (monthly screening suite, annual ANZECC suite as per WMP).<br>• Seepage flow volume<br>• Transfer flow volume<br>• Refer WMP for parameter details (s4.4). | • Continuous monitoring of piezometric head and groundwater levels.<br>• Monthly routine groundwater quality (screening suite) during mining (refer s4.4 of WMP for details).<br>• Annually- Full groundwater quality suite (see s4.4 of WMP).<br>• Continuous monitoring of Village Spring seepage.<br>• Daily monitoring of underground transfers to surface dirty water dam (109ML dam).<br>• Refer site WMP for details including completion of monitoring. |
| **Biodiversity** | | | | |
| ***Prostanthera stricta*** | Representative sample of known locations of *Prostanthera stricta* across the Airly Development Consent Area and EP Area.<br>Additional monitoring sites to be re-established at the commencement of the MW17-18 BMP. Previous *P. stricta* data collected at these sites from 2012 to 2014 by UQ, no data has previously been collected at the new *E. cannonii* sites. | Point intercept method and floristic density plots | • Density/Percent cover<br>• Vegetation condition | • Annually in Spring and Summer |
| ***Eucalyptus cannonii*** | Representative sample of known locations of *Prostanthera stricta* across the Airly Development Consent Area and EP Area. | Tree condition, crown extent, growth changes and associated species assessment. | • Condition, crown extent, growth changes and associated species. | • Annually in Spring and Summer |

| Aspect | Location | Monitoring Method | Parameter | Frequency and Duration |
|---|---|---|---|---|
| **Capertee Rough-barked Apple – Redgum – Yellow Box Grassy Woodland (MU 20) EEC**<br><br>*Note: No EEC is located within current EP Area* | Permanently established plots in PCT 703 within the Airly Development Consent Area | BAM Plot survey to assess vegetation condition (DPIE 2020d) | • Composition based on number native plant species within a 20 x 20m plot for each growth form group.<br>• Structure is assessment of foliage cover for each growth form group.<br>• Stratum & layer in which each species occurs<br>• Growth form for each recorded species.<br>• Species name & estimate of the crown cover for each species<br>• Abundance- estimate of the number of individuals or shoots of a species within the plot. | • Annually in Spring and Summer |
| **Facultative GDEs** | Permanently established plots in PCT 1088 within the Airly Development Consent Area | BAM Plot survey to assess vegetation condition (DPIE 2020d) | • Vegetation condition | • Annually in Spring and Summer |
| **Weed species** | Permanently established plots across the Airly Development Consent Area and EP Area | Point intercept method and floristic density plots | • Density/Percent cover<br>• Vegetation condition | • Annually in Spring and Summer |
| **Glossy-black Cockatoos** | Areas of She-oak (Casuarina and *Allocasuarina* sp., but specifically *Allocasuarina littoralis*) across the Airly Development Consent Area and EP Area<br>Two additional Glossy-black Cockatoo monitoring sites introduced into the EP Area. | Percent cover of Allocasuarina species and the presence and quantity of orts was recorded. | • Species presence /absence /abundance/ distribution | • Annually in Summer |
| **Large Forest Owls** | Valleys and other areas of potential habitat within the Airly Development Consent Area in conjunction with Koala census. | Targeted call-playback/spotlighting<br>Stationary Song Meters to determine presence | • Species presence /absence /abundance/ distribution | • Annually in Spring and Summer |
| **Diurnal Birds** | Across the Airly Development Consent Area | 30 minute surveys across permanent transects | • Species presence /absence /abundance/ distribution | • Annually in Spring and Summer |
| **Microbats** | Foraging and roosting sites and flyways within the Airly Development Consent Area | Anabat units to detect presence of microbat species | • Species presence /absence /abundance/ distribution | • Annually in Summer |
| **Vertebrate Census** | Gully habitats and rock habitats within the Airly Development Consent area and EP Area in conjunction with the reptile census. | Baited stationary infrared cameras to determine presence and count | • Species presence /absence /abundance/ distribution | • Annually in Summer |
| **Koala sites (in conjunction with the Large Forest Owl sites)** | Valleys and other areas of potential habitat within the Airly Development Consent Area in conjunction with Large Forest Owl census. | Stationary Song Meters to determine presence | • Species presence /absence /abundance/ distribution | • Annually in Summer |
| **Gliders - Greater Glider and Squirrel Glider** | Valleys and other areas of potential habitat within the Airly Development Consent Area in conjunction with Large Forest Owl census. | Targeted call-playback/spotlighting | • Species presence /absence /abundance/ distribution | • Annually in Summer |
| **Aquatic Ecology and Stream Health** | | | | |
| **Stream Health** | Third order stream sections within the site boundary for Gap Creek, Genowlan Creek, Torbane Creek.<br>(downstream of current EP Area) | Visual monitoring of watercourses by suitably qualified professionals to identify any instabilities that may form as a result of mining operations. | • Change in stream bed or bank conditions.<br>• Incision or head cut development.<br>• Surface cracking.<br>• Ponding (particularly 'out of channel' ponding).<br>• Step changes in bed profile.<br>• Notable/indicative changes in stream vegetation. | Typically every two years, or where subsidence survey monitoring indicates greater than predicted subsidence.<br>Refer site WMP for full details including completion of monitoring. |
| **Aquatic Ecology**<br>*(Note: see also Groundwater above for **stygofauna**)* | Reference site: Airly Creek Upstream. Dog Trap Creek will be used as a surrogate should Airly Creek upstream be dry in any sampling event.<br>Baseline sites:<br>– Torbane Creek.<br>– Dog Trap Creek.<br>– Gap Creek.<br>– Genowlan Creek.<br>– Genowlan Creek 2.<br>Baseline monitoring to cease following the spring 2017.<br>Impact site: Airly Creek.<br>Refer Figure 4-4 of the WMP. | • Sampling, sorting and identification of macroinvertebrates, associated with pool edge habitat in accordance with the Australian Rivers Assessment System (AUSRIVAS) protocols (Turak et al. 2004).<br>• Assessment of the condition of the aquatic habitat using modified NSW AUSRIVAS field sheets.<br>• Measurement of DO, EC, pH, temperature and turbidity just below the surface of the water column and at depth where sufficient water is available.<br>• Collection of surface water and sediment grab samples for water and sediment quality analysis. | • Species presence/absence<br>• Habitat condition<br>• DO, EC, pH, temperature and turbidity<br>• Sediment quality - selected parameters. | Typically biannually in spring and autumn when monitoring.<br>Refer site WMP for details including completion of monitoring. |

Notes:

1. Approximately six-monthly aerial survey of Extended /Far-field Monitoring and Management Area will continue until 1 year after completion of secondary extraction in areas adjacent to particular sections of cliff unless otherwise agreed with regulators. This will provide data for post-mining areas. Whilst data is held for the entire far-field area, reporting and detail analysis will be by exception (where significant change identified) as noted earlier above.
2. Water quality monitoring for monthly 'screening suites' as per Airly Water Management Plan

**Figure 4.1: Subsidence Monitoring**



## 4.2 Subsidence Movements and Effects Monitoring

### 4.2.1 Underground Survey, Inspections and Mine Control

The mine design has been specifically developed in response to the sensitive surface environment to avoid significant impact. Underground mining control aims to monitor and confirm that formation of underground workings for development and extraction is implemented as per the minimum design specifications that determine the predicted subsidence movements and impacts.[6]

The underground survey, inspections and mine control monitoring will include:

- Ensuring the mine layout is in accordance with design parameters - including final pillar dimensions, roadway widths, mining heights and panel void widths.
- Conventional survey of chain pillars updated weekly in active panel during development, with final survey once final chain pillars formed - to provide accurate "as-built" survey of pillar and roadway dimensions for confirmation against mine design. Conventional survey is undertaken by the mine surveyor in accordance with AIR-ST-9001 Panel Design Standard.
- Routine pillar inspections and Implementation audits during mining and for appropriate period in accessible areas thereafter.
- MW17-18 Master TARP includes detailed measures for the underground mining controls monitoring to ensure that appropriate responses are taken if the mining geometry is not formed as per the approved design.

**Pillar and Roadway Size, Condition and Formation (in the EP Area)**

Underground visual inspections by a mining official and conventional survey data for as-built workings will be compared to mine design requirements for:

- Pillar size (by survey)
- Roadway position/location (online/offline driveage)
- Roadway width
- Rib height
- Panel void width
- Chain pillar condition / floor heave / roof condition

Chain pillars are required to meet the mine design performance measures set[7]. The Airly Technical Services Manager will record and issue designs for minimum pillar dimensions conforming to the performance measures as part of the Authority to Mine process prior to commencement of panel development workings which are then to be implemented by development and extraction crews Any non-conformances will managed in accordance with the MW17-18 Master TARP.

The mine design for proposed workings will be overlaid against the "as built" surveyed workings. The results will be compared with key mine design parameters presented within the Extraction Plan main document.

[6] see Section 3.1.1 (proposed mining geometry and parameters) and Section 5.1.1 (performance measures for mine design and underground mining control) of the EP Main Report. Appropriate trigger values adopted within the MW17-18 Master TARP (Appendix 7 of the EP Main Report).

[7] See Section 5.1.1 of the EP Main Report

Post Mining:

- Accessible pillars in the Extended Monitoring and Management Area (Cliff Line Zone of First Workings) inspected once following second workings within the near-field EP Area.
- Final inspection of chain pillars. At completion of active panel.
- Accessible pillars in the Extended Monitoring and Management Area (Cliff Line Zone of First Workings) e.g. mains panels inspected at 3months and 12months following completion of each panel MW17-MW18.

**Potential Effect on Pillar Stability**

There is not expected to be additional load on pillars downslope of the cliffs from miniwall mining in the EP Area. This is in part, due to the significant horizontal setbacks between secondary extraction in the EP Area and pillars on the downslope side of the cliffs. Miniwall mining to date in previous PPMZ EP Areas has not indicated any issues of additional load on pillars downslope. Quantitative measurements using uniaxial stress cells to understand pillar loading conditions was also conducted in the Mt Airly EP Area (at 15C/T in MG8) and did not raise any concerns for pillars on the downslope side of the cliffs (Strata[2], 2021).

Notwithstanding, underground visual inspections by a mining official will be undertaken in accessible areas of the main gate panel each shift; and within the tail gate and in-bye of the face on the main gate side on a weekly basis (minimum) by the Deputy.

**Baseline**

The mine layout has been developed in accordance with the mine design parameters which have been designed and assessed to be consistent with the predictions in the EIS.[8] This process is undertaken in consultation with the IEP and has included a revised subsidence model calibrated against observed subsidence which is also interrogated to investigate potential improvements in mine design.

### 4.2.2 Airly Mine GNSS Monitoring Stations

Twenty (20) GNSS units, also known as Continually Operating Reference Stations (CORS), have been proposed at targeted locations within the EP Area. The capability and accuracy of this monitoring method has been successfully demonstrated in previous PPMZ EP Areas (Mt Airly and Point Hatteras). The GNSS units are the primary surface subsidence monitoring of ground movements (vertical and horizontal) in the EP Area.

These stations use the Global Navigation Satellite System (GNSS) and record X, Y, Z spatial position readings to <+/-5mm accuracy. The stations provide near real time continuous monitoring, recording readings at 10 second intervals (raw data), and calculating statistical 24hr (daily) averages and rolling 7 day averages at <+/-5mm accuracy. The GNSS units are co-located with photogrammetry geo-reference markers and the data collected will also be used to provide continually operating reference points for the LiDAR.

The continuous and near real time data are envisaged to provide the mine with suitably fast and accurate data to monitor and respond to ground movements, particularly subsidence predictions for this EP Area are exceeded.

Data captured from the GNSS units allows for notifications to be sent to key site personnel when certain trigger values have been exceeded. In addition to routine daily review of data reports by the Mining Engineer/ Technical Services Manager (also further discussed at the weekly Strata Review Meeting), the

[8] For further details of the mine design parameters and subsidence predications and assessment refer to the EP Main Report, in particular Section 3.1 (mine design and planning), Section 5.1.1 (performance measures in mine design and underground mining control) and Section 3.2 (subsidence predictions).

GNSS units have been configured for the follow alerts which will result in appropriate response actions as documented in the MW17-18 Master TARP:

- SMS and Email notification to Mine Surveyor when vertical subsidence exceeds 108mm (TARP L2) – this notification will trigger actions in accordance with the MW17-18 Master TARP.
- SMS and email notifications to Mine Surveyor when vertical subsidence exceeds 125mm (TARP L3) (greater than EIS predictions) - this notification will trigger actions in accordance with the MW17-18 Master TARP including external notifications of exceedance of consent conditions.

The GNSS units are strategically located within both the Near-Field / Active Extraction Area and Extended / Far Field Monitoring Area. The following provides the purpose and some context of the GNSS monitoring network:

- Monitor vertical and horizontal movements from secondary extraction to ensure within modelled predictions.
- Continuous occupation monitoring, including for baseline, at key locations / surface features, including
    - Monitor movements at or toward key sensitive features and areas (i.e., large cliffs primarily on the southern side of the EP Area e.g. sites labelled 8 and 14)
    - Monitor movements in areas of highest depth of cover (e.g. sites labelled 19 and 20)
    - Monitor movements in areas of maximum predicted subsidence (e.g. sites labelled 17 and 18)
    - Public access areas (e.g. site labelled 16),
    - pseudo 'transverse' lines (e.g. sites labelled 4 to 6 and 10 to 12), and
    - pseudo 'longitudinal' lines (e.g. sites labelled 3, 5, 17, 17, 11, 18, 20 and 15).
- Co-located with photogrammetry geo-reference markers to provide continually operating reference points for LiDAR
- Provide notifications to key site personnel in accordance with trigger thresholds presented in the Master TARP

The GNSS units are intended to be deployed continuously at proposed locations throughout the duration of mining within the EP Area and will remain in-situ until data demonstrates subsidence has stabilised following the completion of mining (potentially up to a maximum of 12 months post mining, but noting that monitoring will continue until movement stabilises). Once data has demonstrated subsidence has stabilised following the completion of mining, Airly Mine may seek to re-deploy appropriate units closer to current or future mining areas. Notwithstanding, any potential relocation of individual GNSS units as mining advances would be undertaken in consultation with the IEP, and NSWRR and NPWS prior to doing so.

Raw subsidence monitoring data from the GNSS units for the MW17-18 extraction area will be provided to NPWS on a quarterly (3 monthly) basis.

**Baseline**

The installation of the GNSS units is subject to receiving approval from NPWS. The GNSS units will be installed prior to commencement of secondary extraction and will collect baseline data through to the commencement of secondary extraction of nearest panel (i.e. some stations far from MW17 will continue to provide baseline until mining comes nearer), while some sites are located in the Extended / Far Field Monitoring Area far from predicted subsidence and may provide potential baseline for future mining.

### 4.2.3 LiDAR

High resolution (40pts per square meter) LiDAR will be used for vertical subsidence monitoring. The system identifies ground points and then revisits these each monitoring event ('epochs').

Routine LiDAR surveys are undertaken at approximately six-monthly intervals. The LiDAR surveys are part of a whole of mine monitoring program and cover previously approved EP Areas. Monitoring within the EP Area will be consistent with schedules of previously approved Extraction Plans.

Differential subsidence is measured between each epoch comparing thousands of data points and is georeferenced to the GNSS monitoring network. The system is capable of detecting 50mm subsidence movements at very high confidence level for each epoch.

The point measurement distribution provides a monitoring grid of similar density to conventional subsidence survey lines[9], but with the advantage of extensive coverage over the entire EP Area. This distribution of monitoring points provides a mine-wide subsidence profile of suitable accuracy to complement the integrated subsidence monitoring network (particularly the much higher accuracy GNSS units). Theoretically a subsidence line, and subsidence profile, could be placed anywhere within the EP Area using the data from stereo vertical photogrammetry.

Aerial survey includes consideration of:

- Condition of natural rock structures, including rock falls (natural or otherwise) or significant cracking, including percentage of cliff face area affected,
- Presence/absence of significant damage or change to general land surface of the SCA (topography, soil cover, vegetation cover, etc.); and
- Subsidence that exceeds consent limits (within the 50mm accuracy).

Methodology:

- Fixed wing aircraft to capture LiDAR
- LiDAR resolution will nominally be 40 points per square meter
- Ground control from survey targets co-located with the GNSS monitoring stations
- Ground control is measured on imagery.
- Once satisfactory results obtained in the software (Aero3D) - triangulation imagery is available for stereo measurement derivation of height points that are used for differential subsidence monitoring.
- By using the same flight plan from epoch to epoch the same georeferenced positioning locations are used to perform direct comparisons at the same locations.
- A spatially accurate point cloud is developed as a primary product, from which a Digital Elevation Model (DEM) is generated and subsequently analysed.

Further detailed analysis and/or targeted visual ground inspection will be undertaken if issues are identified from aerial work as per triggers detailed in the *MW17-18 Master TARP*.

**Baseline**

LiDAR baseline for the EP Area was flown in December 2022 and June 2023, with potential for a third survey to be flown prior to secondary extraction commencing in MW17.

### 4.2.4 Trigger based, Targeted Surface Inspection

Trigger-based, targeted surface inspections will also be undertaken where required under the MW17-18 Master TARP and where safely and readily accessible (such as where 4WD trails traverse or are close to the EP Area).

Inspections will be guided wherever possible by related information provided by the integrated monitoring system, including underground and remote/aerial monitoring systems to identify and target key areas required for surface inspection.

Additionally, opportunistic observations will be undertaken by mine personnel during other routine monitoring visits within the EP Area (i.e., for conventional survey).

## 4.3 Natural and Built Features Monitoring

### 4.3.1 Cliffs, Minor Cliffs and Pagodas

Potential subsidence related impacts to the sensitive rock features (i.e., cliffs, minor cliffs and pagodas) will be managed in accordance with the Land Management Plan for MW17-18.

MSEC (2023) concluded that, (considering the very low levels of subsidence predicted over the identified internal cliffs and rock features located near and over MWs 17 to 18), there was only an extremely low probability that cliff instabilities would occur at the identified and listed cliffs, which were mostly relatively short, isolated cliffs located over solid unmined coal areas beyond the edges of the miniwall panels.

MSEC (2023) further advised that because natural rock falls have been reported to occur regularly[10], it is not possible to guarantee that there would be no rock falls reported during the period of mining. However, there should only be occasional falls of small slabs of rock and, because of the very low levels of subsidence being predicted at the identified internal cliffs and rock features, there should be little chance of exceedance of these development approval conditions for cliffs.

Hence, as the predicted levels of subsidence over Genowlan Mountain based on the proposed Extraction Plan Layout for MWs 17 to 18 are similar to those provided in the 2014 EIS, i.e., the maximum predicted subsidence is less than 125 mm with no surface cracking, and the assessed levels of potential impact for the cliffs, are similar to those based on the EIS Layout.

The following monitoring will be implemented during the secondary extraction of Miniwalls 17 to 18 to monitor for the presence/absence of potential subsidence related impacts or change to features (significant rock falls and surface cracking):

- Continuous occupation GNSS monitoring undertaken in accordance with **Section 4.2.2**;
- LiDAR undertaken in accordance with **Section 4.2.3**;
- Triggered targeted visual ground inspection in relevant areas if issues are identified from integrated monitoring network as per triggers within the MW17-18 Master TARP undertaken in accordance with **Section 4.2.4**.

Baseline monitoring of landscape features within the EP Area has commenced and will be obtained by using a combination of methods as follows:

[10] available aerial imagery of cliff lines dating back to 1982 was reviewed using time-lapse software and indicated eight (8) significant natural rock fall events within a 32 year period (indicating approximately once every four years on average). Smaller isolated falls occur more frequently but are generally not noticeable at any great distance.

- Cliff identification and location mapping (Aerometrex, 2020, 2021a, 2021b) – detailed mapping of landscape features was undertaken by Aerometrex in accordance with definitions of cliffs, minor cliffs, pagodas and steep slopes provided in Development Consent SSD_5581.
- Ground inspection (MNC, 2022) – Centennial Airly asked Michael Nicholson Consulting Pty Ltd (MNC) to undertake further site inspections ("ground truthing") of the cliffs that are located within the EP Area to supplement the extensive aerial photogrammetry and cliff identification work that was undertaken previously Aerometrex. The site inspections confirmed the photographic analysis that was undertaken by Aerometrex and advised there were no cliff features that would be particularly sensitivity to subsidence movements.
- LiDAR (December 2022 and June 2023) – Detailed baseline prior to commencement of secondary extraction georeferenced with existing GNSS monitoring network (where available).
- Continuous occupation GNSS monitoring – strategically located GNSS stations within the EP Area will begin collecting near-real time 3D position data prior to the commencement of secondary extraction at <+/-5mm accuracy, including dedicated stations monitoring cliffs.
- Additional pre-Mining High Resolution Stereo Vertical Photogrammetry and High-Definition Oblique 3D Photogrammetry has also been complete (May 2020, November 2020, May 2022 and December 2022) and is available for data analysis and comparison with the above ongoing monitoring if required.

### 4.3.2 General Land Surface – Mugii Murum-ban State Conservation Area

The majority of the land overlying the EP Area is located within the Mugii Murum-ban SCA and is largely inaccessible or very hard to access by virtue of its location (e.g. beneath cliff lines or adjacent steep slopes), rugged topography, moderate to thick vegetation cover and significant rock outcrops dominated by Genowlan Mountain. No adverse impact has been predicted to the surface throughout the SCA within the EP Area.

The following monitoring will be implemented during the secondary extraction of Miniwalls 17 to 18 to monitor for the presence/absence of potential subsidence related impacts or change to features (significant rock falls and surface cracking):

- Continuous occupation GNSS monitoring undertaken in accordance with **Section 4.2.2**;
- LiDAR undertaken in accordance with **Section 4.2.3**;
- Triggered targeted visual ground inspection in relevant areas if issues are identified from integrated monitoring network as per triggers within the MW17-18 Master TARP undertaken in accordance with **Section 4.2.4**.

These methods are deemed appropriate given then predictions of no significant impact. These methods are considered sufficient to pick up any (unpredicted) significant impacts.

### 4.3.3 SCA Management Four-wheel Drive and Walking Trails

The Trig Trail is an unsealed 4WD track located on the top of Genowlan Mountain which provides access to the Trig Station located within the EP Area. It is open to the public via Genowlan Trail, off Glen Davis Road through private property owned by Centennial, which is open to the public. There is a proposal by NPWS for a locked access gate up on Genowlan Mountain in the northeast where the trail meets the Genowlan Point Track.

Formal walking tracks recognised in the SCA draft Plan of Management (Sep 2015) are limited within the EP Area, however off-trail walking access is available throughout the majority of the SCA (including beyond the EP Area).

Targeted inspections of trails within the EP Area will be undertaken if/where triggered by the Master TARP.

### 4.3.4 Permanent Survey Marks

One Permanent Marks (Genowlan [P] Trig Station (TS 7138)) is located within the Near-Field / Principal Subsidence Management Area, in vicinity of the finishing end of MW18.

MSEC (2023) stated that the survey mark located directly above the proposed miniwalls, could experience the full range of predicted subsidence effects.

Consultation between Airly Mine and NSW Spatial Services will be undertaken to determine the requirements to re-coordinate any state survey control marks within the EP Area. If required, on the completion of subsidence from Miniwalls 17 to 18 (i.e., when the ground has stabilised), Airly Mine will re-establish any survey control marks that are required for future use.

### 4.3.5 Surface Water

Only upper ephemeral drainage lines of Genowlan Creek (typically 1st order) are located within the EP Area as illustrated on **Figure 1.2**. MSEC (2023) stated that, the predicted post-mining grades along Genowlan Creek and the other drainage lines are similar to the pre-mining natural grades. It is unlikely, therefore, that there would be adverse changes in ponding or scouring resulting from the mining-related subsidence or tilt. It is expected that no fracturing of the bedrock will be observed over the miniwalls and beneath the sections of the streams that are located directly above and adjacent to the proposed miniwalls. Surface water flow diversions are unlikely to occur along the sections of the streams that are located directly above and adjacent to the proposed miniwalls.

As agreed with agency stakeholders, potential surface water impacts from Airly Mine will be managed in accordance with the Airly Mine Water Management Plan (Airly Mine WMP) (GHD 2021) developed in accordance with Condition 13 in Schedule 4 of SSD_5581.

The surface water monitoring framework outlined in the Airly Mine WMP[11], includes:

- Continuous flow monitoring at Gap, Genowlan Creek and Genowlan Creek 2 site (data logged).
- Monthly routine water quality screening samples during mining.
- Annually- full water quality sampling suite on Gap Creek, the Grotto, Genowlan Creek 2.
- Routine (weekly) and event based (20mm in 24hrs) inspections of mine water dams.
- Monthly and annual sampling of onsite dams.

Monitoring sites and types are summarised below in **Table 4-3**.

**Table 4-3: Surface water monitoring sites**

| Creek System | Monitoring Location | Monitoring type |
|---|---|---|
| Airly Creek | Airly Creek Upstream | • Water quality<br>• Aquatic Ecology |
| | Airly Creek | • Aquatic Ecology |
| | Dog Trap Creek | • Aquatic Ecology |

[11] Refer to the Airly Mine WMP (Appendix 1 of the EP Main Report) for details including completion of monitoring

| Creek System | Monitoring Location | Monitoring type |
|---|---|---|
| Gap-Genowlan Creek | Gap Greek | • Water quality<br>• Flow<br>• Aquatic Ecology |
| | The Grotto | • Water quality |
| | Genowlan Creek | • Flow<br>• Aquatic Ecology |
| | Genowlan Creek 2 | • Water quality<br>• Aquatic Ecology |
| Torbane-Oaky Creek | Torbane Creek | • Aquatic Ecology |

Flows at the Genowlan Creek monitoring sites (located downstream of the EP Area) have been recorded since February 2013. An additional flow monitoring gauge at the Genowlan Creek 2 site was installed in mid-2017. Flows at Genowlan Creek are primarily rainfall-dependent, exhibiting a marked peak after successive daily rainfall events exceeding 30 mm.

Water quality data has been collected at surface water storages on site and Airly Creek since 2010. Baseline water quality monitoring of Gap Creek and Genowlan Creek began in 2012.

Appendix D of the current Airly Mine WMP presents the baseline surface water quality data for selected parameters monitored at surface water storages on site and Airly Creek, Gap Creek and Genowlan Creek.

Monitoring locations for surface water, groundwater, stream stability and aquatic ecology are shown on Figures 4-1, 4-2, 4-3 and 4-4 of the Airly Mine WMP respectively.

### 4.3.6 Groundwater

As agreed with agency stakeholders, potential groundwater impacts from Airly Mine will be managed in accordance with the Airly Mine Water Management Plan (Airly Mine WMP) (GHD 2021) developed in accordance with Condition 13 in Schedule 4 of SSD_5581.

The predicted levels of subsidence over Genowlan Mountain based on the proposed Extraction Plan Layout for MWs 17 to 18 are similar to those provided in the 2014 EIS, i.e., the maximum predicted subsidence is less than 125 mm with no surface cracking, and the assessed levels of potential impact for groundwater, are similar to those based on the EIS Layout.

The groundwater monitoring framework outlined in the Airly Mine WMP[12], includes:

- Continuous monitoring of piezometric head and groundwater levels.
- Monthly routine groundwater quality (screening suite) during mining.
- Annually- Full groundwater quality suite.
- Continuous monitoring of Village Spring seepage.
- Daily monitoring of underground transfers to surface dirty water dam (109ML dam).

A groundwater monitoring network of vibrating wire piezometers (VWP's) and Standpipes has been progressively installed since 2012 (i.e. many key sites have in excess of two years baseline monitoring data) to monitor various targeted strata (including alluvium downstream of the EP Area) and is detailed within the Airly Mine WMP.

[12] Refer to the Airly Mine WMP (Appendix 1 of the EP Main Report) for details including completion of monitoring

All VWPs and standpipe monitoring bores are continuously logged for piezometric head and groundwater levels. Groundwater quality in standpipe monitoring bores is monitored monthly for selected parameters. Sufficient baseline groundwater monitoring data is held for the proposed workings within the EP Area.

Monitoring locations for surface water, groundwater, stream stability and aquatic ecology are shown on Figures 4-1, 4-2, 4-3 and 4-4 of the Airly Mine WMP respectively.

### 4.3.7 Biodiversity

Subsidence related impacts to biodiversity will be managed in accordance with the Biodiversity Management Plan for MW17-18.

The Biodiversity Management Plan prepared for the EP Area (EP-BMP) identified the following:

- Vegetation communities - which predominately consists of PCTs 3865, 3686 and 3695 which are heath communities and open forests typical of ridgetops. No Threatened Ecological Communities occur within this EP area.
- Groundwater Dependent Ecosystems - no GDEs have been identified within the EP Area however, one facultative ecosystem may occur within the gullies on the edges of the EP area, this being vegetation described as Western Blue Mountains Monkey Gum Gully Forest (PCT 3495).
- One threatened flora species is known to occur within this EP area. *Prostanthera stricta* (Mount Vincent Mint Bush; BC Act: Vulnerable; EPBC Act: Vulnerable).
- One threatened fauna species is persistent within the EP area. The Glossy Black-Cockatoo (*Calyptorhynchus lathami*; BC Act: Vulnerable), frequents the area feeding on abundant stands of *Allocasuarina* species.
- Other mobile threatened fauna species particularly woodland birds, microbats, reptiles and arboreal mammals would utilise the habitat features within the area. Key habitat features include:
    - Sandstone habitats;
    - Flowering and fruiting plants;
    - *Allocasuarina* species; and
    - Koala feed trees.

Considering the low impacts predicted (i.e. 20mm limit of vertical subsidence) within the Near-Field / Principal Subsidence Management Area and nil potential for impacts within the Extended / Far Field Monitoring and Management Area, no impact has been predicted to biodiversity of the EP Area, including threatened flora and fauna and facultative Groundwater Dependent Ecosystems.

A broadscale Biodiversity Monitoring Program is currently being undertaken at Airly Mine within the Development Consent Area (SSD_5581) as per the site specific Airly Biodiversity Management Plan (RPS 2017a) required by Condition 15 in Schedule 4 of SSD_5581. The broader monitoring program within the Mining Lease Area includes the current EP Area (MW17-18). The monitoring program commenced in 2012 by the University of Queensland (UQ) and was further developed and refined by in 2015 by RPS whereby it has been carried out annually by RPS to present.

The current Biodiversity Monitoring Program has been reviewed and updated within the context for the current EP Area (MW17-18) taking into consideration previous monitoring results and recommendations, and recent findings of the Baseline Assessment. This allows for the wealth of information obtained from previous monitoring efforts to be integrated into the baseline data and design.

### 4.3.8 Aquatic Ecology & Stream Health

Aquatic ecology and stream health monitoring is undertaken in accordance with the Airly Mine Water Management Plan (GHD 2021), which has been developed in consultation with key agencies including but not limited to the Commonwealth Department of the Environment and Energy (DoEE), NSW Environment Protection Authority (EPA) and the NSW Department of Primary Industries – Water (DPI Water).

Monitoring requirements outlined by GHD (2021) are summarised in the Monitoring Summary Table presented in **Table 4-2**. Monitoring locations are shown on Figure 4-4 of the Airly Mine WMP (*Appendix 1 of the EP Main Report*). Further detail of the aquatic ecology monitoring methodology and regional sampling extent is also provided in the Airly Mine WMP and the Western Region Biodiversity Management Plan, as also referenced in the *MW17-18 BMP*.

**Geomorphic condition and watercourse stability**

Watercourse stability monitoring is undertaken on third order streams within the broader development consent boundary (subject to access requirements), every two years. Watercourse stability monitoring will also be undertaken in areas where subsidence survey monitoring indicates greater than predicted subsidence. Visual monitoring of watercourses is carried out by suitably qualified professionals to identify any instabilities that may form as a result of mining operations. The results of the watercourse stability monitoring program will be compared to baseline data collected.

The visual inspection of watercourses will identify if any of the following potential subsidence impacts occur within the creek lines or immediate catchment flow paths:

- Change in stream bed or bank conditions.
- Incision or head cut development.
- Surface cracking.
- Ponding (particularly 'out of channel' ponding).
- Step changes in bed profile.
- Notable/indicative changes in stream vegetation.

A baseline assessment of geomorphology at Airly Mine was undertaken for the Airly Mine Extension Project (GHD 2014e). Watercourse stability monitoring was last undertaken in 2018 (GHD 2018a).

Geomorphic condition in Torbane and Airly Creeks was mostly moderate, though poor condition reaches were identified associated with active headcuts. Geomorphic condition in Gap, Genowlan and Dog Trap Creeks was good, with the exception of an upstream section of Gap Creek where land clearing has resulted in the channelisation of a narrow valley of fine-grained sediments. Apart from that poor condition reach, Gap, Genowlan and Dog Trap Creeks are characterised by confined, bedrock controlled valley settings, which are geomorphologically stable and subject to only slow rates of change.

The potential impacts of subsidence on these creeks would most likely be observable in areas of bedrock outcropping in the substrate, where any cracks would be evident during inspections.

**Aquatic Ecology**

Aquatic ecology monitoring at Airly Mine has been undertaken within Gap Creek, Genowlan Creek, Airly Creek, Torbane Creek and Dog Trap Creek since 2013. The monitoring methodology includes:

- Sampling, sorting and identification of macroinvertebrates collected from edge habitat in accordance with the Australian Rivers Assessment System (AUSRIVAS) protocols (Turak et al. 2004).
- Assessment of the condition of the aquatic habitat using modified NSW AUSRIVAS field sheets and riparian, channel and environmental (RCE) inventory (Peterson 1992).

- Measurement of DO, EC, pH, temperature and turbidity just below the surface of the water column and at depth where sufficient water is available.
- Collection of surface water and sediment grab samples for water and sediment quality analysis.

Overall, the aquatic habitat in Genowlan Creek was determined to be in the best condition (GHD 2017). The combination of low nutrient and metal concentrations and diverse habitat availability at the site supports a diverse macroinvertebrate community which is largely sensitive to pollution. The macroinvertebrate community in Gap Creek also contains pollution sensitive taxa and there is little disturbance related to human activities at the site, although water scarcity is a limiting constraint.

Airly Creek, Torbane Creek and Dog Trap Creek were more highly disturbed by grazing and agricultural land use compared to the Gap Creek and Genowlan Creek catchments. It is likely that these sites receive groundwater baseflow from the Shoalhaven Group, which is an early Permian marine formation in which groundwater has an elevated EC in the order of 4000 µS/cm. Monitoring sites in these catchments were dominated by pollution dominant taxa. The similarity of the macroinvertebrate communities in the Airly Creek sites upstream and downstream of the surface facilities area indicated that there was no impairment of the community at the downstream site associated with overland flows of discharges from Airly Mine.

# 5 MANAGEMENT, MITIGATION, REMEDIATION AND REPORTING MEASURES

## 5.1 Performance Measures and Indicators

The approved subsidence impact performance measures are specified under Condition 2 in Schedule 3 of SSD_5581. These are detailed in *Section 5.1 of the EP Main Report*, including additional internal performance measures set by Centennial Airly for the mine design (to be monitored by the underground components of the Subsidence Monitoring Program.

To establish compliance with the performance measures, Airly Mine has developed a monitoring program with several integrated components *(this MW17-18 SMP)* and an associated *MW17-18 Master TARP (Appendix 6 of the EP Main Report)*. These documents establish appropriate monitoring elements, parameters and associated trigger levels to demonstrate that the environmental performance satisfies the criteria in *Section 5.1 of the EP Main Report*.

**Table 5-1** contains the performance indicators which have been established for key monitoring aspects with allocated trigger values to define the following key performance scenarios within the MW17-18 TARP (Appendix 6 of the EP Main Report).

**Table 5-1: Performance Indicators & TARP Risk Management Scenarios**

| Performance Indicator | General Description | Action / Response |
|---|---|---|
| **Level 1: Condition Green** | **Operations within predictions, and within approved impacts**. | Continued operations and monitoring as normal. |
| **Level 2: Condition Amber** | **Operations within approved impacts but potentially exceed / exceed predictions**. | Review and investigation processes are engaged, with adaptive management as required. |
| **Level 3: Condition Red** | **Operations exceed approved impact.** *The approved Performance Measures (criteria thresholds) of Development Consent (and any other relevant approvals) are listed in Condition Red.* | Adaptive Management measures are fully engaged as per the TARP and relevant sections of the Extraction Plan and the SMP. |

## 5.2 Remediation and Rehabilitation Measures

Due to the minimal subsidence expected the need to implement remediation/rehabilitation measures for potential impacts are considered unlikely. However, in the event that remediation is required, Airly Mine will undertake remediation in accordance with:

- Conditions 7a)-7c) in Schedule 6 of SSD_5581, noting in particular the requirement to submit a report to DPE describing remediation options and any preferred remediation measures or other course of action;
- Any relevant actions prescribed in the *MW17-18 Master TARP* developed for this Extraction Plan (or other relevant plans of management);
- The current Mining Operations Plan and Rehabilitation Management Plan; and
- In consultation with key stakeholders including any affected land holders and relevant government agencies.

A Response Strategy will be adopted if a significant impact is detected as a result of mining activities within the Extraction Plan area.

## 5.3 Trigger Action Response Plan

A detailed MW17-18 TARP (Appendix 6 of the EP Main Report) has been developed for the Extraction Plan to reflect the commitments of this MW17-18 SMP and other related aspects. Whilst impacts are not predicted nor expected, the MW17-18 TARP provides a process of tiered and/or escalating trigger levels for contingency measures should subsidence and impacts be greater than predicted/approved. The MW17-18 TARP applies only to the EP Area (separate TARPs apply to other established EP Areas in various approved mining zones).

Given the mine has been designed specifically to avoid impacts, the MW17-18 TARP includes detailed measures for Underground Mining Controls to ensure that the mining geometry is formed as per the approved design specifications that determine the predicted subsidence movements and impacts.

The MW17-18 TARP includes detailed performance indicators for land management. The contingency plan where a performance indictor has been exceeded is outlined in the TARP. A trigger will result in additional investigations to determine if the exceedance is related to non-mining-factors or is a consequence of mining activity. The response to these exceedances will follow the TARP. Management / corrective actions can be implemented where required to remedy these non-conformities and report accordingly.

## 5.4 Adaptive Management and Contingency Plan

An Adaptive Management Framework provides for flexible decision making, adjusted to consider uncertainties as management outcomes are understood. The adaptive management approach at Airly Mine is detailed in the EP Main Report *(refer Section 5.5)*.

In summary, adaptive management at Airly Mine involves monitoring and evaluation against performance measures and associated indicators in the MW17-18 TARP established for the extraction plan and supporting management plans. Where performance indicators indicate increasing levels of risk (i.e., where relevant thresholds of conditions green, amber or red are being exceeded), escalating adaptive management measures are engaged in accordance with the MW17-18 TARP. The process has been successfully implemented in existing Extraction Plan areas at Airly Mine and has been updated to reflect EIS commitments and consent requirements for the Airly Mine Extension Project, including specific performance measures.

## 5.5 Incidents, Complaints, Exceedances and Non-Compliances

Incidents, complaints, exceedances and non-compliances are managed accordance with the requirements of relevant approvals and licences including SSD_5581, EPL12374 and EPBC 2013/.7076, relevant legislation and regulations, and generally in accordance with the *Extraction Plan Guideline* (DPE, 2022). A detailed review of the notification requirements relevant to the Extraction Plan, including this MW17-18 SMP, is provided in the EP Main Report *(refer Section 5.7.1)*, including requirements for:

- Incident or non-compliance reporting in accordance with:
    - Consent condition 9 (Schedule 6) of SSD_5581.
    - EPBC 2013/7076 Condition 1, or as triggered by the TARP (reporting incidents under Management Plans as per Schedule 6, Condition 2 of SSD_5581).
    - EPL12374 condition R2
    - WHS Regulation (Mines and Petroleum Sites, 2022) Clause 124 - Duty to notify regulator of certain incidents
    - Section 6 of the Guidelines for Managing Risks of Subsidence (WHS (Mines and Petroleum Sites), February 2017

- Managing complaints.

Incidents, complaints, exceedances and non-compliances will be managed in accordance with the requirements detailed in the EP Main Report *(refer Section 5.6).*

## 5.6 Reporting and Auditing

### 5.6.1 Reporting

Reporting is undertaken in accordance with the requirements of specific requirements of relevant approvals and licences including SSD_5581, EPL12374 and EPBC 2013/7076, and generally in accordance with the *Extraction Plan Guideline* (DPE, 2022). Additionally, high potential incident notifications for unexpected subsidence events in relation to the safety of other persons under WHS legislation has also been included.

A detailed review of the reporting and notification requirements relevant to the Extraction Plan, including this MW17-18 SMP, is provided in the EP Main Report *(refer Section 5.7.1)*, including requirements for:

- Regular reporting of impacts and environmental monitoring results in accordance with Condition 10 of Schedule 6 under SSD_5581;
- Annual reporting required in accordance with condition 11 of Schedule 6 under SSD_5581 and separately under EPBC 2013 / 7076;

Reporting will be undertaken in accordance with the requirements detailed in the EP Main Report *(refer Section 5.7.1)*.

### 5.6.2 Periodic Auditing

Comprehensive Independent Environmental Audits of the entire approved development under development consent SSD_5581 are undertaken within 1 year of commencement and every 3 years thereafter (unless directed otherwise) in accordance with Conditions 12 and 13 of SSD_5581.

Auditing of any rehabilitation undertaken for the mine (including for subsidence if triggered) is undertaken in accordance with the Mining Operations Plan / Rehabilitation Management Plan under Condition 27 in Schedule 4 of development consent SSD_5581.

Additionally, in accordance with section 20(c) of the WHSMP Regulation (2022), auditing will be undertaken in accordance with the Airly Mine Safety Management System (SMS), against the performance standards for measuring the effectiveness of all aspects of the SMS, including the methods, frequency and results of the audit process. The audit should also consider the following matters:

(1) competency of the auditor,

(2) the person responsible for ensuring the audit is conducted, and

(3) the person responsible for implementing the results of the audit.

# 6 PLAN ADMINISTRATION AND RESPONSIBILITIES

## 6.1 Review

In accordance with the requirements under Condition 3 in Schedule 6 of Development Consent SSD_5581, as a minimum Centennial Airly will review this Plan within three months of the following:

a) Submission of an incident report;

b) Submission of an Annual Review (required 31 March annually);

c) Submission of an Independent Environmental Audit; or

d) Any modification to the conditions of SSD_5581.

Where this leads to revisions of the document, within four (4) weeks of the review the revised document must be submitted to DPE for the approval of the Secretary. Continual improvement shall be achieved through monitoring, internal and external communication with stakeholders, implementation of corrective and preventative actions and through monitoring progress against the objectives included in the environmental management plans. The reporting framework (refer **Section 5.5**) will document the effectiveness of this document (and the related Extraction Plan) through comparison of the predicted negligible impacts of subsidence against actual outcomes.

Each variation to this Plan will be identified in the Document Control Table at the beginning of this document.

Additionally, to maintain consistency with existing management plans and previous Extraction Plans at the mine, this MW17-18 SMP will also be reviewed in the event that the following occur:

- Stakeholders raise issues that necessitate a review;
- There are other changes to management requirements (e.g. changes to other related approvals besides consent, such as Mining Lease and/or EPL conditions);
- Where unpredicted impacts or consequences have required implementation of contingency actions under this plan;
- Monitoring or audit processes demonstrate that a review is warranted;
- Where otherwise triggered by the MW17-18 TARP;
- Where triggered by (or for) review of other related management plans (if applicable); or
- Every three (3) years as a minimum (where not already triggered above).

Any amendments to the MW17-18 SMP will be undertaken in accordance with Consent/relevant approvals and in consultation with key relevant stakeholders where required. Following any significant changes, a copy of the amended MW17-18 SMP will be forwarded to all relevant stakeholders.

In addition to planning development consent requirements, Airly Mine must review and as necessary revise the risk control measures implemented for subsidence in accordance with section 15 of the *WHSMP Regulation (2022)*. Any review triggered by WHS Legislation Requirements will be addressed via the process identified in the EP Main Report *(refer Section 5.5)* and the MW17-18 PSMP (Appendix 4 of the EP Main Report).

## 6.2 Key Responsibilities

The responsibility for implementation, monitoring and review of the EP-SMP lies with the Technical Services Manager. The ultimate responsibility for the implementation of the EP-SMP lies with the Mine Manager, who shall make appropriate resources available. The roles and responsibilities for this EP-SMP are outlined in **Table 6-1.**

**Table 6-1: Key Personnel and Accountabilities**

| Position | Responsibility |
|---|---|
| Mine Manager | • Ensuring that sufficient resources are available to implement and execute the requirements of this Plan; and<br>• Reporting triggers/non-conformances to external stakeholders. |
| Technical Services Manager | • Coordinate underground inspections and subsidence monitoring program;<br>• Coordinate implementation of the mine design and Master TARP.<br>• Reporting triggers/non-conformances internally to the mine manager as appropriate.<br>• Reporting to DPE and NSW RR of subsidence and pillar system performance upon completion of specified monitoring intervals.<br>• Coordinating any remediation work as required;<br>• Inspecting targeted accessible areas susceptible to tensile and compressive strains and potential cracking as required (e.g. accessible tracks and trails);<br>• Providing raw subsidence monitoring data from the GNSS units for the MW17-18 extraction area to NPWS on a quarterly (3 monthly) basis.<br>• Co-ordinating the generation and submission of formal reporting requirements outlined in this Plan; and<br>• Reviewing this management plan. |
| Production Manager | • Implement mine design<br>• Establish and maintain underground monitoring and inspections program;<br>• Auditing as required |
| Mine Surveyor | • Survey as built initial development pillars<br>• Establish and maintain subsidence monitoring program;<br>• Internal reporting as required.<br>• Mark up centre lines for driveage in pillars<br>• Produce final mining plan for extraction workings to be carried out in consultation with the Technical Services Manager.<br>• External notifications if/as required to NSW Spatial Services (Office of Surveyor General) for potential impacts to State Survey Marks.<br>• Survey and reporting of pillars following development |
| Superintendent Environment and Community | Implementation, monitoring and review of this plan, including:<br>• The carrying out of targeted inspections;<br>• The installation and maintenance of signage where required;<br>• Reporting triggers/non-conformances internally to the Mine Manager as appropriate;<br>• Consulting with land owners, landholders and managers regarding any land management issues arising from subsidence within the EP Area. This includes (but may not be limited to) NPWS, Office of Crown Lands and private landowners within the EP Area (if and as applicable);<br>• Consultation during the review process with relevant stakeholders and distributing this management plan; |

# 7 REFERENCES

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SCT (2021b). *Airly Mine Subsidence and Pillar Width Modelling Assessment – Point Hatteras Mining Area, Mt Genowlan (Report No. AIRLY5265)*

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Strata$^2$ (2019a). *Panel and Pillar Mining Zone: Revised Subsidence Estimates and Impacts (Report No. AIR-006-Rev1)*

Strata$^2$ (2019b). *Estimation of Surface Impacts (including Cliffs) due to the Extraction of Miniwalls 2 to 15' (Report No. AIR-004-Rev0)*

RPS (2022a). *Airly Extraction Plan for the Cliff Line Zone ML1814 and MW17-19 Extraction Plan Area Historical Heritage Management Plan Update & Phase 1 Baseline Historical Heritage Assessment (Report No. PR152234-1)*

RPS (2022b). *Desktop review of ML 1814 area and MW17-19 EP Area for Aboriginal Cultural Heritage (Report No. AU213005571)*

RPS (2023). *Baseline Biodiversity Report MW17-19 EP Area and CLZ (ML1814) EP Area (Report No. 152229)*

# APPENDIX 6Master Trigger Action Response Plan for MW17-18 (MW17-18 Master TARP)

| Aspect | Performance Criterion<br>e.g., Consent Criteria / EIS Commitments | Condition Green<br>(Operations within Predictions & Approved Impacts)<br>*Continue Operations/Monitoring as Normal* | Condition Amber<br>(Operations within Approved Impact Performance Measures but potentially exceeding predictions/designs)<br>*Review Processes & Adaptive Management as Required* | Condition Red<br>(Operations Exceed Approved Impact Performance Measures)<br>*Adaptive Management Process Fully Engaged* |
|---|---|---|---|---|
| **Underground Mining Control:**<br><br>**First Workings (development) and Second Workings (extraction) width / height / pillar size** | **First Workings beneath any feature requiring no or negligible[3] environmental consequences (and all first workings beneath cliffs) required to be long term stable and non-subsiding.**<br><br>**All Second Workings to be carried out only in accordance with an approved Extraction Plan**<br><br>**Design Parameters to achieve predicted subsidence as per Table 8.5 of the EIS and Section 3.3.1 of the current Extraction Plan Main Report**<br><br>*Note: Exceedance of approved mine design parameters may not automatically cause a surface impact or environmental consequence / non-compliance with the performance measures of SSD_5581. Subsequently, appropriate responses to check if such impacts have occurred are additionally triggered elsewhere below for all relevant aspects.* | **TRIGGERS:**<br>• Underground mine survey and inspections confirms dimensions as mined are within compliant specifications, including:<br>○ Extraction height ≤ 3.0m average across miniwall panel as mined<br>○ Maximum roadway width ≤ 5.5m average across gateroad as mined.<br>○ Maximum void width 70.5m on average across miniwall panel as mined<br>○ Minimum Pillar System Factor of Safety (FOS) ≥1.6 (after extraction is complete)<br>○ Pillar width/height (w/h) ratio >9.0 average across panel<br>○ Rib spall <400mm on both ribs additional after rib support<br>○ Floor heave negligible or not observed<br>• Geotechnical Engineer audit of the underground geological mapping prior to extraction identifies no additional potential impacts of any anomalous geological structures (i.e., normal faults with throws exceeding seam thickness or thrust faults)<br>• Depth of Cover (DOC) above secondary extraction is >160m and <320m<br>• Second workings are located **beyond** an angle of draw of 26.5 degrees of the crest of any cliffs identified in the Cliff Line Zone of First Workings<br>• Secondary extraction by Panel and Pillar mining occurs **within** MW17-18 Panel & Pillar Mining Zone EP Area | **TRIGGERS:**<br>• Underground mine survey and inspections confirms **minor variations** in dimensions as mined compared to compliant specifications, including:<br>○ Extraction height >3.2m in isolated areas of miniwall panel outside of geological structure zones<br>○ Offline driveage >2m<br>○ Non-compliance with condition green for FOS, w/h ratio, maximum or minimum DOC, and/or final pillar size<br>○ Rib spall 400-500mm on both ribs additional after rib support<br>○ Floor heave observed not severe enough to impede operations<br>• Geotechnical Engineer audit of the underground geological mapping prior to extraction identifies potential impacts of any anomalous geological structures (i.e., normal faults with throws exceeding seam thickness or thrust faults) consistent with the EIS | **TRIGGERS:**<br>• Underground mine survey and inspections confirms **significant variation** (i.e. greater on average across panel as mined) in dimensions as mined compared to approved minimum design parameters and /or statutory design requirements[1], including:<br>○ Extraction height >3.0m average across miniwall panel<br>○ Maximum roadway width >5.5m on average across gateroad as mined.<br>○ Maximum void width >70.5m on average across miniwall panel as mined.<br>○ Minimum Pillar System FOS <1.6 across the panel (after extraction is complete)<br>○ Final pillar W/H ratio <9.0 average across panel without further controls implemented<br>○ Rib spall >500mm on both ribs additional after rib support<br>○ Significant roof deterioration and floor heave observed that is not isolated and consistently impedes operations<br>○ Pillar condition deterioration/increased spalling observed.<br>• Geotechnical Engineer audit of the underground geological mapping prior to extraction identifies potential impacts of any anomalous geological structures (i.e., normal faults with throws exceeding seam thickness or thrust faults) inconsistent with the EIS<br>• Depth of Cover (DOC) above secondary extraction is <160m or >320m<br>• Second workings occur **within** an angle of draw of 26.5 degrees of the crest of any cliffs identified in the Cliff Line Zone of First Workings<br>• Secondary extraction by Panel and Pillar mining occurs **beyond** MW17-18 Panel & Pillar Mining Zone EP Area |
| | | **ACTIONS & RESPONSES**:<br>• No response required when above parameters are met<br>• Continue Subsidence Monitoring Program to ensure impacts are as designed | **ACTIONS & RESPONSES**:<br>• Refer to and implement *Strata Management Plan* as required for additional roof support and/or rib support<br>• Review and improve training and communication with mining crews<br>• Retraining of development and miniwall crews where required<br>• Minor incident internal investigation process if offline driveage has occurred (where minor and non-reportable to Resource Regulator)<br>• Review and upgrade operational control and communication systems<br>• Review current subsidence monitoring results against the criteria of the related TARP aspects, including ***Ground Movement and Subsidence Effects Monitoring*** *and* ***Cliffs and Pagodas*** for compliance | **ACTIONS & RESPONSES**:<br>In addition to all actions and responses as per Condition Amber, Airly Mine will:<br>• Notify and consult with relevant stakeholders as per requirements specified within the Extraction Plan/SMP/PSMP, Development Consent and related approvals<br>• Take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur<br>• Cease secondary extraction operations in relevant areas if appropriate |

| Aspect | Performance Criterion<br>e.g., Consent Criteria / EIS Commitments | Condition Green<br>(Operations within Predictions & Approved Impacts)<br>*Continue Operations/Monitoring as Normal* | Condition Amber<br>(Operations within Approved Impact Performance Measures but potentially exceeding predictions/designs)<br>*Review Processes & Adaptive Management as Required* | Condition Red<br>(Operations Exceed Approved Impact Performance Measures)<br>*Adaptive Management Process Fully Engaged* |
|---|---|---|---|---|
| **Ground Movement and Subsidence Effects Monitoring:**<br><br>**Vertical Subsidence and Incremental Subsidence (Modelled vs Actual)** | **Subsidence design parameters to achieve no greater subsidence impacts or environmental consequences than predicted in the EIS are outlined in Table 8.5 of the EIS and Section 3.3.1 of the current Extraction Plan Main Report**<br><br>*<u>Note</u>: Exceedance of the predicted/approved subsidence parameters may not automatically cause a surface impact or environmental consequence / non-compliance with the performance measures of SSD_5581. Subsequently, appropriate responses to check if such impacts have occurred are additionally triggered elsewhere below for all relevant aspects. Destruction caused by vandalism, lightning and other damage is beyond the control of Airly Mine. Any damaged GNSS Stations will be replaced as soon as possible. The GNSS monitoring location layout provides some redundancy for assessing results against triggers in the event of any loss.* | **<u>TRIGGERS:</u>**<br>• Regular review of the GNSS monitoring network and detailed analysis of other subsidence monitoring data shows the incremental subsidence monitoring results for each panel are **within or below** modelled subsidence predictions (SCT, 2023), including:<br>  ○ Vertical subsidence after one miniwall ≤59mm<br>  ○ Vertical subsidence after two miniwalls ≤108mm<br>*Note, these trigger values include a maximum subsidence tolerance/natural variability of 20mm above the modelled predictions.*<br>• No alarm / notification from the GNSS monitoring network is received by Mine Surveyor / Technical Services Manager i.e., vertical subsidence measured at all GNSS stations is ≤120mm<br><br>**<u>ACTIONS & RESPONSES</u>**:<br>• No response required when above parameters are met<br>• Continue Subsidence Monitoring Program | **<u>TRIGGERS:</u>**<br>• Regular review of the GNSS monitoring network and detailed analysis of other subsidence monitoring data shows the incremental subsidence monitoring results for each panel are **greater than** 20mm (i.e., tolerance band) above modelled subsidence predictions (SCT, 2023), including:<br>  ○ Vertical subsidence after one miniwall >59mm<br>  ○ Vertical subsidence after two miniwalls >108mm<br>• Alarm / notification from the GNSS monitoring network is received by Mine Surveyor / Technical Services Manager i.e., vertical subsidence measured at any GNSS station is >120mm<br><br>**<u>ACTIONS & RESPONSES</u>**:<br>In consultation with the DPE incl IEP and NPWS, Airly Mine will:<br>• Investigate exceedance of trigger threshold / performance measure<br>• Review correlation data/process and subsidence predictions where appropriate<br>• Review mining methods, operations and monitoring against mine design criteria and implement Adaptive Management process as required, including consideration of the following potential actions where applicable:<br>  ○ Increase the size of protection zones by commencing or stopping extraction further away from sensitive features than planned, for example, change the finish position of the current panel (for an increased horizontal setback) and/or change the start/finish position of future panels which have already been formed/developed<br>  ○ Review panel design and modify pillar designs to suit altered pillar dimensions as required for future panels.<br>  ○ Change the dimension of pillars or void widths in future (unformed) panels (i.e., narrower voids, larger pillars, or a combination of both) to ensure extraction is within appropriate limits.<br>  ○ Relocate the miniwall equipment to avoid mining under and/or moving around sensitive features<br>• Review TARP triggers<br>• Review and update the subsidence modelling/predictions (against all available information) to assess the likelihood that subsidence after three miniwalls will remain below the maximum predictions of the EIS i.e., ≤125mm<br>• Review current subsidence monitoring results against the criteria of the related TARP aspects, including ***Cliffs and Pagodas*** for compliance | **<u>TRIGGERS:</u>**<br>• Alarm / notification from the GNSS monitoring network of the above triggers is received by Mine Surveyor / Technical Services Manager ***and*** Mine Manager i.e., vertical subsidence measured at any GNSS station is >125mm<br><br>**<u>ACTIONS & RESPONSES</u>**:<br>In addition to all actions and responses as per Condition Amber, Airly Mine will:<br>• Notify and consult with relevant stakeholders as per requirements specified within the Extraction Plan/SMP/PSMP, Development Consent and related approvals<br>• Notify the landowner i.e., NPWS<br>• Take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur<br>• Cease secondary extraction operations in relevant areas if appropriate and safe<br>• Following consultation and implementation of necessary changes to mine design, monitoring analysed and confirmed by external consultant. Where confirmed compliant (i.e., revised mine design performs as intended), and related performance measures satisfied, consider applying to regulators for a justified variation to the Extraction Plan to align remaining panels to the revised designs. |

| Aspect | Performance Criterion<br>e.g., Consent Criteria / EIS Commitments | Condition Green<br>(Operations within Predictions & Approved Impacts)<br>***Continue Operations/Monitoring as Normal*** | Condition Amber<br>(Operations within Approved Impact Performance Measures but potentially exceeding predictions/designs)<br>***Review Processes & Adaptive Management as Required*** | Condition Red<br>(Operations Exceed Approved Impact Performance Measures)<br>***Adaptive Management Process Fully Engaged*** |
|---|---|---|---|---|
| **Cliffs and Pagodas** | **<u>Cliffs and pagodas</u>** within 26.5 degrees of any Airly mine workings in the EP Area, other than pagodas affected by the New Hartley Shale Mine Potential Interaction Zone:<br>*No greater subsidence Impacts or environmental consequences than predicted in the EIS:*<br>*(i.e., Occasional rock falls, displacement or dislodgment of boulders or slabs of less than 30 $m^3$, or fracturing occurs, that do not impact Aboriginal heritage, EECs, or public safety, **that in total. do not impact more than 2% of the total area of such cliffs or pagodas**)*<br><br>**<u>Minor Cliffs and Steep Slopes</u>:**<br>*No greater subsidence impacts or environmental consequences than predicted in the MEP EIS.*<br>*(i.e. negligible[3] impact, no surface cracking, collapse of features or slope failure for CLZ of First Workings).*<br><br>*(Table 8.3 and Table 10.60 of EIS)* | **<u>TRIGGERS</u>**:<br>• Subsidence monitoring remains compliant within condition green triggers for ground movements and effects, and does not identify any mining induced impacts from extraction within the EP Area, including:<br>○ No Damage to Pagoda/Beehive formations (including visible cracking, rock fall).<br>○ No Damage to cliff and minor cliff faces (e.g. no rock fall, cracking).<br>• Underground Mining Controls and monitoring indicates all parameters are within design criteria / Level Green trigger levels. | **<u>TRIGGERS</u>**:<br>**<u>Level A:</u> Surface impacts are not yet observed but monitoring indicates *potential* to occur:**<br>• Subsidence monitoring indicates potential for surface impact requiring further investigation (i.e., Condition Amber triggered for ***Ground Movements and Subsidence Effects Monitoring*** and/or ***Underground Mining Control***)<br>• Subsidence monitoring indicates potential for development of subsidence which may result in a failure of ground (*High Potential Incidents* as per section 124(5m) of the WHSMP Regulations 2022)<br>**<u>Level B:</u> Surface impacts are observed:**<br>• Impact observed but yet to be confirmed if mining induced or natural rock fall<br>• The following mining-induced impacts occur but are **within** approved impacts of development consent SSD_5581 (i.e. still below Condition Red):<br>○ *Occasional rock falls, displacement or dislodgment of boulders or slabs of less than 30 $m^3$, or fracturing occurs, that do not impact Aboriginal heritage, EECs, or public safety, that in total. do not impact more than 2% of the total area of cliffs (excluding minor cliffs) or pagodas within 26.5 degrees of any Airly mine workings in the EP Area.*<br>• Any of the following events occurs that would have been a dangerous incident if a person were reasonably in the vicinity at the time when the event occurred (*High Potential Incidents* as per section 124(5a) of the WHSMP Regulations 2022):<br>○ *a failure of ground, or of slope stability control measures*<br>○ *rock falls, instability of cliffs, steep slopes or natural dams, occurrence of sinkholes, development of surface cracking or deformations due to subsidence.* | **<u>TRIGGERS</u>**:<br>• Subsidence monitoring identifies that there are mining induced surface impacts exceeding the Performance Measures approved by Development Consent SSD_5581 and/or which cause or threaten material harm to the environment or safety of persons on the surface over the mining area. These are summarised as follows:<br><br>**Impacts Exceeding Approved Performance Measures of** (as per Table 1, Sch3 SSD_5581)**:**<br>○ **Cliffs (major cliffs) and pagodas:** Non-occasional rock falls, displacement or dislodgment of boulders or slabs of **greater than** 30 $m^3$, or fracturing occurs, that **do impact** Aboriginal heritage, EECs or public safety, that in total do impact **more than 2%** of the total area of cliffs (excluding minor cliffs) or pagodas within 26.5 degrees of any Airly mine workings in the EP Area.<br>○ **Minor Cliffs and Steep Slopes:** Greater subsidence impacts or environmental consequences than predicted in the MEP EIS. (i.e. exceed negligible[3] impact, e.g. fracturing or collapse of steep slopes)<br><br>**Other Relevant Impacts:**<br>○ Failure of ground/slope stability control measures occurs (Including landslips)<br>○ Mining-induced instability of cliffs, steep slopes occurs<br>○ Development of surface cracking or deformations which present potential risk to the public/others (i.e., where trip hazards / step formation occurs or where there is potential for instability of a rock formation). |

| Aspect | Performance Criterion<br>e.g., Consent Criteria / EIS Commitments | Condition Green<br>(Operations within Predictions & Approved Impacts)<br>*Continue Operations/Monitoring as Normal* | Condition Amber<br>(Operations within Approved Impact Performance Measures but potentially exceeding predictions/designs)<br>*Review Processes & Adaptive Management as Required* | Condition Red<br>(Operations Exceed Approved Impact Performance Measures)<br>*Adaptive Management Process Fully Engaged* |
|---|---|---|---|---|
| **Cliffs and Pagodas (Continued)** | | **ACTIONS & RESPONSES**:<br>• No response required.<br>• Continue Subsidence Monitoring Program. | **ACTIONS & RESPONSES**:<br>In addition to Condition Amber action/responses for ***Underground Mining Control*** and/or ***Ground Movement and Subsidence Effects Monitoring***, Airly Mine will:<br>**Level A: Surface impacts are not observed but monitoring indicates their potential to occur:**<br>• Assess the public safety risk and likelihood for mine-induced surface impacts and Record Assessment<br>• If no public safety risk identified and/or mine-induced surface impacts are considered unlikely, continue Subsidence Monitoring Program<br>• If public safety risk identified and/or mine-induced surface impacts are considered likely<br>  ○ Further notify NPWS and key stakeholders and consider additional warning signs / closure of access in affected areas (including potential barricades if necessary to prevent access)<br>  ○ Further notify Resource Regulator under relevant WHS laws (i.e., for high potential incidents)<br>  ○ Undertake geotechnical risk assessment and targeted surface visual inspection over area possibly impacted and if surface impacts are observed refer Level B responses<br>**Level B: Surface impacts are observed:**<br>In addition to Level A action/responses above, Airly Mine will review available data or undertake targeted surface investigations to confirm if the impact is mining-induced or related to natural surface movements or activation of a natural feature:<br>• If confirmed as not a mine-induced impact, continue Subsidence Monitoring Program and notify NPWS and key stakeholders<br>• If mine-induced impact is confirmed:<br>  ○ Notify and consult with relevant stakeholders as per requirements specified within the Extraction Plan/SMP/PSMP, Development Consent and related approvals<br>  ○ Compare the impacts to relevant approved performance measure thresholds (refer condition red trigger levels), if above thresholds, refer Condition Red responses<br>  ○ Where applicable (e.g., potential for rockfall in vicinity of known heritage sites), review requirements of previously established TARPs for Heritage (Historic and Aboriginal and Cultural) Management Plans previously approved for related EP Areas in vicinity of cliffs (e.g., CLZ) | **ACTIONS & RESPONSES**:<br>In addition to all actions and responses as per Condition Amber, Airly Mine will:<br>• Take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur.<br>• Undertake targeted surface inspections (by suitably qualified personnel) if safely and readily accessible (or aerial if otherwise) where potential impact necessitates further assessment is required to quantify impacts, as determined in consultation with key stakeholders (OEH, NPWS, DPE and the NSW RR).<br>• Where fracturing has occurred and potential for instability is noted, undertake specialist geotechnical assessment to confirm level of residual instability, potential safety risks and recommended courses of action (with direction from PIS[2], DPE, NPWS/BCD).<br>• Cease secondary extraction in relevant areas where appropriate (with direction from PIS[2] and DPE).<br>• Consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action.<br>• Implement remediation measures as directed by the Secretary, to the satisfaction of the Secretary.<br>• Written reporting to relevant agencies as per Development Consent/relevant approvals as detailed in Extraction Plan. |

| Aspect | Performance Criterion<br>e.g., Consent Criteria / EIS Commitments | Condition Green<br>(Operations within Predictions & Approved Impacts)<br>***Continue Operations/Monitoring as Normal*** | Condition Amber<br>(Operations within Approved Impact Performance Measures but potentially exceeding predictions/designs)<br>***Review Processes & Adaptive Management as Required*** | Condition Red<br>(Operations Exceed Approved Impact Performance Measures)<br>***Adaptive Management Process Fully Engaged*** |
|---|---|---|---|---|
| **Unsealed Access Roads and Tracks and General Land Surface**<br>(MMBSCA Management 4WD Trails and walking tracks; steep slopes and native vegetation cover) | **Steep slopes and all other land not covered by a performance measure above** No greater subsidence impacts or environmental consequences than predicted in the EIS<br><br>**Other built features** Use should be maintained wherever practicable in consultation with BCD<br>Damage must be fully repairable and must be fully repaired | **TRIGGERS**:<br>• Scheduled monitoring (surface inspections of the MMBSCA Management Trails) remains compliant within condition green triggers for ground movements and effects, **and** does **not identify** any mining induced impacts, such as:<br>  ○ Visible cracking/fracturing (soil, trails, rock, etc).<br>  ○ Change in grade/heaving/buckling<br>  ○ Increased ponding<br>• Underground Mining Controls and Monitoring indicates all parameters are within design criteria / Level Green trigger levels.<br><br>**ACTIONS & RESPONSES**:<br>• No response required when above parameters are met.<br>• Continue Subsidence Monitoring Program. | **TRIGGERS**:<br>• Scheduled monitoring (surface inspections) of MMBSCA Management Trails does **not identify** any mining induced impacts (refer examples in Condition Green); however, underground monitoring or aerial monitoring systems trigger further investigation/surface inspection and/or<br>• Condition Amber for ground movements and effects is triggered (refer earlier above)<br><br>See also ***Ground Movement and Subsidence Effects Monitoring*** and ***Underground Mining Control*** elements above for related triggers/responses that require further investigation to confirm any *potential* surface impacts<br><br>**ACTIONS & RESPONSES**:<br>• Airly ECM (or delegate) to undertake targeted surface inspection of accessible access roads and trails in relevant area to confirm if any impact at surface<br>• Notify landowner i.e., NPWS<br>• **If no impacts observed**, continue Subsidence Monitoring Program<br>• **If impact observed, refer Condition Red responses.** | **TRIGGERS**:<br>• Scheduled monitoring (surface inspections of MMBSCA Management Trails) **identifies** the development of mining induced surface cracking/fracturing or deformation.<br>• Mining-induced changes in grade, heaving or buckling, increased ponding or other significant damage to MMBSCA management trails are observed during monitoring.<br>• Any of the following events occurs that would have been a dangerous incident if a person were reasonably in the vicinity at the time when the event occurred (High Potential Incidents as per Cl 124(5a) of the WHSMP Regulations 2022):<br>  ○ *a failure of ground, or of slope stability control measures*<br>  ○ *rock falls, instability of cliffs, steep slopes or natural dams, occurrence of sinkholes, **development of surface cracking** or deformations due to subsidence.*<br><br>**ACTIONS & RESPONSES**:<br>Review available data or undertake targeted surface investigations to confirm if the impact is mining-induced or related to natural surface movements or activation of a natural feature:<br>• If confirmed related to natural surface movements or activation of a natural feature, continue Subsidence Monitoring Program<br>• If confirmed mining induced impacts, Airly Mine will:<br>  ○ Notify and consult with relevant stakeholders as per requirements specified within the Extraction Plan/SMP/PSMP, Development Consent and related approvals.<br>  ○ Assess public safety risk. Consider erecting warning signs/warning tape or restricting access in immediate area.<br>  ○ Notify Resource Regulator under relevant WHS laws (i.e. for high potential incidents).<br>  ○ Take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur.<br>  ○ Implement **Adaptive Management** process as described within the Extraction Plan.<br>  ○ Cease secondary extraction in that area if appropriate (with direction from PIS[2] and DPE).<br>  ○ Investigate remedial options in consultation with relevant stakeholders (incl. NPWS and DPE). Implement suitable remedial option once agreed. |

| Aspect | Performance Criterion<br>e.g., Consent Criteria / EIS Commitments | Condition Green<br>(Operations within Predictions & Approved Impacts)<br>*Continue Operations/Monitoring as Normal* | Condition Amber<br>(Operations within Approved Impact Performance Measures but potentially exceeding predictions/designs)<br>*Review Processes & Adaptive Management as Required* | Condition Red<br>(Operations Exceed Approved Impact Performance Measures)<br>*Adaptive Management Process Fully Engaged* |
|---|---|---|---|---|
| **Biodiversity and Sensitive Vegetation:**<br><br>EEC / GDE, Threatened Species, Habitat, Aquatic Ecology | Negligible[3] Environmental Consequences to terrestrial threatened species, threatened populations, EECs and GDE's.<br><br>No significant adverse Impact predicted in the EIS. | **TRIGGERS**:<br>• Mining induced impacts to key elements are not identified by subsidence monitoring as per Subsidence Monitoring Program or routine environmental monitoring undertaken as part of separate site EMPs (including surface and groundwater, biodiversity).<br>• Underground Mining Controls and Monitoring indicates all parameters are within design criteria / Level Green trigger levels. | **TRIGGERS**:<br>• Subsidence monitoring program (underground/surface/aerial) **identifies potential for impact** at surface in the vicinity of sensitive vegetation / habitat area(s); and/or<br>• Potential Impacts to key elements are identified (but not yet confirmed if mining induced) by routine environmental monitoring (including surface flow gauging, water quality, related groundwater levels and routine biodiversity monitoring); and/or<br>• Amber Level triggers for surface water/groundwater (including alluvium) are triggered in the site Water Management Plan (Appendix D), indicating potential for Biodiversity impact requiring further monitoring/assessment. | **TRIGGERS**:<br>• **Mining induced impacts** (beyond levels approved by consent / compared to baseline are identified by:<br>  ○ Subsidence monitoring program (underground/surface/aerial); and/or<br>  ○ by investigations and actions arising from Condition Amber; and/or<br>  ○ environmental monitoring (including flow gauging, water quality and Biodiversity).<br>• Red Level triggers for surface water/groundwater (incl. Biodiversity) are triggered in the Airly Mine Water Management Plan (Appendix D); |
| | | **ACTIONS & RESPONSES**:<br>• No response required when above parameters are met.<br>• Continue Subsidence monitoring<br>• Continue Biodiversity monitoring | **ACTIONS & RESPONSES**:<br>• Review and confirm monitoring data, cross check Biodiversity monitoring data against other related environmental data and integrated subsidence monitoring and underground monitoring data;<br>• Analysis such as Analysis of Variance (ANOVA) would be performed to determine if the change meets a significance threshold. This analysis would be performed as part of a trigger investigation. An interim level of significance is benchmarked at 5% or p=0.05.<br>• Notify NPWS/OEH/BCD and relevant stakeholders of current findings and proposed approach for investigation.<br>• Implement responses as per relevant Amber Level trigger/responses above (where triggered) for surface water/groundwater elements in the Water Management Plan.<br>• Where review of underground monitoring and/or Biodiversity monitoring data indicates potential for mining-induced impact, or there is insufficient data to quantify the above, undertake targeted monitoring inspection over the relevant surface area to confirm and quantify the scale/extent/nature of potential surface impacts.<br>• Undertake further investigations as appropriate with the aim of identifying the cause of the issue. Assess need for any increase to monitoring frequency or additional monitoring where relevant.<br>• Continue monitoring program. | **ACTIONS & RESPONSES**:<br>• Undertake incident notifications immediately where material harm to the environment is threatened or caused, in accordance with Reporting and Notifications section of this management plan.<br>• **Implement Adaptive Management** process as outlined within the Extraction Plan and Master TARP.<br>• Take all necessary steps to ensure that the exceedance ceases and does not recur (including ceasing workings in relevant areas where appropriate while incident investigated)<br>• Targeted field inspection by Environment & Community Coordinator with invitation to relevant stakeholders.<br>• Monitor impact.<br>• Investigate exceedance of subsidence prediction model.<br>• Explore all remediation options and submit a report to the department outlining them<br>• Implement remediation measures to the satisfaction of the secretary.<br>• Review of mining design / predictions against mine design criteria.<br>• Identify and implement possible changes to mine design (to make more conservative) in consultation with relevant stakeholders, if necessary (e.g. undertake review of Extraction Plan).<br>• Written reporting as per Consent / relevant approvals |
| **Surface water and Groundwater** | - | - | | |
| | | ***Refer dedicated TARP within the Airly Mine Water Management Plan (Airly Mine WMP) – Appendix 1 (TARPs)*** | | |

| Aspect | Performance Criterion<br>e.g., Consent Criteria / EIS Commitments | Condition Green<br>(Operations within Predictions & Approved Impacts)<br>***Continue Operations/Monitoring as Normal*** | Condition Amber<br>(Operations within Approved Impact Performance Measures but potentially exceeding predictions/designs)<br>***Review Processes & Adaptive Management as Required*** | Condition Red<br>(Operations Exceed Approved Impact Performance Measures)<br>***Adaptive Management Process Fully Engaged*** |
|---|---|---|---|---|
| **Aboriginal and Cultural Heritage Sites** | Negligible[3] Environmental Consequences<br>*(Table 1, Condition 2 Schedule 3)* | ***No registered Aboriginal and Cultural Heritage sites located within the Extraction Plan Area.***<br>*(including within the Near-field / Principal Subsidence Management Area or the Extended/Far-field Monitoring and Management Area)*<br>*Note: Other heritage sites located elsewhere within the Airly Mine development consent area are managed under the Airly Mine Western Region Historic Heritage Management Plan, including actions for managing discovery of any new sites.* | | |
| **Historic Heritage** | Negligible[3] Environmental Consequences | ***No Historic Heritage sites are located within the Extraction Plan Area***<br>*(including within the Near-field / Principal Subsidence Management Area or the Extended/Far-field Monitoring and Management Area)*<br>*Note: Other heritage sites located elsewhere within the Airly Mine development consent area are managed under management plans previously approved for the CLZ EP Area as well as the Airly Mine Western Region Historic Heritage Management Plan, including actions for managing discovery of any new sites.* | | |

1) *By law, pillar sizes must conform to minimum requirements set by Schedule 3 (High Risk Activities), Part 3 (underground coal mines), Clause 16 (Formation of Non-Conforming Pillars) of the WHS (Mines and Petroleum Sites) Regulations 2022*
2) *PIS – Principal Inspector - Subsidence, NSW Resource Regulator (Mine Safety).*
3) *"Negligible' impact is defined by development consent SSD_5581 as "Small and unimportant, such as to be not worth considering". With respect to biodiversity monitoring specifically, for the purposes of this MW17-18 BMP negligible is defined as 'In the longer term being small and insignificant and causing little or no impact. Short term impacts may be greater than negligible but if they are of limited duration they may be negligible when considered over the longer term'.*

*Other General Notes:*

- *Detailed mine design parameters and associated subsidence predictions are provided within the EP Main Report (see Section 3)*

# APPENDIX 7 Graphical Plans for MW17-18

Appendix 7 contains graphical plans prepared in accordance with the *Extraction Plan Guideline* (DPE, 2022) and *Managing Risks of Subsidence Guideline* (NSW RR, 2017).

| | |
|---|---|
| **Plan 1** | Existing and Future Workings |
| **Plan 2** | Surface Features (Natural and Built) |
| **Plan 3** | Geological and Seam Data |
| **Plan 4** | Existing Workings in Other Seams |
| **Plan 5** | Mining Titles and Land Ownership |
| **Plan 6** | Geological Sections |
| **Plan 7** | Subsidence Monitoring |

N 6333 000

N 6332 000

N 6331 000

E 224 000

E 225 000

E 226 000

E 227 000

ML1331

ML1814

MW -13

MW -14

MW -15B

MW -17

MW -18

MW -20

MW -21

HB1

HB2

HB3a

HB3b

HB3c

HB4a

HB5b

1144.3m

914.7m

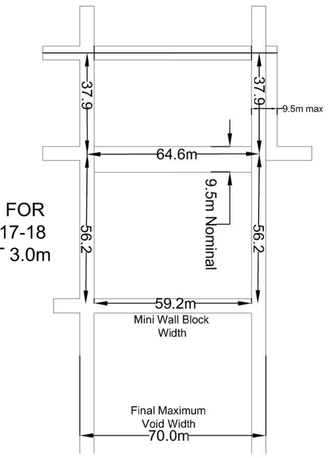
400 Panel

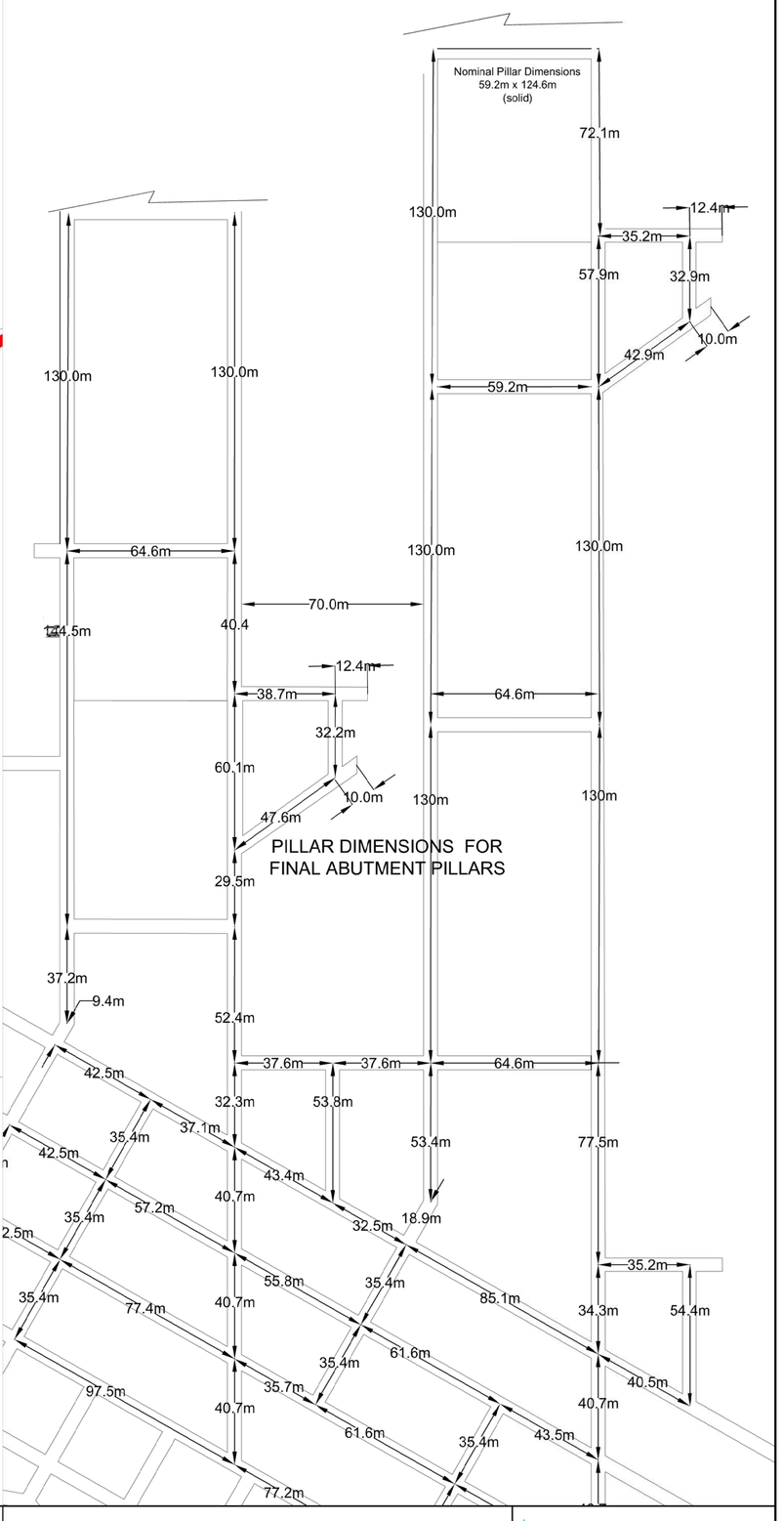
401 Panel

402 Panel

500 Panel

PILLAR DIMENSIONS FOR TYPICAL MINIWALLS 17-18 RUN OF FACE HEIGHT 3.0m




Note:
There is no area which has heightened exposure of spontaneous combustion or outburst risk

LEGEND
- EXISTING WORKINGS
- PROPOSED WORKINGS
- GRID: MGA Zone 56
- CREEK PROTECTION ZONE
- M.L. 1331 and M.L. 1814
- 26.5° OFFSET FROM TOP OF CLIFF IN THE CLIFF ZONE OF FIRST WORKINGS AS DEFINED BY AEROMETREX
- AIRLY MOD 3 EP AREA (28/07/2015)
- AIRLY MOD 3 EP VARIATION AREA (2016)
- CLIFF ZONE OF FIRST WORKINGS SSD5581
- MINI WALL EXTRACTION AREA
- Predicted 20mm Subsidence line

APPROVED BY & DATED:
Ryan Davidson 12/07/2023
Ryan Davidson- Manager of Mining Engineering
MINE OPERATOR- Centennial Airly Pty Ltd

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| | |
|---|---|
| DATE | 12/07/2023 |
| SEAM | LITHGOW |
| SCALE | 1:4000 on AO Plan |
| DRAWN | Brett Haddon |
| REVISION | 1 |
| REFERENCE | N:\Survey\1.MGA2020\PLANS\SURFACE\Extraction Plans\Geovolan 17-18 walls\Plan 1\Airly EP NPE-Extraction Geovolan - Plan 1.dwg |

# AIRLY COLLIERY- ML1331 & ML1814
## EXTRACTION PLAN - MINI WALL EXTRACTION FOR MWS 17-18
## PLAN 1- WORKINGS & DIMENSIONS

CENTENNIAL AIRLY

DRG. No. AM0 3418 | A0

N 6 333 000

N 6 332 000

N 6 331 000

E 224 000

E 225 000

E 226 000

E 227 000

E 228 000

ML1331

ML1814

ARP14
ARP13
ARP13SP
GENOWLAN CREEK 2

ARP04
ARP05

ARP09
GENOWLAN CREEK

ARP07
ARP12

ARP15SP
ARP15

ARP06

TS7138

R17
R18
R6

45-1-2768
45-1-2766
45-1-2748
45-1-0167
45-1-2743
45-1-2744
45-1-2764
45-1-2747
45-1-0127

Comms Tower

MW -13
MW -14
MW -15B
MW -17
MW -18
MW -20
MW -21

HB1
HB2
HB3a
HB3b
HB4a
HB5b
HB5c

40 Panel
400A Panel
500 Panel
401 Panel
402 Panel

ROAD
TRAIL
DOG TRAP CREEK

LEGEND

EXISTING WORKINGS
PROPOSED WORKINGS
26.5 degree Offset from top of Cliffs
20mm Subsidence Area (Predicted Limit of Impact)

ABORIGINAL SITE - ARTEFACT SCATTER
ABORIGINAL SITE - SHELTER WITH ARTEFACTS
ABORIGINAL SITE - SHELTER WITH DEPOSITS
ABORIGINAL SITE - ISOLATED FIND
ABORIGINAL SITE - SCARRED TREE
HISTORICAL HERITAGE SITE
SENSITIVE RECEPTORS

SURFACE CONTOURS (5m INTERVAL)
TELSTRA LINE
Surface drainage lines
ROADS & TRACKS
GRID: MGA Zone 56

CLIFF ZONE of First Workings SSD5581
MINI WALL EXTRACTION AREA
CREEK PROTECTION ZONE
M.L. 1331 and ML1814

AEROMETREX DEFINED Cliff Zone Cliffs Heights
AEROMETREX DEFINED Panel and Pillar Zone Cliffs Heights

APPROVED BY & DATED:
12/07/2023
Ryan Davidson- Manager of Mining Engineering
MINE OPERATOR- Centennial Airly Pty Ltd

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| | |
|---|---|
| DATE | 12/07/2023 |
| SEAM | LITHGOW |
| SCALE | 1:4000 |
| DRAWN | Brett Haddon |
| REVISION | 1 |

REFERENCE N:\Survey\1.IVGA2020\PLANS\SURFACE\Extraction Plans\Genowlan 17-18 walls\Plan 2\Airly EP MPE-Extraction Genowlan- Plan 2.dwg

# AIRLY COLLIERY- ML1331 & ML1814
## EXTRACTION PLAN - MINI WALL EXTRACTION FOR MWS 17 - 18
## PLAN 2- Surface Features

CENTENNIAL AIRLY

DRG. No. AM03419 | A0

N 6333 000

N 6332 000

N 6331 000

E 224 000

E 225 000

E 226 000

E 227 000

ML1331

ML1814

MW -13

MW -14

MW -15B

MW -17

MW -18

MW -20

MW -21

HB1

HB2

HB3a

HB3b

HB3c

400 Panel

400A Panel

3.2

3.4

3.6

LEGEND

- EXISTING WORKINGS
- PROPOSED WORKINGS
- GRID: MGA Zone 56
- M.L. 1331and M.L.1814
- 3.4 LITHGOW SEAM THICKNESS ISOPACHS
- OVERBURDEN THICKNESS ISOPACHS
- AEROMETREX DEFINED Cliff Zone Cliffs Heights
- AEROMETREX DEFINED Panel end Pillar Zone Cliffs Heights
- CLIFF ZONE OF FIRST WORKINGS SSD5581
- MINI WALL EXTRACTION AREA
- SRK GEOLOGICAL STRUCTURES (SURFACE & BASEMENT FEATURES )
- MAPPED FAULTS and JOINTS

APPROVED BY & DATED:

Ryan Davidson 12/07/2023

Ryan Davidson- Manager of Mining Engineering

MINE OPERATOR- Centennial Airly Pty Ltd

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REFERENCE N:\Survey\1.MGA2020\PLANS\SURFACE\Extraction Plans\Geocretan 17-18 walls\Plan 3\Airly EXP Mkrwatt Extraction Geocretan 17-18 Plan 3.dwg

| | |
|---|---|
| DATE | 12/07/2023 |
| SEAM | LITHGOW |
| SCALE | 1:4000 on A0 Plan |
| DRAWN | Brett Haddon |
| REVISION | 0 |

# AIRLY COLLIERY- ML1331 & ML1814
## EXTRACTION PLAN - MINI WALL EXTRACTION FOR MWS 17 -18
## PLAN 3 - GEOLOGICAL DATA

CENTENNIAL AIRLY

DRG. No. AM03420 A0

N 6333 000

N 6332 000

N 6331 000

E 224 000

E 225 000

E 226 000

E 227 000

ML1331

ML1814

HB1

HB2

HB3a

HB3b

HB3c

MW -13

MW -14

MW -15B

MW -17

MW -18

MW -20

MW -21

400 Panel

400A Panel

401 Panel

402 Panel

121 Panel

3.2

3.4

3.6

LEGEND

EXISTING WORKINGS

PROPOSED WORKINGS

GRID: MGA Zone 56

M.L. 1331and M.L.1814

3.4 LITHGOW SEAM THICKNESS ISOPACHS

OVERBURDEN THICKNESS ISOPACHS

AEROMETREX DEFINED Cliff Zone Cliffs Heights

AEROMETREX DEFINED Panel and Pillar Zone Cliffs Heights

CLIFF ZONE OF FIRST WORKINGS SSD5581

MINI WALL EXTRACTION AREA

SRK GEOLOGICAL STRUCTURES (SURFACE & BASEMENT FEATURES )

MAPPED FAULTS and JOINTS

APPROVED BY & DATED:

Ryan Davidson 12/07/2023

Ryan Davidson- Manager of Mining Engineering

MINE OPERATOR- Centennial Airly Pty Ltd

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REFERENCE N:\Survey\1 MGA2020\PLANS\SURFACE\Extraction Plans\Genoelan 17-18 walls\Plan 4-Airly EXP Mineset\ Extraction Genoelan-17-18 Plan 4.dwg

| | |
|---|---|
| DATE | 12/07/2023 |
| SEAM | LITHGOW |
| SCALE | 1:4000 on A0 Plan |
| DRAWN | Brett Haddon |
| REVISION | 1 |

# AIRLY COLLIERY- ML1331 & ML1814
## EXTRACTION PLAN - MINI WALL EXTRACTION FOR MWS 17 -18
## PLAN 4 - OTHER SEAMS

CENTENNIAL AIRLY

DRG. No. AM03421 A0

N

MURUM-BAN STATE CONSERVATION AREA

REFERENCE NOT HELD

LOT 83 DP755757

LOT 89 DP755757

LOT 90 DP755757

REFERENCE NOT HELD

LOT 121 DP755757

CROWN RESERVE FOR WATER

LOT 7001 DP1057060

LOT 4/2 DP758011

LOT 3/2 DP758011

LOT 4/1 DP758011

LOT 2/1 DP758011

LOT 5/1 DP758011

LOT 3/1 DP758011

LOT 1/1 DP758011

CROWN ROAD

CROWN ROAD RESERVE

TRAIL

CAR

ROAD

MW -13

MW -14

MW -15B

MW -17

MW -18

MW -20

MW -21

HB1

HB2

HB3a

HB3b

HB3c

HB4a

HB5b

ML1331

ML1814

TS7138

N 6 333 000

N 6 332 000

N 6 331 000

E 224 000

E 225 000

E 226 000

E 227 000

ML1331

## Schedule Of Lease

ML1331
Grant Date:12/10/1993
Renewal Date:08/05/2014
Expiry Date:12/10/2035

ML1814
Submitted:25/05/2018
Grant Date:22/07/2021
Expiry Date: 22/07/2042

LEGEND

- EXISTING WORKINGS
- PROPOSED WORKINGS
- GRID: MGA Zone 56
- ROADS & TRACKS
- TS7138 Property of the Land and Property Information (LPI)
- Telecommunications Tower compound Local Government LCC
- MINI WALL EXTRACTION AREA
- FREEHOLD LAND
- CENTENNIAL OWNED LAND
- CROWN LAND
- GARDENS OF STONE NATIONAL PARK
- MUGII MURUM-BAN STATE CONSERVATION AREA
- ML1331 and ML1814

NOTE: NATIONAL PARKS & WILDLIFE SERVICE IS LAND OWNER OF MUGII MURUM-BAN STATE CONSERVATION AREA

APPROVED BY & DATED:
12/07/2023
Ryan Davidson- Manager of Mining Engineering
MINE OPERATOR- Centennial Airly Pty Ltd

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REFERENCE N:\Survey\1.MGA2020\PLAN\SURFACE\Extraction Plans\Genovelan 17-18 walls\Plan 5Airly EXP Mini Wall Extraction Genovelan - Plan 5.dwg

| | |
|---|---|
| DATE | 12/07/2023 |
| SEAM | LITHGOW |
| SCALE | 1:4000 |
| DRAWN | Brett Haddon |
| REVISION | 1 |

# AIRLY COLLIERY- ML1331 & ML1814
## EXTRACTION PLAN - MINI WALL EXTRACTION FOR MWS 17 - 18
## PLAN 5- Mining Titles and Land Ownership

CENTENNIAL AIRLY

DRG. No. AM03440 | A0

N 6333 000

N 6332 000

N 6331 000

E 224 000

E 225 000

E 226 000

E 227 000

ML1331

ML1814

ML1331

HB1

HB2

No.2

ARP07

AYC0002

ARP06

MW -13

MW -14

MW -15B

MW -17

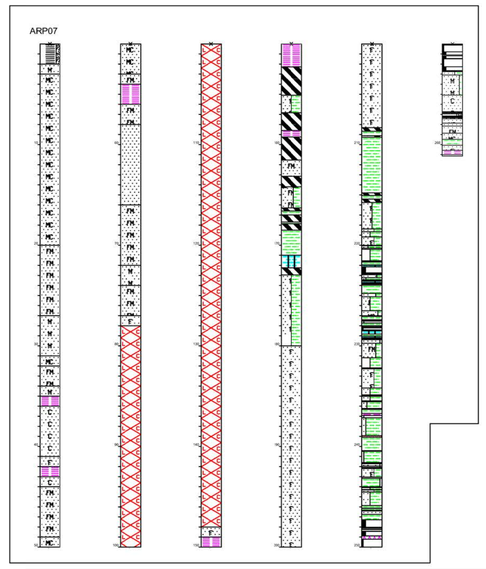
MW -18

500 Panel

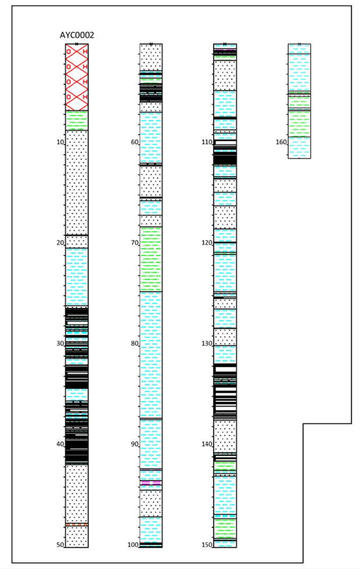
402 Panel

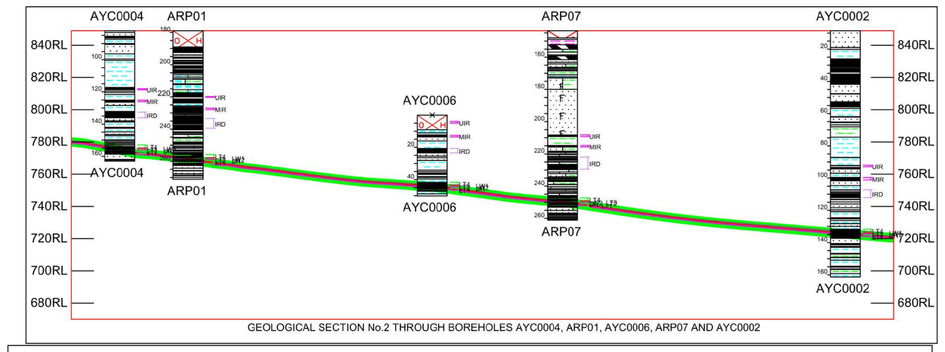
400 Panel

DETAILED GEOTECHNICAL LOG OF BOREHOLE ARP07

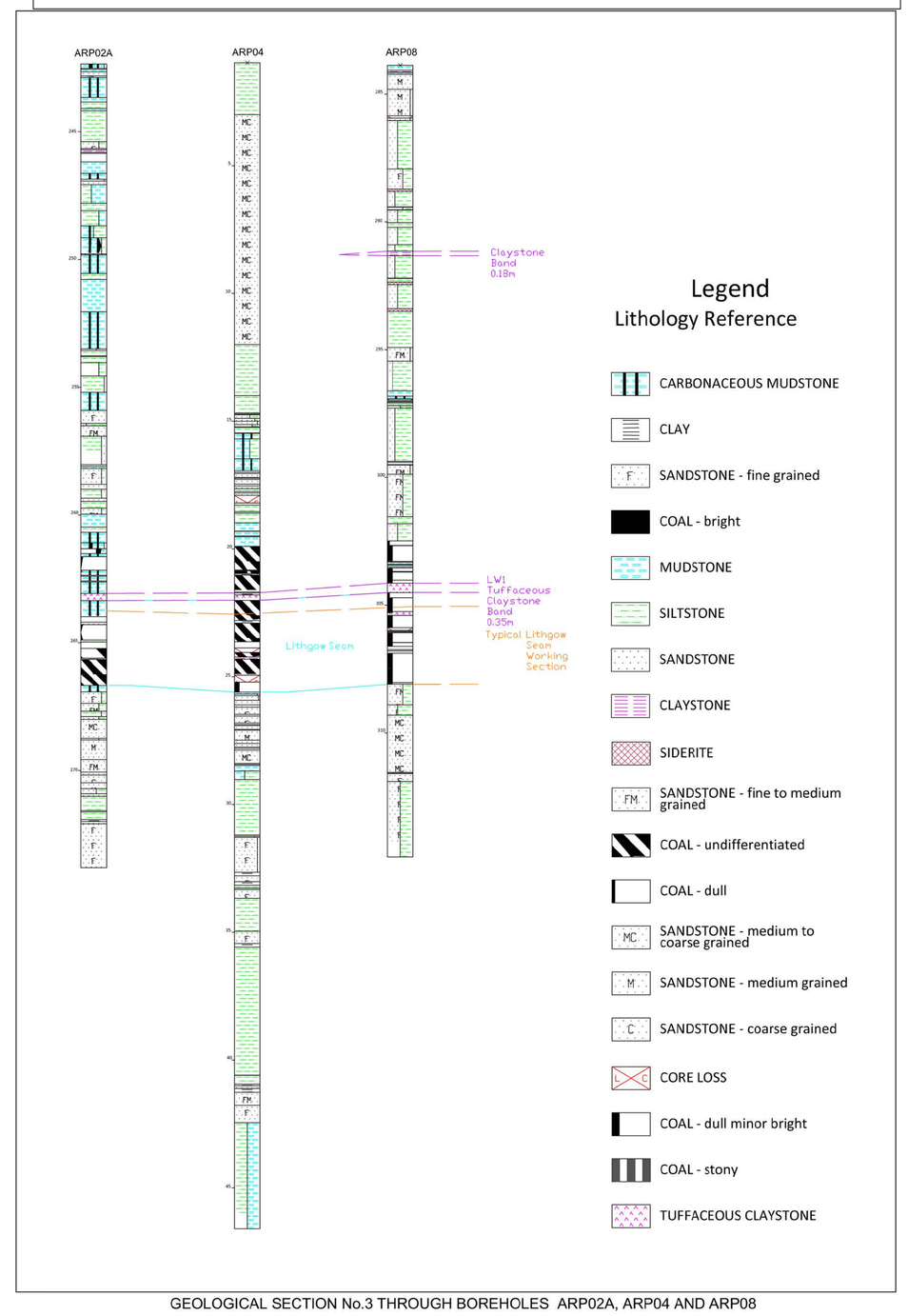



DETAILED GEOTECHNICAL LOG OF BOREHOLE AYC0002




GEOLOGICAL SECTION No.2 THROUGH BOREHOLES AYC0004, ARP01, AYC0006, ARP07 AND AYC0002




GEOLOGICAL SECTION No.3 THROUGH BOREHOLES ARP02A, ARP04 AND ARP08

LEGEND
EXISTING WORKINGS
PROPOSED WORKINGS
ARP05 Boreholes
N 6 322 000 GRID: MGA Zone 56
Predicted 20mm Subsidence line
M.L. 1331and M.L.1814
MINI WALL EXTRACTION AREA

APPROVED BY & DATED:
12/07/2023
Ryan Davidson- Manager of Mining Engineering
MINE OPERATOR- Centennial Airly Pty Ltd

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| | |
|---|---|
| DATE | 12/07/2023 |
| SEAM | LITHGOW |
| SCALE | 1:4000 on AO Plan |
| DRAWN | Brett Haddon |
| REVISION | 1 |
| REFERENCE | N:\Survey1.\MGA2020\PLANS\SURFACE\Extraction Plans\Geovoxlan 17-18 walls\Plan 6\Airly EXP Mini Wall Extration Geovoxlan- Plan 6.dwg |

# AIRLY COLLIERY- ML1331 & ML1814
## EXTRACTION PLAN - MINI WALL EXTRACTION FOR MWS 17 - 18
## PLAN 6 - GEOLOGICAL SECTIONS

CENTENNIAL AIRLY

DRG. No. AM03422 | A0

N 6334 000

N 6333 000

N 6332 000

E 223 000

E 224 000

E 225 000

E 226 000

E 227 000

ARP03

ARP02

ARP11

ARP04

ARP05

ARP08

ARP14

ARP13

ARP13SP

ARP09

ARP07

ARP12

ARP15SP

ARP15

ARP06

R17

R18

R6

GAP CREEK

GAP CREEK PROTECTION ZONE - NO MINING ALLOWED

GENOWLAN CREEK 2

GENOWLAN CREEK

THE GROTTO

TS7138

ML1331

ML1814

MW -07

MW -08

MW -09

MW -10

MW -11

MW -12

MW -13

MW -14

MW -15A

MW -15B

MW -16

MW -17

MW -18

HB1

HB2

45-1-2765

45-1-2748

45-1-2743

45-1-2742

45-1-2766

45-1-2744

45-1-2764

45-1-2747

45-1-0127

205 Panel

209 Panel

121 Panel

120 Panel

206 Panel

400 Panel

400A Panel

401 Panel

500 Panel

MALCOLMS GULLY TRAIL

GAP TRAIL

AIRLY TRAIL

DAVIS TRAIL

ROAD

45-1

LEGEND

EXISTING WORKINGS
PROPOSED WORKINGS
NEW HARTLEY SHALE MINE OLD WORKINGS
26.5 degree Offset plus 50m SETBACK / FIRST WORKINGS ONLY AREA

ABORIGINAL SITE - ARTEFACT SCATTER
ABORIGINAL SITE - SHELTER WITH ARTEFACTS
ABORIGINAL SITE - SHELTER WITH DEPOSITS
ABORIGINAL SITE - ISOLATED FIND
ABORIGINAL SITE - SCARRED TREE
HISTORICAL HERITAGE SITE
SENSITIVE RECEPTORS
MINIWALL EXTRACTION AREA

GPS-CORS and Photo Target
Proposed GPS-CORS & Photo Target
SURFACE CONTOURS (5m INTERVAL)
WATERCOURSES
26.5 degree offset from Cliffs in the Cliff zone
PREDICTED SUBSIDENCE CONTOUR 10MM MWS (13-16)
PREDICTED SUBSIDENCE CONTOUR 50MM MWS (13-16)
PREDICTED SUBSIDENCE CONTOUR 20MM MWS (13-16)

AEROMETREX
Cliff Zone
Cliffs Heights
AEROMETREX Panel and Pillar Zone
Cliffs Heights
CLIFF ZONE OF FIRST WORKINGS SSD5581

AIRLY MOD 3 EP AREA (28/07/2015)
AIRLY MOD 3 EP VARIATION AREA (2016)
CREEK PROTECTION ZONE
GRID: MGA2020 Zone 56
ROADS & TRACKS

WATER MONITORING SITE
GROUNDWATER MONITORING SITE
GROUNDWATER MONITORING SITE
M.L.1331 M.L.1814
Mt Genowlan Panel &Pillar Mining Zone EP and HRA area (Excendsd Subsidence Management & Monitoring Area)
Principal Monitoring and Management Area

APPROVED BY & DATED:

Ryan Davidson- Mining Engineering Manager

07/11/2023

Brett Haddon- Mine Surveyor

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| | |
|---|---|
| DATE | 7/11/2023 |
| SEAM | LITHGOW |
| SCALE | 1:4000 on A0 plan |
| DRAWN | Brett Haddon |
| REVISION | 0 |

REFERENCE N:\Survey\1.MGA2020\PLANS\SURFACE\Extraction Plans\X-Refs\SurfaceFeatsnand MiningZonesCombined2020.dwg

# AIRLY COLLIERY- ML1331 ML1841
## EXTRACTION PLAN - MINI WALL EXTRACTION FOR MWS 17-18
## PLAN 7 - Subsidence Monitoring

CENTENNIAL AIRLY

DRG. No. AM03541 | A0

# Attachment A

# IDENTIFICATION OF NATURAL AND BUILT FEATURES CHECKLIST

| Features | Near-field / Principal Subsidence Management Area | Far-field / Extended Subsidence Monitoring and Management Area | Comments |
|---|---|---|---|
| **Natural and Heritage Features** | | | |
| **WATER** | | | |
| Catchment areas and declared Special Areas; | × | × | |
| Rivers and creeks (including aquatic ecology); | ✓ | ✓ | There are minor ephemeral drainage lines mapped within the Project area. |
| Aquifers, known groundwater resources; | × | × | |
| Springs; | × | × | |
| Sea/lake; | × | × | |
| Shorelines; | × | × | |
| Natural dams; | × | × | |
| Any other feature considered significant. | × | × | |
| **LAND** | | | |
| Cliffs / minor cliffs; | ✓ | ✓ | The Project area contains diverse geological and geomorphological features, such as cliffs, pagoda rock formations, steep slopes, sandstone escarpments deeply incised canyons/gorges including the upper reaches of an area known as the Grotto. |
| pagodas / rock formations; | ✓ | ✓ | |
| Steep slopes; | ✓ | ✓ | |
| Escarpments; | ✓ | ✓ | |
| Land prone to flooding or inundation; | × | × | |
| National parks; | × | × | |
| State recreation areas; | ✓ | ✓ | The Project area lies within the Mugii Murum-ban State Conservation Area. |
| State forests particularly areas zoned FMZ 1, 2 and 3; | × | × | |
| Areas of significant geological interest, and | × | × | |
| Any other feature considered significant. | × | × | |
| **BIODIVERSITY** | | | |
| Swamps, wetlands, water related ecosystems; | × | × | |
| Upland swamps; | × | × | |
| Hanging swamps; | × | × | |
| Endangered Ecological Communities; | × | × | It is considered **unlikely** that EECs are present in the Project area. |
| Potential for Groundwater Dependent Ecosystems and stygofauna; | ✓ | ✓ | Facultative GDEs may occur on the edges of the Project area, Stygofauna may be present in the groundwater. |

| Features | Near-field / Principal Subsidence Management Area | Far-field / Extended Subsidence Monitoring and Management Area | Comments |
|---|---|---|---|
| Threatened and protected species; | ✓ | ✓ | One threatened flora species occurs within the EP Area; Prostanthera stricta (Mount Vincent Mint Bush; BC Act: Vulnerable; EPBC Act: Vulnerable).<br>A total of 42 threatened fauna species occur within the locality (within 10 km of the EP Area) and have habitat in the EP Area. |
| Natural vegetation; | ✓ | ✓ | The Project area was found to potentially encompass eight PCTs. Broadscale vegetation types include dry sclerophyll forest, wet sclerophyll forest and heath. |
| Fauna habitats; | ✓ | ✓ | Several key habitat features for threatened fauna are present in the Project area. |
| Any other feature considered significant. | × | × | |
| **HERITAGE** | | | |
| Aboriginal heritage sites; | × | × | Baseline assessment complete. There are no known Aboriginal heritae sites. |
| Non-Aboriginal (historic) heritage sites; | × | × | Baseline assessment complete. There are no known historic heritae sites. |
| Any other feature considered significant. | × | × | |
| **Built Features:** | | | |
| **PUBLIC UTILITIES** | | | |
| Railways; | × | × | |
| Roads (all types); | ✓ | ✓ | Four-wheel drive roads, management trails and walking tracks, in particular the Trig Trail. |
| Bridges; | × | × | |
| Tunnels; | × | × | |
| Culverts; | × | × | |
| Water/gas/sewerage pipelines; | × | × | |
| Liquid fuel pipelines; | × | × | |
| Electricity transmission lines (overhead/underground) and associated plants; | × | × | |
| Telecommunication lines (overhead/underground) and associated plants; | × | × | |
| Water tanks, water and sewage treatment works; | × | × | |
| Dams, reservoirs and associated works; | × | × | |
| Air strips, and | × | × | |
| Any other infrastructure items. | × | × | |

| Features | Near-field / Principal Subsidence Management Area | Far-field / Extended Subsidence Monitoring and Management Area | Comments |
|---|---|---|---|
| **PUBLIC AMENITIES** | | | |
| Hospitals; | × | × | |
| Places of worship; | × | × | |
| Schools; | × | × | |
| Shopping centres; | × | × | |
| Community centres; | × | × | |
| Office buildings; | × | × | |
| Swimming pools; | × | × | |
| Bowling greens; | × | × | |
| Ovals and cricket grounds; | × | × | |
| Race courses; | × | × | |
| Golf courses; | × | × | |
| Tennis courts, and | × | × | |
| Any other amenities considered significant. | × | × | |
| **FARM LAND AND FACILITIES** | | | |
| Agricultural utilisation or agricultural suitability of farm land; | × | × | |
| Farm buildings / sheds; | × | × | |
| Gas and / or fuel storages; | × | × | |
| Poultry sheds; | × | × | |
| Glass houses; | × | × | |
| Hydroponic systems; | × | × | |
| Irrigation systems; | × | × | |
| Fences; | × | × | |
| Farm dams; | × | × | |
| Wells, bores, and | × | × | |
| Any other feature considered significant. | × | × | |
| **INDUSTRIAL, COMMERCIAL AND BUSINESS ESTABLISHMENTS** | | | |
| Factories; | × | × | |
| Workshops; | × | × | |
| Business or commercial establishments; | × | × | |
| Gas and / or fuel storages and associated plants; | × | × | |
| Waste storages and associated plants; | × | × | |

| Features | Near-field / Principal Subsidence Management Area | Far-field / Extended Subsidence Monitoring and Management Area | Comments |
|---|---|---|---|
| Buildings, equipment and operations that are sensitive to surface movements; | × | × | |
| Surface mining (open cut) voids and rehabilitated areas; | × | × | |
| Mine infrastructure including tailings dams and emplacement areas, and | × | × | |
| Any other feature considered significant. | × | × | |
| **RESIDENTIAL ESTABLISHMENTS** | | | |
| Houses; | × | × | |
| Flats / Units; | × | × | |
| Caravan parks; | × | × | |
| Retirement/aged care villages; | × | × | |
| Associated structures such as workshops, garages, on-site waste water systems, water or gas tanks, swimming pools and tennis courts, and | × | × | |
| Any other feature considered significant. | × | × | |
| **OTHER BUILT FEATURES** | | | |
| Permanent Survey Control Marks; | ✓ | × | One Permanent Marks (Genowlan [P] Trig Station (TS 7138)) is located in vicinity of the finishing end of MW18 |
| Items of Architectural Significance; | × | × | |
| Any Known Future Developments; and | × | × | |
| Any Other Item of Significance. | × | × | |

# Attachment B

## RELEVANT LEGAL AND OTHER REQUIREMENTS

### for the MW17-18 Panel & Pillar Mining Zone Extraction Plan

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# 1 ADDITIONAL REQUIREMENTS OF DEVELOPMENT CONSENT CONDITIONS, EIS AND STATEMENT OF COMMITMENTS

In addition to the key specific conditions of Development Consent SSD_5581 for the preparation of Extraction Plans and supporting sub-plans **Tables Table 1.1** and **Table 1.2** below describe other relevant requirements of the consent and documentation formally comprising the EIS as defined in SSD_5581. These include (but are not limited to) Statements of Commitments from the EIS and subsequent. Responses to Submissions by Centennial, including responses to the Independent Review Panel Report.

**Table 1.1. Other Relevant Conditions of Development Consent SSD_5581**

| Clause | Requirement | Section Addressed |
|---|---|---|
| **Schedule 2** | | |
| **Condition 1** *(Obligation to minimise harm to the environment)* | In addition to meeting the specific performance measures and criteria established under this consent, the Applicant must implement all reasonable and feasible measures to prevent and/or minimise any harm to the environment that may result from the construction, operation, or rehabilitation of the development. | Extraction Plan and supporting sub-plans |
| **Condition 2** *(Terms of Consent)* | The Applicant must carry out the development<br>a) Generally in accordance with the EIS and the Mining Schedule (See Figure 3 in Appendix 2); and<br>b) In accordance with the IPRP's Report and the conditions of this consent. | Attachment B (this document), Table 1.1 and 1.2<br><br>Extraction Plan and supporting sub-plans |
| **Schedule 3** | | |
| **Condition 1** (Restrictions on Mining) | The Applicant must not carry out any second workings:<br>a) in the Panel and Pillar Extraction Zone within an angle of draw of 26.5 degrees of the crest of any cliffs identified in the Cliff Line Zone of First Workings before at least four adjacent extraction panels in the Panel and Pillar Zone beneath Mount Airly have completed;<br>b) in the Partial Pillar Extraction Zone within an angle of draw of 26.5 degrees of the toe of any cliffs identified in the Cliff Line Zone of First Workings before it has completed the Trial Mining Area in Panels 206 and 207 as shown in Appendix 11;<br>c) within an angle of draw of 26.5 degrees plus 50 metres of limit of the New Hartley Shale Mine workings. | Section 3.1 (Mine Planning and Design) |
| **Schedule 6** | | |
| **Condition 4** *(Updating and Staging of Strategies, Plans or Programs)* | …With the agreement of the Secretary, the Applicant may also submit any strategy, plan or program required by this consent on a staged basis….<br>Note: If the submission of any strategy, plan or program is to be staged, then the relevant strategy, plan or program must clearly describe the specific stage to which the strategy, plan or program applies, the relationship of the stage to any future stages, and the trigger for updating the strategy, plan or program. | Section 1.2 (Scope) |
| **Condition 5** *(Relationships between Management Plans)* | The Water, Biodiversity and Heritage Management Plans required by conditions 13, 15 and 19 of Schedule 4, respectively, are to be prepared in respect of all parts of the development that are not covered by an Extraction Plan approved under condition 7 of Schedule 3. In particular, those management plans should address all areas subject to existing or proposed surface disturbance associated with the development. | Airly Mine Water Management Plan (Appendix 1)<br>Biodiversity Management Plan for MW17-18 (MW17-18 BMP) (Appendix 3) |

| Clause | Requirement | Section Addressed |
|---|---|---|
| **Condition 6** *(Consolidation of Strategies, Plans or Programs)* | With the Approval of the Secretary, the Applicant may incorporate any strategies, plans and programs required by this consent (except those required under Condition 7, Schedule 3) with the strategies, plans or programs required for Centennial Coal's mining operations in the Lithgow Local Government Area.<br>(Centennial Note: the condition infers that management plans required for Extraction Plans cannot be 'incorporated' within Centennial's regional management plans, separate dedicated management plans must be prepared for Extraction Plans). | Extraction Plan and supporting sub-plans |
| **Condition 7** *(Adaptive Management)* | The Applicant must assess and manage development-related risks to ensure that there are no exceedances of the performance measures and/or criteria in Schedules 3 and 4.<br>….Where any exceedance of these criteria and/or performance measures has occurred, the Applicant must, at the earliest opportunity:<br>a) Take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur;<br>b) Consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action; and<br>c) Implement remediation measures as directed by the Secretary, to the satisfaction of the Secretary. | Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6) |
| **Condition 9** *(Incident Reporting)* | The applicant must immediately notify the Secretary and any other relevant agencies of any incident. Within 7 days of the date of the incident the applicant must provide the secretary and any relevant agencies with a detailed report on the incident and such further reports as may be requested. <Note: Refer SSD_5581 for definitions of incidents> | Section 5.6 (Incidents, Complaints, Exceedances and Non-compliances) |
| **Condition 10** *(Regular Reporting)* | The applicant must provide regular reporting on the environmental performance of the development on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of this consent. | Section 5.7 (Reporting and Auditing) |
| **Condition 14** *(Access to Information)* | The applicant must:<br>a) Make the following information publicly available on its website:<br>• …..Approved strategies, plans or programs required under the conditions of this consent;<br>• A comprehensive summary of the monitoring results of the development, which have been reported in accordance with the various plans and programs approved under the conditions of this consent;<br>• A complaints register, which is to be updated on a monthly basis<br>• ….The last five (5) Annual Reviews<br>• ….Any report and/or advice issued by the IEP to the Applicant in respect of a draft or approved Extraction Plan. | Section 5.7 (Reporting and Auditing) |

## Table 1.2. Relevant Requirements of the EIS, Statements of Commitment, and Supporting Documents

| Relevant Section | Requirement | Section Addressed |
|---|---|---|
| **Statement Of Commitments** *((Revised SOC Section 6 of the RTS (2015) as added to EIS Chapter 11 (Sep, 2014))* | | |
| Subsidence | All subsidence impacts to surface sensitive features are minimised. | Section 3.2 (Subsidence Predictions) |
| | Mining operations will be conducted in accordance with the design parameters and those parameters will be implemented in the areas defined in the EIS. Geotechnical reviews of first workings development prior to the commencement of any extraction that may result in surface subsidence will be undertaken on an ongoing basis. | Section 5.1 (Performance Measures and Indicators)<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6) |
| | • A new extraction plan will be developed as required by the new consent and in accordance with any requirements of the Mining Act 1992. An independent review of the geotechnical and subsidence aspects of the EIS will be undertaken prior to the development of the Extraction Plan and as part of the Response to Submissions Process.<br>• The Extraction Plan will provide detail around the management of subsidence impacts on the natural and built environment. The Plan is supported by a Subsidence Monitoring Program and consultation process. | Extraction Plan and supporting sub-plans<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| General | **Action:** Operations will be undertaken in accordance with the description provided in the EIS. (Desired Outcome: all operations are undertaken in a manner that will minimise the environmental impacts associated with the project). | Extraction Plan and supporting sub-plans |
| **Environmental Impact Statement** – Airly Mine Extension Project (Sep 2014) | | |
| Section 8.3.7.2<br>Proposed Mining Methods - Panel and Pillar Mining Zone | Mining in Panel and Pillar Mining Zone consists of highly sub-critical void widths with large interpanel chain pillars to minimise thew extent of caving above the void and allows spanning of the overburden between chain pillars. A typical panel and pillar layout is shown in Figure 8.8 (EIS). Key features of this type of mining include:<br>• Mining height: <3.0 m<br>• Maximum roadway width: ≤ 5.5 m<br>• Nominal void width: 61mPillar system FOS: ≥1.6 (after extraction is complete)<br>• Pillar width to height ratio: >9 | Section 3.1 (Mine Planning and Design)<br>Technical Report: Pillar Width Modelling (SCT, 2023) (Attachment E) |
| Executive Summary<br><br>Summary of Environmental Impacts | **Hazards Management**<br>No increased environmental or safety risk from hazardous materials, spontaneous combustion, bushfire or public safety will occur due to the Project. | Public Safety Management Plan for MW17-18 (MW17-18 PSMP) (Appendix 4) |
| Section 10.8.3.4<br>Land Use | There will be no mining impacts, including on the landforms and topography (Section 10.8.3.5), that would create a hazard to public safety or cause areas of the SCA to be closed to mining impacts. Therefore there will be no impact on the current land use for recreation. | Public Safety Management Plan for MW17-18 (MW17-18 PSMP) (Appendix 4) |
| Section 10.12.3.5<br>Page 472 | Public safety is a priority management aspect at Airly Mine. Centennial Airly recognises the proximity of the township of Capertee to Airly Mine and the mine's location within the Mugii Murum-ban SCA, and would accordingly implement procedures and controls to protect the safety of the public. | Public Safety Management Plan for MW17-18 (MW17-18 PSMP) (Appendix 4) |
| **Responses to PAC** *(December 2015)* | | |
| Recommendation 5 | All information relevant to the Independent Expert Panel's advice and recommendations is made publicly available on the Applicant's website. | Section 5.7 (Reporting and Auditing) |

| Relevant Section | Requirement | Section Addressed |
|---|---|---|
| **Centennial Responses to the IRP Report** (8 July 2016) | | |
| IRP Recommendation 1 | ***High confidence subsidence monitoring over initial panel and pillar mining areas (i.e. mini wall or partial extraction mining areas) is required to confirm the levels of ground movement are as predicted and the protection zones proposed are appropriate to provide a high level of protection to cliff formations. Initial monitoring should be conducted in areas remote from sensitive features and prior to any mining in these sensitive areas.***<br>Centennial Response Commitment:<br>Over initial panel and pillar mining areas, Centennial Airly will adopt both conventional (subsidence lines) and trial a range of non-conventional (remote sensing) subsidence monitoring methods. This will allow Centennial Airly to validate the accuracy and suitability of non-conventional subsidence monitoring methods to measure ground movements as a result of mining activities. Conventional subsidence monitoring lines will be established wherever possible in areas of existing disturbance and in consultation with the National Parks and Wildlife Service to limit impacts on the sensitive environment of the Mugii Murum-ban State Conservation Area in which Centennial Airly operates.<br>Subsidence monitoring data collected over initial panel and pillar mining areas will be used to validate and refine the existing subsidence model and predictions. Mining will progress from areas of lower surface sensitive features to areas of higher surface sensitive features. The mine design will be adapted, if required, based on results from initial subsidence monitoring results and will be refined as the mine progresses to ensure adequate protection of cliff formations and compliance with the performance measures detailed within the conditions of consent. A conceptual plan showing the progression of mining at Airly Mine from areas of lower sensitive surface features to higher sensitivity surface features is provided as an Appendix A. | Section 4 (Monitoring Program)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5) |
| IRP Recommendation 2 | ***The IRP recommend that at the Extraction Plan stage, an assessment of the likely stability of cliff formations at pinch points is included in the protection zone sizing strategy on a case by case basis to recognise the particular sensitivities of individual cliff formations, particularly cliff height and cliff geometry, to mining induced ground movements and to manage the range of other influences that can affect cliff line stability other than just vertical subsidence.***<br>Centennial Response Commitment:<br>As part of the Extraction Plan Process, Centennial Airly will include an assessment of the likely stability of cliff formations at pinch points on the protection zone sizing strategy | Stakeholder Consultation (Attachment D)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| IRP Recommendation 3 | ***A program of further work is recommended at the Extraction Plan stage to confirm the loading distributions in the vicinity of steeply dipping terrain below high cliffs where pillar splitting-and-quartering is proposed does not lead to loading conditions significantly higher than the tributary area loading used in the various assessments.***<br>Centennial Response Commitment:<br>As part of the Extraction Plan, Centennial Airly will confirm the loading distributions in the vicinity of steeply dipping terrain below high cliffs where pillar splitting-and-quartering is proposed. | **Not Applicable for current Extraction Plan** |
| IRP Recommendation 4 | ***Issues of public safety and how they will be managed in the vicinity of internal cliffs into the future does not appear to have been specifically addressed and would need to be addressed at EP stage***<br>Centennial Response Commitment:<br>As part of the Extraction Plan, Centennial Airly will develop a Public Safety Management Plan to identify management of public safety in the vicinity of internal cliffs. | Public Safety Management Plan for MW17-18 (MW17-18 PSMP) (Appendix 4) |

| Relevant Section | Requirement | Section Addressed |
|---|---|---|
| IRP Recommendation 5 | ***The IRP recommend conventional survey monitoring with high confidence far field GPS survey control over the initial three or four panels mined using the panel and pillar mining system in areas remote from sensitive features and at the greatest overburden depth that is practical, ideally greater than 250 m.***<br>Centennial Response Commitment:<br>Over initial panel and pillar mining areas, Centennial Airly will adopt both conventional (subsidence lines) and trial a range of non-conventional (remote sensing) subsidence monitoring methods. This will allow Centennial Airly to validate the accuracy and suitability of non-conventional subsidence monitoring methods to measure ground movements as a result of mining activities. Conventional subsidence monitoring lines will be established wherever possible in areas of existing disturbance and in consultation with the National Parks and Wildlife Service to limit impacts on the sensitive environment of the Mugii Murum-ban State Conservation Area in which Centennial Airly operates**.** | Section 4 (Monitoring Program)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5)<br>Stakeholder Consultation (Attachment D) |
| **Responses to IRP/IEP** *(16 July 2016)* | | |
| IRP Additional Recommendation 1 | The monitoring program should include re-surveys of subsidence across the first mined panels to confirm the significance or otherwise of potential delayed sag subsidence over narrow panels.<br>Centennial Response Commitment:<br>The number and frequency of re-surveys and the appropriate time to cease re-surveys (i.e. when subsidence is deemed to have ceased) will be determined as part of the Extraction Plan to be developed post approval. Such details would be determined in consultation with any post approval Independent Review Panel to ensure that the subsidence impact of both multiple panels and time are properly understood. | **Not Applicable for current Extraction Plan** |
| IRP Additional Recommendation 2 | ***It is recommended that early panels of each mining system are located in areas where high confidence measurements of the surface movements can be measured across multiple panels so that the ground movements can be confirmed as being <125mm within the survey tolerance.***<br>Centennial Response Commitment:<br>The panel and pillar mining system proposed will cover a wide enough area that multiple adjacent panels would be mined. Therefore it will be possible to measure the impacts of multiple panels from this mining system. Section 8.5 of the EIS and Section 8 of the associated Subsidence Impact Assessment mention that the initial mining area of Mount Airly is well suited to the installation of conventional, high confidence subsidence monitoring arrays to establish mining system performance. Airly has committed to carrying out such monitoring on Mount Airly. This would include multiple panel monitoring as well as correlations between surface movements and underground pillar stresses as well as proving the effectiveness of remote monitoring techniques.<br>As the pillar splitting and quartering (shallow zone) and partial pillar extraction systems are only practiced below the cliffs in a narrow perimeter around the outside of the mesa complex, the limited area of these workings does not allow for multiple panels to be arranged side by side. It would not be possible to measure multiple panel impacts. There are some limited opportunities to install conventional subsidence monitoring for workings below the cliffs. Airly has already installed one subsidence monitoring line over the splitting and quartering workings of the 200 Panel which is currently in the post-mining phase of measurements. A further subsidence monitoring line is currently in the approval phase. This is to be located in the area of Airly Gap over the splitting and quartering workings of the 121 panel as committed to in MOD3 of DA162/91. This will monitor from the | Section 1.3 (Extraction Plan Area)<br>Section 3.1 (Mine Planning and Design)<br>Section 4 (Monitoring Program)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5)<br>Stakeholder Consultation (Attachment D)<br>Technical Report: Pillar Width Modelling (SCT, 2023) (Attachment E)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |

| Relevant Section | Requirement | Section Addressed |
|---|---|---|
| | shallowest extremity to the base of the cliffs in that area to ascertain the movement from the planned extraction depth range of 30-110m and beyond to the base of the cliffs. | |
| IRP Additional Recommendation 3 | ***The IRP recommend monitoring strategies such as satellite interferometry is conducted across the monitoring area and adjacent areas more than once to develop confidence in the results prior to mining. Broad coverage is a strength of this system.***<br>Centennial Response Commitment:<br>Airly has already begun a baseline data collection of the entire mining lease using the Cosma Skymed X band InSAR satellite constellation with data analysis from TRE in Canada. A preliminary stack of 15 images was collected from February to June 2016 and assessed in July 2016. Some indications of movement were detected in the vicinity of the 101A panel that was being extracted at the time providing some initial indications that this technology may be applicable. TRE have indicated that a baseline of around 12-18 months of data is required to increase point density in treed areas and bring accuracy levels down to single digit millimetres. Airly Mine in currently reviewing a proposal to extend the baseline data collection for another 12 months. The ongoing subsidence monitoring program will be detailed within the Extraction Plan. A review of the adequacy of the baseline data and ongoing subsidence monitoring program should form part of the role of the post approval IRP. | Section 4 (Monitoring Program)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5)<br>Stakeholder Consultation (Attachment D) |
| IRP Additional Recommendation 4 | ***It is further recommended that mining under significant cliff lines that rely on subsidence being less than 125mm for their protection be delayed until there is monitoring experience to demonstrate that subsidence levels can be maintained at the same or similar levels to those experienced at Clarence Colliery.***<br>Centennial Response Commitment:<br>This can be accommodated in the mine plan and addressed through the post approval Extraction Plan. | Section 1.3 (Extraction Plan Area)<br>Section 3.1 (Mine Planning and Design)<br>Section 4 (Monitoring Program)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5)<br>Stakeholder Consultation (Attachment D)<br>Technical Report: Pillar Width Modelling (SCT, 2023) (Attachment E)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| IRP Additional Recommendation 5 | ***A probabilistic study to quantify the risks of sink hole formation is recommended in relation to mining in the shallow zone.***<br>Centennial Response Commitment:<br>Airly Mine already has two separate reports prepared on the subject of sink hole formation in shallow areas of the mine commissioned as part of the High Risk Activity (HRA) for mining at depths <50m required under the WHS (Mines) Regulation 2014. The risk from such an occurrence was considered to be low. A Public Safety Management Plan is in place for the current Extraction Plan under DA 162/91 that addresses management of sinkhole formation based on the assessment reports. This management plan was also accepted as adequate for the purposes of the HRA notification for shallow workings. Any need for further assessment of the risk of sinkhole formation will be addressed as part of the development of the Extraction Plan for shallow workings post approval. | **Not Applicable for current Extraction Plan** |

| Relevant Section | Requirement | Section Addressed |
|---|---|---|
| IRP Additional Recommendation 6 | ***The existing proposed setback for second workings to cliff lines in the vicinity of the New Hartley Shale Mine Potential Interaction Zone is a distance defined by half the depth of cover (or 26.5 degrees). The IRP recommend this be increased by an additional 50m (i.e. half DoC plus 50m) from the top of all significant and internal cliffs in the vicinity of the old workings.***<br>Centennial Response Commitment:<br>This can be accommodated in the mine plan and addressed through the post approval Extraction Plan. | **Not Applicable the New Hartley Shale Mine Potential Interaction Zone is not within the current Extraction Plan Area** |
| Additional Note | In addition to the (above) recommendations, it should be noted that the IRP Report does suggest that the Airly MEP proposed mine plan no longer involves pillar lifting as an extraction method (i.e. the partial pillar extraction zone). Although it is not currently proposed to undertake partial pillar extraction as originally proposed in the EIS, this mining method is still considered a potential option should it be considered appropriate. Any future use of this mining method will be considered as part of a future Extraction Plan and subject to review and consideration of any subsidence impacts by the post approval Independent Review Panel. **Not using the partial pillar extraction method would result in less impact than originally predicted in the EIS and therefore not be a significant change to the project.** The impacts to the mine plan would be as follows:<br>• **The shallow zone increase in size to move up to the maximum assessed depth of 110m;**<br>• **The Cliff Line Zone of First Workings increases in size to the slopes below the cliffs to a depth of 110m;**<br>Subsidence would reduce from the maximum predicted value of 49mm at the maximum assessed depth of 100m (table 10 Golder 2014) for single sided lifting partial pillar extraction to 25.5mm at a comparative depth for splitting and quartering with a worst case including post mining flooding. Splitting and Quartering with no post mining flooding at 110m depth is predicted to have 20mm or less subsidence (Section 7 Golder 2014 SIA). | **Not Applicable for current Extraction Plan** |

# 2 MINING LEASES

Airly Mine operates under 2 leases. ML1331 and ML1814. Approved mining authorities granted under the NSW Mining Act 1992 held for Airly Mine include Mining Lease ML1331 and ML1814.

ML1331 was renewed in May 2014 and last varied on 1 September 2022 (which came into effect on 17 October 2022) to modernise the lease conditions and align with the prescribed standard conditions in the Mining Regulation 2016, Schedule 8A, Part 2.

ML1814 was granted into effect on 22 July 2021.

# 3 WHS LAWS

**Table 3.1** below summarises key requirements of relevant Regulations under Work Health and Safety legislation applicable to mines.

In addition, the related requirements of the Managing Risks of Subsidence Guideline (NSW RR, 2017) are addressed separately in **Table 3.2**. This publication provides a summary of key provisions under the Work Health and Safety Act 2011 (WHS Act), Work Health and Safety Regulation 2011 (WHS Regulation), Work Health and Safety (Mines and Petroleum Sites) Act 2013 (WHSMP Act) and the Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 (WHSMP Regulation) as interpreted by the Department of Industry – Resources Regulator (Mine Safety) at the time of writing (February 2017).

The *Public Safety Management Plan for MW17-18 (MW17-18 PSMP)* has been prepared in general accordance with the requirements outline in **Table 3.1** and **Table 3.2** and forms the Principal Hazard Management Plan for subsidence in relation to WHS requirements for the EP Area.

**Table 3.1. Summary of Additional WHS Regulations Relating to Mine Subsidence**

| WHS Legislation Clause | Requirement | Section Addressed |
|---|---|---|
| WHS Regulation 2011<br>Clause 34 | **Duty to Identify Hazards:**<br>A duty holder, in managing risks to health and safety, must identify reasonably foreseeable hazards that could give rise to risks to health and safety. | Section 2.4 (Risk Assessment)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Extraction Plan and supporting sub-plans |
| WHS Regulation 2011<br>Clause 35 | **Managing Risks to Health and Safety:**<br>A duty holder, in managing risks to health and safety, must:<br>(a) eliminate risks to health and safety so far as is reasonably practicable, and<br>(b) if it is not reasonably practicable to eliminate risks to health and safety, minimise those risks so far as is reasonably practicable. | Section 2.4 (Risk Assessment)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Extraction Plan and supporting sub-plans |
| WHS Regulation 2011<br>Clause 36 | **Hierarchy of Control Measures:**<br>(1) This clause applies if it is not reasonably practicable for a duty holder to eliminate risks to health and safety.<br>(2) A duty holder, in minimising risks to health and safety, must implement risk control measures in accordance with this clause.<br>(3) The duty holder must minimise risks, so far as is reasonably practicable, by doing 1 or more of the following:<br>(a) substituting (wholly or partly) the hazard giving rise to the risk with something that gives rise to a lesser risk,<br>(b) isolating the hazard from any person exposed to it,<br>(c) implementing engineering controls.<br>(4) If a risk then remains, the duty holder must minimise the remaining risk, so far as is reasonably practicable, by implementing administrative controls.<br>(5) If a risk then remains, the duty holder must minimise the remaining risk, so far as is reasonably practicable, by ensuring the provision and use of suitable personal protective equipment.<br>Note. A combination of the controls set out in this clause may be used to minimise risks, so far as is reasonably practicable, if a single control is not sufficient for the purpose. | Section 2.4 (Risk Assessment)<br>Section 3.1 (Mine Planning and Design)<br>Section 4 (Monitoring Program)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Extraction Plan and supporting sub-plans |

| WHS Legislation Clause | Requirement | Section Addressed |
|---|---|---|
| WHS Regulation 2011<br>Clause 37 | **Maintenance of Control Measures:**<br>A duty holder who implements a control measure to eliminate or minimise risks to health and safety must ensure that the control measure is, and is maintained so that it remains, effective, including by ensuring that the control measure is and remains:<br>(a) fit for purpose, and<br>(b) suitable for the nature and duration of the work, and<br>(c) installed, set up and used correctly. | Section 3.1 (Mine Planning and Design)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5)<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6) |
| WHS Regulation 2011<br>Clause 38 | **Review of Control Measures:**<br>(1) A duty holder must review and as necessary revise control measures implemented under this Regulation so as to maintain, so far as is reasonably practicable, a work environment that is without risks to health or safety.<br>(2) Without limiting subclause (1), the duty holder must review and as necessary revise a control measure in the following circumstances:<br>(a) the control measure does not control the risk it was implemented to control so far as is reasonably practicable,<br>(b) before a change at the workplace that is likely to give rise to a new or different risk to health or safety that the measure may not effectively control,<br>(c) a new relevant hazard or risk is identified,<br>(d) the results of consultation by the duty holder under the Act or this Regulation indicate that a review is necessary,<br>(e) a health and safety representative requests a review under subclause (4).<br>(3) Without limiting subclause (2) (b), a change at the workplace includes:<br>(a) a change to the workplace itself or any aspect of the work environment, or<br>(b) a change to a system of work, a process or a procedure.<br>(4) A health and safety representative for workers at a workplace may request a review of a control measure if the representative reasonably believes that:<br>(a) a circumstance referred to in subclause (2) (a), (b), (c) or (d)<br>affects or may affect the health and safety of a member of the work group represented by the health and safety representative, and<br>(b) the duty holder has not adequately reviewed the control measure in response to the circumstance. | Section 2.4 (Risk Assessment)<br>Section 3.1 (Mine Planning and Design)<br>Section 4 (Monitoring Program)<br>Extraction Plan and supporting sub-plans<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6) |
| WHS Regulation (Mines and Petroleum Sites) 2022<br>Section 14 | **Management of Risks to Health and Safety (Cl 617 model WHS Regulations):**<br>(1) A person conducting a business or undertaking at a mine must manage risks to health and safety associated with mining operations at the mine in accordance with Part 3.1 of the WHS Regulations.<br>(2) A person conducting a business or undertaking at a mine must ensure that a risk assessment is conducted in accordance with this clause by a person who is competent to conduct the particular risk assessment having regard to the nature of the hazard.<br>(3) In conducting a risk assessment, the person must have regard to:<br>(a) the nature of the hazard, and<br>(b) the likelihood of the hazard affecting the health or safety of a person, and<br>(c) the severity of the potential health and safety consequences.<br>(4) Nothing in subclause (3) limits the operation of any other requirement to conduct a risk assessment under this Regulation. | Subsidence and Environmental Risk Assessment (Attachment C) |

| WHS Legislation Clause | Requirement | Section Addressed |
|---|---|---|
| | (5) A person conducting a business or undertaking at a mine (who is the mine operator of the mine or who is a contractor) must keep a record of the following:<br>(a) each risk assessment conducted under this clause and the name and competency of the person who conducted the risk assessment,<br>(b) the control measures implemented to eliminate or minimise any risk that was identified through any such risk assessment.<br>(6) A person conducting a business or undertaking at a mine is not required to keep a record of a risk assessment if:<br>(a) the risk assessment is one that an individual worker is required to carry out before commencing a particular task, and<br>(b) the person keeps a record of risk assessments that addresses the overall activity being undertaken (of which the task forms a part) such as risk assessments carried out in relation to the development of the safety management system for the mine or for a principal mining hazard management plan.<br>(7) The record kept under subclause (5) by an operator of a mine or petroleum site forms part of:<br>(a) the safety management system of a mine or petroleum site, and<br>(b) the records of the mine or petroleum site<br>(8) A record, kept under subsection (5) by a contractor who has prepared a contractor health and safety management plan, forms part of the plan | |
| WHS Regulation (Mines and Petroleum Sites) Section 15 | **Review of Control Measures (Cl 618 Model WHS Regulations):**<br>(1) A person conducting a business or undertaking at a mine must review and as necessary revise control measures implemented under clause 9 in the following circumstances:<br>(a) an audit of the effectiveness of the safety management system for the mine indicates a deficiency in a control measure,<br>(b) a worker is moved from a hazard or assigned to different work in response to a recommendation contained in a health monitoring report provided under Part 4,<br>(c) an incident referred to in section 124 occurs,<br>(d) any other incident occurs that is required to be notified to the regulator under the WHS laws.<br>(2) The mine operator of a mine must ensure that a control measure that is the subject of a request by a health and safety representative under clause 38 (4) of the WHS Regulations is reviewed and as necessary revised, whether the request is made to the mine operator or notified to the mine operator under subclause (3) by another person conducting a business or undertaking at the mine.<br>(3) A person conducting a business or undertaking at the mine who is not the mine operator of the mine must immediately notify the mine operator of a request made to the person under clause 38 (4) of the WHS Regulations.<br>(4) A health and safety representative for workers at the mine may request a review of a control measure under clause 38 (4) of the WHS Regulations as if the circumstances referred to in subclause (1) were included as a circumstance in clause 38 (4) (a) of the WHS Regulations. | Section 2.4 (Risk Assessment)<br>Section 3.1 (Mine Planning and Design)<br>Section 4 (Monitoring Program)<br>Extraction Plan and supporting sub-plans<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6) |
| WHS Regulation (Mines and Petroleum Sites)<br>27<br>*Identification of principal mining hazard* | (1) The mine operator of a mine must identify all principal mining hazards associated with mining operations at the mine.<br>(2) The mine operator must conduct, in relation to each principal mining hazard identified, a risk assessment that involves a comprehensive and systematic investigation and analysis of all aspects of risk to health and safety associated with the principal mining hazard. | Section 2.1.2 (Work, Health and Safety Laws (subsidence related))<br>Subsidence and Environmental Risk Assessment (Attachment C) |

| WHS Legislation Clause | Requirement | Section Addressed |
|---|---|---|
| *management plan* | (3) The mine operator, in conducting a risk assessment under subclause (2), must:<br>(a) use investigation and analysis methods that are appropriate to the principal mining hazard being considered, and<br>(b) consider the principal mining hazard individually and also cumulatively with other hazards at the mine. | Centennial Risk Management System – consistent with AS/NZS ISO 31000:2009<br>Independent Expert Panel (IEP) Review |
| WHS Regulation (Mines and Petroleum Sites)<br>Section 28<br>*Preparation of principal mining hazard management plan* | (1) The mine operator of a mine must consider the following when preparing a principal mining hazard management plan for a principal mining hazard at the mine in accordance with this clause and Schedule 1.<br>(2) A principal mining hazard management plan must:<br>(a) provide for the management of all aspects of risk control in relation to the principal mining hazard, and<br>(b) so far as is reasonably practicable, be set out and expressed in a way that is readily understandable by persons who use it.<br>(3) A principal mining hazard management plan must:<br>(a) describe the nature of the principal mining hazard to which the plan relates, and<br>(b) describe how the principal mining hazard relates to other hazards associated with mining operations at the mine, and<br>(c) describe the analysis methods used in identifying the principal mining hazard to which the plan relates, and<br>(d) include a record of the most recent risk assessment conducted in relation to the principal mining hazard, and<br>(e) describe the investigation and analysis methods used in determining the control measures to be implemented, and<br>(f) describe all control measures to be implemented to manage risks to health and safety associated with the principal mining hazard, and<br>(g) describe the arrangements in place for providing the information, training and instruction required by clause 39 of the WHS Regulations in relation to the principal mining hazard, and<br>(h) refer to any design principles, engineering standards and technical standards relied on for control measures for the principal mining hazard, and<br>(i) set out the reasons for adopting or rejecting each control measure considered.<br>(4) The mine operator of a mine must consider the following when preparing a principal mining hazard management plan for a principal mining hazard at the mine:<br>(a) the matters set out in Schedule 1 in respect of the principal mining hazard, and<br>(b) any other matter relevant to managing the risks associated with the principal mining hazard at the mine.<br>(5) The operator of a mine or petroleum site at which there is a principal hazard must ensure no mining operations or petroleum operations are carried out at the mine or petroleum site that may give rise to the hazard before the principal hazard management plan for the hazard has been prepared in accordance with this section. | Section 2.1.2 (Work, Health and Safety Laws (subsidence related))<br>Extraction Plan and supporting sub-plans<br>Subsidence and Environmental Risk Assessment (Attachment C) |
| WHS Regulation (Mines and Petroleum Sites)<br>70<br>*Subsidence* | (1) In complying with section 14, the mine operator of an underground coal mine must manage risks to health and safety associated with subsidence at the mine.<br>(2) Without limiting subclause (1), the mine operator must ensure that: | Section 2.4 (Risk Assessment)<br>Section 3.1 (Mine Planning and Design)<br>Section 4 (Monitoring Program) |

| WHS Legislation Clause | Requirement | Section Addressed |
|---|---|---|
| | (a) so far as is reasonably practicable, the rate, method, layout, schedule and sequence of mining operations do not put the health and safety of any person at risk from subsidence, and<br>(b) monitoring of subsidence is conducted, including monitoring of its effects on relevant surface and subsurface features, and<br>(c) an investigation of subsidence and any interpretation of subsidence information is carried out only by a competent person, and<br>(d) all subsidence monitoring data is provided to the regulator in the form and at the times required by the regulator, and<br>(e) so far as is reasonably practicable, procedures are implemented for the effective consultation, co-operation and co-ordination of action with respect to subsidence between the mine operator and relevant persons conducting any business or undertaking that is, or is likely to be, affected by subsidence | Extraction Plan and supporting sub-plans<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6) |
| WHS Regulation (Mines and Petroleum Sites)<br>Section 124<br>*Duty to notify regulator of certain incidents* | (1) The operator of a mine or petroleum site must take all reasonable steps to ensure that the regulator is notified in accordance with this clause after becoming aware of an incident (other than a notifiable incident) arising out of the carrying out of mining operations or petroleum operations at the mine or petroleum site, but only if the incident:<br>(a) results in illness or injury that requires medical treatment within the meaning of Schedule 9, Section 12 or<br>(b) is a high potential incident.<br>(6) In this section 5:<br>*high potential incident* means any of the following:<br>an indication from monitoring data of the development of subsidence which may result in any incident referred to in clause<br>190 (1) (p) - a failure of ground, or of slope stability control measures, or<br>190 (1) (q) - rock falls, instability of cliffs, steep slopes or natural dams, occurrence of sinkholes, development of surface cracking or deformations or release of gas at the surface, due to subsidence. | Section 5.6 (Incidents, Complaints, Exceedances and Non-compliances)<br>Section 5.7 (Reporting and Auditing)<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6)<br>Airly Mine Safety Management System |
| WHS Regulation (Mines and Petroleum Sites)<br>Schedule 1<br>Subsidence<br>Section 6 3C<br>*Principal hazard management plans – additional matters to be considered* | **Subsidence:**<br>The following matters must be considered in developing the control measures to manage the risks of subsidence:<br>(a) the characteristics of all relevant surface and subsurface features,<br>(b) the characteristics of all relevant geological, hydrogeological, hydrological, geotechnical, topographic and climatic conditions, including any conditions that may cause elevated or abnormal subsidence or the formation of sinkholes,<br>(c) the characteristics of any previously excavated or abandoned workings that may interact with any proposed or existing mine workings,<br>(d) the existence, distribution, geometry and stability of significant voids, standing pillars or remnants within any old pillar workings that may interact with any proposed or existing mine workings,<br>(e) the predicted and actual nature, magnitude, distribution, timing and duration of subsidence,<br>(f) the rate, method, layout, schedule and sequence of mining operations. | Extraction Plan and supporting sub-plans<br>Public Safety Management Plan for MW17-18 (MW17-18 PSMP) (Appendix 4)<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6)<br>Technical Report: Pillar Width Modelling (SCT, 2023) (Attachment E)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| WHS Regulation (Mines) 2014<br>Schedule 1<br>Clause 9 | **Subsidence:**<br>The following matters must be considered in developing the control measures to manage the risks of subsidence:<br>(a) the characteristics of all relevant surface and subsurface features, | Extraction Plan and supporting sub-plans<br>Public Safety Management Plan for MW17-18 (MW17-18 PSMP) (Appendix 4) |

| WHS Legislation Clause | Requirement | Section Addressed |
|---|---|---|
| | (b) the characteristics of all relevant geological, hydrogeological, hydrological, geotechnical, topographic and climatic conditions, including any conditions that may cause elevated or abnormal subsidence or the formation of sinkholes,<br>(c) the characteristics of any previously excavated or abandoned workings that may interact with any proposed or existing mine workings,<br>(d) the existence, distribution, geometry and stability of significant voids, standing pillars or remnants within any old pillar workings that may interact with any proposed or existing mine workings,<br>(e) the predicted and actual nature, magnitude, distribution, timing and duration of subsidence,<br>(f) the rate, method, layout, schedule and sequence of mining operations. | Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6)<br>Technical Report: Pillar Width Modelling (SCT, 2023) (Attachment E)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| WHS Regulation (Mines and Petroleum Sites)<br>Schedule 3<br>Section 17<br>*High Risk Activities* | **Secondary Extraction or Pillar Extraction, Splitting or Reduction:**<br>(1) Secondary extraction is identified as a high risk activity. The following are identified as high risk activities:<br>(a) secondary extraction by longwall mining, shortwall mining or miniwall mining,<br>(b) pillar extraction,<br>(c) pillar splitting,<br>(d) pillar reduction.<br>(2) The waiting period for any such activity is 3 months.<br>(3) The information and documents that must be provided in relation to any such activity are as follows:<br>(a) details of the authoritative sources used in determining that the proposed method of work can be done safely,<br>(b) engineering plans showing the manner and sequence of extraction, endorsed by the individual nominated to exercise the statutory function of mining engineering manager at the mine,<br>(c) information about the land above or in the vicinity of the proposed activity including land use and details of who owns or occupies any land that may be affected by subsidence,<br>(d) in the case of a pillar extraction, details of the procedures for the recovery of buried and immobile mining plant in or around a goaf,<br>(e) details of how the risks to the health and safety of workers and other persons from subsidence caused by the activity will be managed. | HRA for secondary extraction submitted separately to Extraction Plan (concurrent processes).<br>Extraction Plan and supporting sub-plans<br>Graphical Plans for MW17-18 (Appendix 7)<br>Subsidence and Environmental Risk Assessment (Attachment C) |
| WHS Regulation (Mines) 2014<br>Schedule 3<br>Section 18<br>*High Risk Activities* | **Shallow Depth of Cover Mining:**<br>(1) Mining operations in locations where the depth of cover is less than 50 metres is identified as a high risk activity.<br>(2) The waiting period for the activity is 3 months.<br>(3) The information and documents that must be provided in relation to the activity are as follows:<br>(a) an engineering drawing of the activity, endorsed by the individual nominated to exercise the statutory function of mining engineering manager at the mine,<br>(b) survey plans certified by an individual nominated to exercise the statutory function of mining surveyor at the mine,<br>(c) a geotechnical report on the activity,<br>(d) information on how the risks to the health and safety of workers and other persons from the potential formation of sinkholes will be managed. | **Not Applicable for current Extraction Plan** |

**Table 3.2: Requirements of the Managing Risks of Subsidence Guideline (WHS Mines and Petroleum Legislation), NSW Department of Industry Resources Regulator (Mine Safety), 2017**

| Referenced Section | Guideline Requirement | Where Addressed |
|---|---|---|
| Primary Duty of Care to 'Other Persons' (S1.2, S2.1) | Under Section 19 of the Work Health and Safety Act 2011 (WHS Act) all persons conducting a business or undertaking (PCBUs), including mine operators, must ensure, so far as is reasonably practicable that:<br>• all persons conducting a business or undertaking (PCBUs), including mine operators, must ensure, so far as is reasonably practicable, the health and safety of workers they engage or cause to be engaged, or whose work activities they influence or direct. | Airly Mine Safety Management System<br>Public Safety Management Plan for MW17-18 (MW17-18 PSMP) (Appendix 4) |
| | • that the health and safety **of other persons** is not put at risk from work carried out as part of the conduct of the business or undertaking. | Public Safety Management Plan for MW17-18 (MW17-18 PSMP) (Appendix 4)<br>Subsidence and Environmental Risk Assessment (Attachment C) |
| Subsidence (S1.3) | The Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 (WHSMP Regulation), defines subsidence as meaning "*the deformation or displacement of any part of the ground surface or subsurface strata caused by the extraction of minerals*". Such **deformation or displacement has potential to cause hazardous conditions, which must be controlled to ensure, so far as is reasonably practicable, that the health and safety of workers and other persons is not put at risk from subsidence.** | Public Safety Management Plan for MW17-18 (MW17-18 PSMP) (Appendix 4)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| Managing Risks of Subsidence (Overview) (S2.1); and<br>Scope of Subsidence Risk Management (S2.2) | Under clause 67(1) of the WHSMP Regulation (2014), the operator of an underground coal mine must manage risks to health and safety associated with subsidence at the mine. Clause 67(2) sets out specific requirements in relation to subsidence. | Public Safety Management Plan for MW17-18 (MW17-18 PSMP) (Appendix 4)<br>Subsidence and Environmental Risk Assessment (Attachment C) |
| Scope of Subsidence Risk Management (S2.2)<br><br>Mining Operations Where Risk Management Is Required (S2.2.1) | In defining the scope of subsidence risk management for a particular mining operation, the mine operator must consider all risks to health and safety associated with subsidence at the mine.<br>The mine operator of an underground coal mine must manage risks of subsidence due to:<br>(1) Secondary extraction by longwall mining, shortwall mining or miniwall mining<br>(2) Pillar extraction, pillar splitting or pillar reduction;<br>(3) Shallow depth of cover mining where the depth of cover is less than 50m, irrespective of first or secondary workings;<br>(4) Highwall mining; and<br>(5) Any other circumstances where underground coal mining may lead to subsidence, for example, subsidence observed above first workings as a result of excessive settlement of pillars on weak claystone floor strata. | Public Safety Management Plan for MW17-18 (MW17-18 PSMP) (Appendix 4)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |

| Referenced Section | Guideline Requirement | Where Addressed |
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| Surface and Subsurface Features Where Risk Management is Required (S2.2.2) | The surface and subsurface features refer to features which could give rise to risks to health and safety, if the features are affected by subsidence.<br>The surface and subsurface features include:<br>(1) Public utilities (e.g. highways, railways, tunnels, bridges, air strips, electrical transmission infrastructure or pressurised gas pipelines),<br>(2) Public amenities (e.g. shopping centres, hospitals, churches, sport facilities, child care centres or schools),<br>(3) Built features other than public utilities and amenities (e.g. dwellings, factories, workshops, privately owned gas storages or surface mining voids or facilities), and<br>**(4) Natural features (e.g. cliffs, steep slopes, natural caves or dams or surface of land), where subsidence may result in hazardous conditions due to instability of rock or soil masses, rock falls, landslide, fractures, sinkholes, inundation, gas release or pollution of drinking water.** | Extraction Plan and supporting sub-plans<br>Public Safety Management Plan for MW17-18 (MW17-18 PSMP) (Appendix 4)<br>Subsidence and Environmental Risk Assessment (Attachment C) |
| Area Requiring Risk Management (S2.2.3) | **The area requiring risk management is defined by the areal distribution of relevant and appropriate components of subsidence.** For example, the use of the vertical displacement may not be relevant and appropriate to define an area if the risks from the development of horizontal displacement need to be managed. In practice, the areal distribution of horizontal displacement can be noticeably different from the vertical displacement.<br>When defining the area where risk management is required, consideration should be given to any factors that may cause the development of far-field subsidence, such as:<br>(1) Overlying or underlying mine workings, in particular, old pillar workings,<br>(2) Topographic characteristics of the land,<br>(3) Nature and magnitude of horizontal stress field,<br>(4) Geological structures, and<br>(5) Complexities or anomalies in overburden geological or geotechnical conditions.<br>The intensity of risk management across the area may vary depending on the nature, likelihood, potential consequences and complexity of subsidence hazards at any particular location within the area where risk management is required. | Extraction Plan and supporting sub-plans<br>Public Safety Management Plan for MW17-18 (MW17-18 PSMP) (Appendix 4)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| Period Requiring Risk Management (S2.2.4) | The **period requiring risk management is defined from the onset of subsidence to a point in time when risks of subsidence have become negligible to the health and safety of people.**<br>The definition should be made based on relevant and appropriate components of subsidence. For example, the period requiring risk management for bridges affected by subsidence may need to be defined by considering valley closures and horizontal displacement, which may commence earlier and finish later than vertical subsidence.<br>**When defining the period of risk management, consideration should be given to any factors that may cause the development of long-term subsidence or delayed subsidence, such as:**<br>(1) Overlying or underlying mine workings, in particular, old pillar workings,<br>(2) Topographic characteristics of the land,<br>(3) Nature and magnitude of horizontal stress field,<br>(4) Geological structures,<br>(5) Climate conditions,<br>(6) Water in the mine workings, and<br>(7) Complexities or anomalies in overburden, roof or floor geological or geotechnical conditions, in particular, the nature and existence of | Section 3.1 (Mine Planning and Design)<br>Section 4 (Monitoring Program)<br>Extraction Plan and supporting sub-plans<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F), including unconventional subsidence assessment among others<br>Subsidence Monitoring Program for MW17-18 |

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| | claystone in the floor or roof strata, which have a potential for strength deterioration over time.<br>The intensity of risk management may vary depending on the nature, likelihood, potential consequences and complexity of subsidence hazards at any particular time during the period requiring risk management. | (MW17-18 SMP) (Appendix 5)<br>Public Safety Management Plan for MW17-18 (MW17-18 PSMP) (Appendix 4) |
| Identification and Understanding of Subsidence Hazards (S2.3) | Under clause 34 of the WHS Regulation, a duty holder, including the mine operator, must identify all reasonably foreseeable hazards that could give rise to risks to health and safety.<br>To understand the identified subsidence hazards, **the scope of investigation and analysis should include:**<br>(1) The nature of the hazards, including their magnitude, location, distribution, timing and duration,<br>(2) The likelihood of the hazards affecting the health or safety of a person, and<br>(3) The severity of the potential health and safety consequences.<br>When identifying, investigating and analysing subsidence hazards, the mine operator should consider the matters set out in sections 2.3.1 to 2.3.4 below | Section 3.1 (Mine Planning and Design)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| Factors Affecting Subsidence Hazards (S2.3.1) | The **following factors should be considered when identifying, investigating and analysing subsidence hazards:**<br>(1) The **characteristics of all relevant surface and subsurface features** as set out in section 2.2.2 above, including any known future developments (e.g. sub-divisions or other improvements) within the area where risk management is required,<br>(2) The **characteristics of the mining operation**, including the rate, method, layout, schedule and sequence of mining operations, the thickness of the seam to be mined, extraction height and cover depth,<br>(3) The **characteristics of any previously excavated or abandoned workings that may interact** with any proposed or existing mine workings,<br>(4) The existence, distribution, geometry and stability of significant voids, standing pillars or remnants within any old pillar workings that may interact with any proposed or existing mine workings (for further details, refer to section 2.3.3.2 below),<br>(5) The **characteristics of all relevant geological, hydrogeological, hydrological, geotechnical, topographical and climatic conditions** of the area **where risk management is required**, including the structural, lithological and geotechnical characteristics of the overburden, inter-burden, floor and roof strata,<br>(6) The characteristics of any conditions that may cause elevated or abnormal subsidence or formation of sinkholes (for further details, refer to section 2.3.3 below), and<br>(7) The predicted and actual nature, magnitude, location, distribution, timing and duration of subsidence. | Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F), including specific assessment of uncertainty aspects |
| Uncertainty (S2.3.2) | Uncertainty has the potential to lead to an incomplete, inaccurate, inappropriate or a lack of understanding of subsidence hazards. Consequently, this may affect the basis on which risk control measures will be developed and selected.<br>Generally, uncertainty occurs as a result of:<br>(1) The inherent variations and complexities of the environment within which subsidence risk management takes place. This is often the case where very large volume of heterogeneous rock/soil masses containing numerous geological structures and other discontinuities are deformed as a result of underground coal mining operations,<br>(2) The assumptions used during investigations, analysis or risk assessments, or<br>(3) Available information that: | Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F), including specific assessment of uncertainty aspects |

| Referenced Section | Guideline Requirement | Where Addressed |
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| | (a) is partial,<br>(b) is vague,<br>(c) consists of an unknown level of accuracy or reliability,<br>(d) is variable or subject to different interpretations,<br>(e) is conflicting or inconsistent,<br>(f) involves factors whose relationship or interaction is unknown,<br>(g) involves a range of possibilities, or<br>(h) changes over time.<br>The characteristics of the above-mentioned information are due to the inherent variations and complexities described above and the nature of subsidence engineering, which often requires input from:<br>(1) Multiple engineering or science disciplines,<br>(2) Multiple organisations or stakeholders, or<br>(3) Multiple phases of investigations with varying qualities.<br>Uncertainty is a significant matter when managing risks to health and safety associated with subsidence. It is important to specifically address any uncertainties when managing risks to health and safety associated with subsidence. For further guidance, refer to sections 2.5.3 and 2.7 of this guideline. | |
| Specific Subsidence Issues (S2.3.3) | The specific subsidence issues refer to **conditions that may cause elevated or abnormal subsidence, which may result in an unplanned event that causes harm to people**. For example, subsidence that occurs earlier or later than predicted could result in a hazardous condition where no risk control measures have been implemented.<br>Abnormal subsidence means the development of subsidence that is:<br>(1) Different from the predicted nature (e.g. tension or compression), magnitude, location, distribution, timing or duration of subsidence, or<br>(2) Difficult to predict or unexpected in terms of the nature (e.g. tension or compression), magnitude, location, distribution, timing or duration of subsidence.<br>Based on the current industry experience and knowledge, sections 2.3.3.1 to 2.3.3.9 of this guideline provide a non-exhaustive list of situations where there is a potential for the development of abnormal subsidence.<br>The **mine operator should ensure that hazard identification, investigation and analysis consider any situation (including the situations set out in sections 2.3.3.1 to 2.3.3.9 below, if relevant**), where there is a potential for the development of abnormal subsidence.<br>Specific considerations in risk control (see sections 2.5.3 and 2.7 below) are also necessary in these situations (including those set out in sections 2.3.3.1 to 2.3.3.9 below, if relevant) to ensure that the risk management system is capable of responding to any changes in an adequate and timely manner. | Section 3.1 (Mine Planning and Design)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| | **Long Term or Delayed Subsidence (S2.3.3.1):**<br>Risk management of long-term subsidence or delayed subsidence is difficult due to **uncertainty in the timing and duration of the risks**. This is one of the important factors causing the unplanned subsidence impacts previously observed in NSW. The occurrence of either long-term or delayed subsidence is **determined by the long-term stability of first workings** or partially extracted workings, if these workings are not properly designed taking into consideration the site conditions.<br>Where the long-term stability of first workings or partially extracted workings is required for the protection of surface or subsurface features, the **mine operator should ensure the hazards of long-term subsidence or delayed subsidence are adequately identified and assessed taking into consideration:**<br>(1) The relevant mine design parameters, such as the layout of mine workings and the geometry and strengths of pillars, | Section 3.1 (Mine Planning and Design)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |

| Referenced Section | Guideline Requirement | Where Addressed |
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| | (2) The presence and characteristics of water affecting the strata surrounding the mine workings,<br>(3) The structural, lithological and geotechnical characteristics of the overburden, inter-burden, floor and roof strata, in particular, any claystone units in the floor or roof that have a potential for strength degradation when affected by water ingress into the fabric of rocks, and<br>(4) Any conditions that may cause increased loading on the pillars or changes to the stress environment surrounding the mine workings, for example, interactions with the adjacent old workings or the presence of any spanning massive strata in the roof or overburden | |
| | **Multi-Seam Mining Involving Old Pillar Workings (S2.3.3.2):**<br>In the context of managing the risks of subsidence, the old pillar workings refer to:<br>(1) Any overlying old pillar workings, and<br>(2) Certain underlying old pillar workings, which are located within the influence of the stresses induced by any proposed or existing mine workings.<br>The interactions of the old pillar workings with any proposed or existing mine workings have a potential to cause:<br>(1) Far-field subsidence,<br>(2) Elevated subsidence,<br>(3) Irregular distribution of subsidence, or<br>(4) Elevated strains, tilts and curvature resulting from the above-mentioned irregular distribution of subsidence.<br>The hazard identification, investigation and analysis should consider the existence, distribution, geometry and stability of significant voids, standing pillars or remnants within any old pillar workings that may interact with any proposed or existing mine workings. | Section 3.1 (Mine Planning and Design)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| | **Multi-seam mining involving previously extracted longwalls (S2.3.3.3)** | **Not Applicable**<br>No previous longwall mining in EP Area (or beyond) |
| | **Massive Strata (S2.3.3.4):**<br>Depending on the mechanical strengths and geometrical attributes of the massive strata in relation to the characteristics of the mine layout design, the presence of the massive strata in the roof or overburden has a potential to cause:<br>(1) Reduced subsidence,<br>(2) Far-field subsidence,<br>(3) Complicated loading conditions on pillars,<br>(4) Irregular or abrupt distribution of subsidence, or<br>(5) Elevated strains, tilts and curvature resulting from the irregular or abrupt distribution of subsidence.<br>The reduced subsidence may be of benefit if the mine layout can be appropriately designed in relation to the mechanical and geometrical attributes of the massive strata in the roof or overburden. However, the other above-mentioned effects will cause difficulty or uncertainty in risk management. For example, it will be difficult or impossible to predict the strains or tilts associated with the irregular or abrupt distribution of subsidence. | Section 3.1 (Mine Planning and Design)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| | **Creek Crossings, Valleys or Gorges (S2.3.3.5):**<br>Underground coal mining beneath or in the vicinity of creek crossings, valleys or gorges, irrespective of their steepness, has a potential to cause:<br>(1) Valley closure, and | Section 3.1 (Mine Planning and Design)<br>Subsidence and Environmental Risk |

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| | (2) Upsidence of the valley floor.<br>Valley closure and upsidence may develop outside the normal distribution limit of the vertical displacement.<br>Any built features or public utilities (e.g. bridges or high pressurised gas pipelines) that are located across or on the floor of these topographic features may be subject to elevated and complicated stress conditions that may exceed their design capacities for managing risks to health and safety.<br>Creek crossings, valleys or gorges are sometimes surface expressions of geological structures (e.g. faults). In these cases, specific considerations in risk control (see sections 2.5.3 and 2.7 below) are important as it may be difficult to understand the nature of the risks prior to the development of subsidence. | Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| | **Steep Topography (S2.3.3.6):**<br>Underground coal mining in areas with steep topography has a potential to:<br>(1) Cause tensile strains on the hill tops or along the valley sides, resulting in hazardous conditions such as damage to built features, rock falls or slope instability,<br>(2) Contribute to the development of valley closure, or<br>(3) Contribute to the development of upsidence of the valley floor.<br>The complex effects of steep topography on subsidence development are not at present commonly considered across the coal mining industry. As a result, there is a potential for unplanned events when undertaking underground coal mining in areas with steep topography. The effects of steep topography on subsidence development should be considered by the mine operator as part of the hazard identification, investigation and analysis. | Section 3.1 (Mine Planning and Design)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| | **Geological Features (S2.3.3.7):**<br>Geological structures, in particular, faults, folds, sills or dykes, are one of the most important factors causing the development of abnormal subsidence. The hazard identification, investigation and analysis should consider the geological structures on both regional and local scales, as relevant | Section 3.1 (Mine Planning and Design)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| | **Sinkhole Formations (S2.3.3.8):**<br>Sinkholes, or potholes, are the most hazardous form of subsidence because:<br>(1) Their impacts on any affected surface or subsurface features are likely to occur rapidly or abruptly,<br>(2) Any surface or subsurface features located within the areas affected by a sinkhole are likely to be severely damaged resulting in hazardous conditions, and<br>(3) It is difficult to predict or monitor the timing of the impact of sinkhole formation.<br>In NSW, sinkholes have generally been observed above partially extracted workings, including first workings, under the depth of cover generally less than 50 metres. The geological, geotechnical, hydrogeological and climatic conditions are known to be the important factors for sinkhole formation, which should be considered as part of the hazard identification, investigation and analysis | **Not Applicable to current EP Area.**<br>Minimum Depth of Cover is >50m |
| | **Shear Strain (S2.3.3.9):**<br>Shear strain is one of the components of deformation. However, shear strain has not been recognised in the conventional subsidence engineering theories and the coal mining industry has not commonly considered it when managing risks of subsidence. Therefore, it has a potential to cause unplanned events. | Section 3.1 (Mine Planning and Design)<br>Subsidence and Environmental Risk Assessment (Attachment C) |

| Referenced Section | Guideline Requirement | Where Addressed |
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| | In recent years, investigations have established evidence that shear strain is an inherent component of subsidence. The investigations have also shown that shear strain is a significant factor that causes damage to dwellings or other built structures in areas with deep cover depths, where the conventional horizontal strains may otherwise indicate a low level of risks. Shear strain should be considered as part of the hazard identification, investigation and analysis | Technical Report: Pillar Width Modelling (SCT, 2023) (Attachment E)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| Procedures and Outcomes (S2.3.4) | Under clause 67(2)(c) of the WHSMP Regulation, the mine operator of an underground coal mine must ensure that any investigation of subsidence and any interpretation of subsidence information are carried out only by a competent person<br>The mine operator of an underground coal mine should identify, investigate and analyse all reasonably foreseeable subsidence hazards by considering the matters set out in sections 2.3.1 to 2.3.3 above (as relevant), as well as any other relevant site-specific factors associated with subsidence at the mine. | |
| | The outcomes of the subsidence hazard identification, investigation and analysis should detail:<br>(1) The mine operator's understanding of all identified subsidence hazards, including:<br>(a) The nature of the hazards, including their magnitude, location, distribution, timing and duration,<br>(b) The likelihood of the hazards affecting the health or safety of a person, and<br>(c) The severity of the potential health and safety consequences,<br>(2) Any limitations and assumptions used in the investigation and analysis,<br>(3) Any identified site-specific factors that have a potential to cause the development of abnormal subsidence, and<br>(4) Any identified site-specific factors that may cause uncertainty which may potentially lead to incomplete, inaccurate, inappropriate or even a lack of understanding of subsidence hazards.<br>Importantly, the mine operator should consider the above-mentioned details (see items (1) to (4) above) when:<br>(1) Developing risk scenarios to manage uncertainty (refer to section 2.5.3 below),<br>(2) Managing change and continual improvement to risk management (refer to section 2.7 below), or<br>(3) Designing the subsidence monitoring program (refer to section 2.9 below). | Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| Assessment of Risks of Subsidence (S2.4) | Under clause 9(2) of the WHSMP Regulation, a PCBU at a mine, including the mine operator, must ensure that a risk assessment is conducted in accordance with clause 9 by a person who is competent to conduct the particular risk assessment having regard to the nature of the hazard. | Subsidence and Environmental Risk Assessment (Attachment C) |
| | In conducting a risk assessment, the mine operator **should have regard to the outcomes of subsidence hazard identification, investigation and analysis as set out in section 2.3.4 above**. | Section 3.1 (Mine Planning and Design)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |

| Referenced Section | Guideline Requirement | Where Addressed |
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| | The participation in subsidence risk assessment by the stakeholders, such as authorities or operators of public utilities or amenities, is essential to ensure the validity and adequacy of the risk assessment. Further guidance on consultation, co-operation and co-ordination is provided in section 2.8 of this guideline. | Subsidence and Environmental Risk Assessment (Attachment C)v |
| | In undertaking a risk assessment, the mine operator may refer to the relevant publications, such as AS/NZS ISO 31000:2009 and SA/SNZ HB 436:2013, and specific standards adopted by stakeholders. | Subsidence and Environmental Risk Assessment (Attachment C) |
| | Under clause 9(5) of the WHSMP Regulation, the mine operator (or a PCBU at a mine, who is a contractor) must keep a record of the following:<br>(1) Each risk assessment conducted and the name and competency of the person who conducted the risk assessment, and<br>(2) The control measures implemented to eliminate or minimise any risk that was identified through any such risk assessment.<br>However, under clause 9(6) of the WHSMP Regulation, a PCBU at a mine is not required to keep a record of the risk assessment if:<br>(a) the risk assessment is one that an individual worker is required to carry out before commencing a particular task, and<br>(b) the person keeps a record of risk assessments that addresses the overall activity being undertaken, such as risk assessments carried out in relation to the development of the safety management system (SMS) or for a PHMP. | Subsidence and Environmental Risk Assessment (Attachment C) |
| Development & Selection of Risk Control Measures (S2.5) | In complying with Part 3.1 of the WHS Regulation, the mine operator must develop and implement risk control measures that:<br>(1) Eliminate risks to health and safety so far as reasonably practicable; and<br>(2) If it is not reasonably practicable to eliminate risks to health and safety - minimise those risks so far as is reasonably practicable.<br>The various ways of controlling risks can be ranked from the highest level of protection and reliability to the lowest. This is referred to as the hierarchy of control measures.<br>The mine operator must apply the hierarchy of control measures to manage the risks to health and safety in accordance with clause 36 of the WHS Regulation. | Subsidence and Environmental Risk Assessment (Attachment C) |
| | When applying the hierarchy of control measures to manage the risks of subsidence, the mine operator should consider:<br>(1) All possible risk control measures for the identified subsidence hazards (refer to sections 2.3 and 2.4 above), and<br>(2) The underground coal mine, including the rate, method, layout, schedule and sequence of mining operations, as one of the available risk control measures pursuant to clause 67(2)(a) of the WHSMP Regulation. For more information, refer to section 3.5.1 and Appendix A of this guideline. The mine operator should work through the hierarchy to ensure that the most effective and reliable risk control measures are developed and selected for implementation. | Subsidence and Environmental Risk Assessment (Attachment C) |
| Selection of Risk Control Measures to be Implemented Before or During Subsidence Development (S2.5.2) | There are primarily two different methods to control the risks of subsidence, namely:<br>**Method A** – Selection of risk control measures to be implemented prior to the development of subsidence, and<br>**Method B** – Selection of risk control measures to be implemented during the development of subsidence. The risk control measures should be implemented in a timely manner in response to the results of monitoring and consultation with stakeholders. A trigger action response plan (TARP) is commonly used by the underground coal mining industry for this method. | Section 3.1 (Mine Planning and Design)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6) |

| Referenced Section | Guideline Requirement | Where Addressed |
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| Control Measures for Risk Scenarios (S2.5.3) | Where there is uncertainty about a subsidence hazard with potentially severe health and safety consequences, it is important to prepare for potential variations in the nature and likelihood of the hazard. The mine operator should establish relevant risk scenarios so that there is preparedness for change, instead of adopting a single management strategy. Effective and reliable risk control measures should be developed and selected for each of the risk scenarios in accordance with section 2.5.1 of this guideline.<br>A contingency plan should be developed and used to implement the risk control measures selected for the risk scenarios, if changes identified by monitoring and stakeholder consultation warrant such implementation. | Section 4 (Monitoring Program)<br>Section 5.1 (Performance Measures and Indicators)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6) |
| Implementation and Maintenance of Risk Control Measures – General (S2.6.1) | Under clause 37 of the WHS Regulation, a duty holder, including a mine operator, who implements a control measure to eliminate or minimise risks to health and safety must ensure that the control measure is, and is maintained so that it remains, effective, including by ensuring that the control measure is and remains:<br>(1) Fit for purpose, and<br>(2) Suitable for the nature and duration of the work, and<br>(3) Installed, set up and used correctly.<br>When implementing and maintaining the risk control measures developed in accordance with sections 2.5.1 to 2.5.3 above, the mine operator should:<br>(1) Ensure that the risk control measures are installed, set up and used correctly in terms of:<br>(a) their design specification,<br>(b) operational requirements, and<br>(c) location, timing and duration of implementation or maintenance,<br>(2) Ensure that it is feasible to implement and maintain the risk control measures having regard to:<br>(a) site-specific conditions (e.g. land access to implement and maintain the risk control measures,<br>(b) the weather, in particular, adverse weather conditions,<br>(c) availability of technologies,<br>(d) availability of resources, and<br>(e) availability of time to complete the implementation and maintenance,<br>(3) Have a defined schedule to implement and maintain the risk control measures,<br>(4) Define the accountability of the competent person who implements and maintains the risk control measures,<br>(5) Measure the progress of implementation and maintenance against the development of subsidence to ensure timely completion of the implementation and maintenance of risk control measures,<br>(6) Ensure that the implementation and maintenance of one group of risk control measures do not adversely affect the functionality and effectiveness of other groups of risk control measures,<br>(7) Monitor the risk control measures to ensure that they remain effective (refer to section 2.9.1 below),<br>(8) Maintain the risk control measures so that they remain effective,<br>(9) Rectify any failures, malfunctions, defects or deterioration of the implemented risk control measures, and<br>(10) Ensure preparedness for change through the implementation of a contingency plan (refer to section 2.5.3 above) so that the risk control remains effective on an on-going basis. | Section 3.1 (Mine Planning and Design)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5)<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6) |

| Referenced Section | Guideline Requirement | Where Addressed |
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| Trigger Action Response Plan (TARP) (S2.6.2) | A TARP should be put in place only after a risk assessment has verified the selection of the most effective control measures. In managing the risks of subsidence, a TARP may be used where:<br>(1) There is a gradual and slow deteriorating trend in the development of subsidence,<br>(2) The surface and subsurface features have defined tolerances for subsidence, against which certain triggers can be established and used, and<br>(3) It is feasible to implement the selected risk control measures in a timely manner to control the risks during the development of subsidence. | Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6) |
| Continual Improvement & Change Management (S2.7) | This section of the guideline is particularly relevant where there is a high level of uncertainty about the nature and likelihood of a subsidence hazard with potentially severe health and safety consequences. | Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| | During the development of subsidence, the mine operator should:<br>(1) Gain an improved understanding of subsidence hazards through:<br>(a) on-going subsidence monitoring and reviews (refer to section 2.9 below),<br>(b) additional investigations and assessments, as necessary,<br>(c) on-going verification of the risk assessments previously conducted,<br>(d) on-going verification of the assumptions used during the subsidence hazard identification, investigation, analysis and risk assessment previously conducted, and<br>(e) on-going update of relevant subsidence and geological database for the underground coal mine, | Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5) |
| | (2) Revise risk control measures in response to an improved understanding of subsidence hazards through:<br>(a) on-going testing and verification of the effectiveness and reliability of the implemented risk control measures,<br>(b) applying the hierarchy of control measures to select the most effective risk control measures, as necessary,<br>(c) implementing additional risk control measures or modifications to the existing risk control measures, as necessary, and<br>(d) modifying the rate, method, layout, schedule and sequence of mining operations, as necessary, | Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5) |
| | (3) Regularly consult with stakeholders in relation to managing the risks of subsidence (refer to section 2.8 below), | Section 2.6 (Consultation)<br>Stakeholder Consultation (Attachment D) |
| | (4) Ensure on-going detection of early warnings of changes from the results of risk assessments to facilitate corrective or proactive management actions or the commencement of emergency procedures in a timely manner, and | Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5)<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6) |

| Referenced Section | Guideline Requirement | Where Addressed |
|---|---|---|
| | (5) Ensure timely implementation of a contingency plan in the event that the implemented risk control measures are not effective. This contingency plan needs to be established taking into consideration the risk scenarios as discussed in section 2.5.3 of this guideline | Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6) |
| Consultation, Co-operation, and Co-ordination (S2.8) | Under clause 67(2)(e) of the WHSMP Regulation, "the mine operator must ensure that so far as is reasonably practicable, procedures are implemented for the effective consultation, co-operation and co-ordination of action with respect to subsidence between the mine operator and relevant persons conducting any business or undertaking that is, or is likely to be, affected by subsidence". | Section 2.6 (Consultation)<br>Stakeholder Consultation (Attachment D) |
| | The procedures for consultation, co-operation and co-ordination of action with respect to subsidence should include:<br>(1) A process for identifying stakeholders, such as authorities or operators responsible for public utilities or amenities or owners or operators of an industrial or commercial establishment, who may be affected by subsidence, | Section 2.6 (Consultation)<br>Stakeholder Consultation (Attachment D) |
| | (2) A mechanism to undertake and record regular consultation between the mine operator and stakeholders during subsidence risk management. The following questions should be addressed during the consultation:<br>(a) have all subsidence hazards been identified?<br>(b) is the mine operator's understanding of subsidence hazards still current and correct?<br>(c) have the implemented risk control measures been working effectively?<br>(d) are the risks of subsidence being adequately managed?<br>(e) have there been any early warnings of changes from the results of risk assessments, which warrant corrective or proactive management actions or the commencement of emergency procedures?<br>(f) have any incidents of subsidence occurred and what is the learning from the investigations of these incidents?<br>(g) should the implemented risk control measures be revised according to the results of subsidence monitoring and review? | Section 2.6 (Consultation)<br>Section 5.7 (Reporting and Auditing)<br>Stakeholder Consultation (Attachment D) |
| | (3) A mechanism to ensure effective communication between the mine operator and stakeholders, and | Section 2.6 (Consultation)<br>Section 5.7 (Reporting and Auditing) |
| | (4) A process for obtaining stakeholder endorsement of the relevant risk management plans | Extraction Plan and supporting sub-plans |
| Monitoring and Review (S2.9):<br>Subsidence Monitoring (s2.9.1) | *Note: Refer to Subsidence Monitoring Program for compliance with guidelines requirements for s2.9.1 (Subsidence Monitoring) including detailed requirements in s2.9.1-2.9.3 (including baseline etc), as per cross references included below to the SMP where these are addressed.* | Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5) |
| Objectives of Subsidence Monitoring (S2.9.1.1) | In undertaking subsidence monitoring, the mine operator should determine how the monitoring data is to be captured, recorded, communicated and, importantly, acted upon, for the purpose of: | Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5) |
| | (1) Ensuring that the mine operator has a current and correct understanding of the hazards of subsidence | |
| | (2) Ensuring that the risk control measures are maintained so that they remain effective, | |
| | (3) Avoiding unplanned events. | |

| Referenced Section | Guideline Requirement | Where Addressed |
|---|---|---|
| | (4) Detecting early warnings of changes from the results of risk assessments to facilitate corrective or proactive management actions or the commencement of emergency procedures, | |
| | (5) Identifying emerging new risks of subsidence, and | |
| | (6) Informing the continual improvement and change management. | |
| Scope of Subsidence Monitoring (S2.9.1.2) | The scope of subsidence monitoring must include: | |
| | Monitoring of subsidence | Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5) |
| | Monitoring of the effects of subsidence on relevant surface or subsurface features | |
| Design, Implementation and Maintenance of Subsidence Monitoring (S2.9.1.3) | When designing, implementing and maintaining a subsidence monitoring program, the mine operator of an underground coal mine should: | |
| | (1) Address the objective and scope of the subsidence monitoring program (refer to sections 2.9.1.1 and 2.9.1.2 above | Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5) |
| | (2) Consider the outcomes of subsidence hazard identification, investigation and analysis (refer to section 2.3.4 above). In particular, the subsidence monitoring program should be designed and implemented to assist with:<br>(a) the verification of the risk assessments previously conducted,<br>(b) the verification of the assumptions used during the investigations, analyses or risk assessments previously conducted;<br>(c) the management of uncertainty and abnormal subsidence, | |
| | (3) Consider the results of stakeholder consultation | |
| | (4) Ensure that the monitoring activities are carried out by a competent person | |
| | The subsidence monitoring program should specify: | |
| | (1) The individual monitoring activities of the subsidence monitoring program, | Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5)<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6) |
| | (2) The information to be captured from each of the individual monitoring activities | |
| | (3) The locations and area where each of the individual monitoring activities will be undertaken, in particular, the layout and/or locations of instrumentation, monitoring points and inspections, | |
| | (4) The timing, frequency and duration of monitoring activities and reporting | |
| | (5) The monitoring methods, technologies, industry standards and codes of practice that apply when undertaking the monitoring activities | |
| | (6) The measures and procedures for quality assurance | |
| | (7) The measures and procedures for detecting emerging new risks or early warnings of changes from the results of risk assessments | |
| | (8) The measures and procedures for recording and reporting monitoring results to the regulator and stakeholders | |
| | (9) The measures and procedures for rectifying any disturbances to or malfunctions of the implemented monitoring device in a timely manner so that the subsidence monitoring program remains effective | |
| | (10) A set of criteria, which if satisfied, enables a competent person to vary the implemented subsidence monitoring program (e.g. timing, frequency or duration of subsidence monitoring or reporting) | |

| Referenced Section | Guideline Requirement | Where Addressed |
|---|---|---|
| | (11) Any necessary "redundancies", that is, different monitoring technologies or procedures that are to be used to monitor the same subsidence hazard. "Redundancies" should be considered where the subsidence hazard may have potentially severe health and safety consequences | |
| | (12) Relevant details of a proposed subsidence monitoring program should be demonstrated on a graphical plan (i.e. Plan 7) that is part of the HRA notification (refer to the NSW Department of Industry WHS guideline "Notifying the regulator of a high risk activity"). | |
| Baseline Subsidence Data (S2.9.1.4) | Prior to the development of subsidence, the mine operator should complete:<br>(1) The design and implementation of the subsidence monitoring program in accordance with section 2.9.1.3 above | Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5) |
| | (2) The collection of base-line subsidence data in accordance with the subsidence monitoring program | |
| Review *(Subsidence Monitoring)* (S2.9.2) | The mine operator must ensure that any interpretation of subsidence information (e.g. reviewing the risk control measures for subsidence) is carried out only by a competent person | Section 6.2 (Review of the Extraction Plan)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5) |
| | The mine operator must review and as necessary revise the risk control measures implemented for subsidence in accordance with clause 10 of the WHSMP Regulation | |
| | In undertaking the reviews, the stakeholders must, so far as is reasonably practicable, be consulted and the following questions should be addressed"<br>(1) Have all subsidence hazards been identified?<br>(2) Is the mine operator's understanding of subsidence hazards still current and correct?<br>(3) Have the implemented risk control measures been working effectively?<br>(4) Are the risks of subsidence being adequately managed?<br>(5) Have there been any early warnings of changes from the results of risk assessments, which warrant corrective or proactive management actions or the commencement of emergency procedures?<br>(6) Have any incidents of subsidence occurred and what is the learning from the investigations of these incidents?<br>(7) Should the implemented risk control measures be revised according to the results of subsidence monitoring and review? | |
| **PRINCIPAL HAZARD MANAGEMENT PLANS** | | |
| **Principle Hazard Management Plan** for subsidence (S3), General (S3.1) | The guidance notes provided for the development and selection of risk control measures (refer to sections 2.5.1 to 2.5.3 above) and management of uncertainty, abnormal subsidence and changes (refer to sections 2.3 and 2.7 above) are particularly relevant to a PHMP for subsidence. Sections 2 and 3 of this guideline should be considered when identifying a principal hazard and developing and implementing a PHMP for subsidence. | Section 2.1.2 (Work, Health and Safety Laws (subsidence related))<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6)<br>Subsidence and Environmental Risk Assessment (Attachment C) |
| Identifying Principal Hazards in Relation to Subsidence (S3.2) | To identify principal hazards in relation to subsidence, the mine operator should conduct a comprehensive and systematic investigation and analysis of all relevant matters set out in section 2 of this guideline, in particular, sections 2.2, 2.3 and 2.8 above. | Section 2.1.2 (Work, Health and Safety Laws (subsidence related))<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6)<br>Subsidence and Environmental Risk Assessment (Attachment C) |

| Referenced Section | Guideline Requirement | Where Addressed |
|---|---|---|
| Risk Assessment (S3.3) | In satisfying Clause 23(2) of the WHSMP Regulation…The mine operator, **in undertaking a risk assessment for a principal hazard of subsidence, must:**<br>(1) Ensure that the risk assessment involves a comprehensive and systematic investigation and analysis of all aspects of risk to health and safety associated with the principal hazard,<br>(2) Use investigation and analysis methods that are appropriate to the principal hazard being considered. For example:<br>(a) a historical mine layout plan is not appropriate for assessing the stability of overlying or underlying old pillar workings underneath a major public utility if the accuracy of the layout plan cannot be verified,<br>(b) any structural conditions of a dwelling that may become hazardous when affected by subsidence should be identified and assessed by a competent person prior to the development of subsidence. The results of the investigation should be used for the development and implementation of appropriate risk control measures, or<br>(c) it is not appropriate to assess the stability of embankments supporting critical transport infrastructure based on assumed mechanical parameters for the embankments. These parameters should be obtained through site-specific investigations, and<br>(3) Consider the principal hazard individually and also cumulatively with other hazards at the mine (e.g. inflow or inrush of water).<br>To conduct the risk assessment for a principal hazard of subsidence, the mine operator **should conduct a comprehensive and systematic investigation and analysis of all relevant matters set out in section 2 of this guideline, in particular, sections 2.2 to 2.5 and section 2.8** above. | Section 2.1.2 (Work, Health and Safety Laws (subsidence related))<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F)<br>Subsidence and Environmental Risk Assessment (Attachment C) |
| Preparing a PHMP for Subsidence (S3.4) | Under clause 24 of the WHSMP Regulation, the mine operator **must prepare a PHMP for each principal hazard** associated with mining operations at the mine in accordance with clause 24 and Schedule 1.<br>Clause 3C of Schedule 1 of the WHSMP Regulation states that:<br>"The following matters must be considered in developing the control measures to manage the risks of subsidence:<br>(a) the characteristics of all relevant surface and subsurface features,<br>(b) the characteristics of all relevant geological, hydrogeological, hydrological, geotechnical, topographic and climatic conditions, including any conditions that may cause elevated or abnormal subsidence or the formation of sinkholes,<br>(c) the characteristics of any previously excavated or abandoned workings that may interact with any proposed or existing mine workings,<br>(d) the existence, distribution, geometry and stability of significant voids, standing pillars or remnants within any old pillar workings that may interact with any proposed or existing mine workings,<br>(e) the predicted and actual nature, magnitude, distribution, timing and duration of subsidence,<br>(f) the rate, method, layout, schedule and sequence of mining operations."<br>In addition to the requirements of clause 3C of Schedule 1, the mine operator should prepare the PHMP for subsidence by comprehensively and systematically considering all relevant matters set out in section 2 of this guideline. | Section 2.1.2 (Work, Health and Safety Laws (subsidence related))<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F)<br>Subsidence and Environmental Risk Assessment (Attachment C) |

| Referenced Section | Guideline Requirement | Where Addressed |
|---|---|---|
| | The PHMP for subsidence is part of the SMS for a mine (see clause 14(1)(c)(i)) of the WHSMP Regulation, which must be implemented so far as is reasonably practicable under clause 13(2) of the WHSMP Regulation). For guidance notes on SMS, refer to "NSW code of practice - Safety management systems in mines". | Section 2.1.2 (Work, Health and Safety Laws (subsidence related))<br>Airly Mine Safety Management System |
| | Under clause 24(3) of the WHSMP Regulation, the PHMP for subsidence must:<br>(1) Describe the nature of the principal hazard of subsidence to which the plan relates. The descriptions should be based on the results of investigations and analyses undertaken in accordance with the relevant matters set out in section 2 of this guideline, in particular, sections 2.2 to 2.4 and 2.8 above,<br>(2) Describe how the principal hazard of subsidence relates to other hazards associated with mining operations at the mine,<br>(3) Describe the analysis methods used in identifying the principal hazard of subsidence to which the plan relates,<br>(4) Include a record of the most recent risk assessment conducted in relation to the principal hazard of subsidence,<br>(5) Describe the investigation and analysis methods used in determining the control measures to be implemented,<br>(6) Describe all control measures to be implemented to manage risks to health and safety associated with the principal hazard of subsidence. The descriptions should be provided in accordance with all relevant matters set out in section 2 of this guideline, in particular sections 2.5 to 2.9 above,<br>(7) Refer to any design principles, engineering standards and technical standards relied on for control measures for the principal hazard of subsidence, and<br>(8) Set out the reasons for adopting or rejecting each control measure considered. | Section 2.1.2 (Work, Health and Safety Laws (subsidence related))<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6)<br>Subsidence and Environmental Risk Assessment (Attachment C) |
| | Under clause 24(5) of the WHSMP Regulation, the mine operator must ensure that no mining operations are carried out at the mine that may give rise to a principal hazard before the PHMP for that hazard has been prepared. A PHMP for subsidence should be prepared and implemented prior to the development of subsidence that may give rise to the principal hazard of subsidence. | Section 2.1.2 (Work, Health and Safety Laws (subsidence related)) |
| Other Matters Relevant to Managing Risks Associated with a Principal Hazard in Relation to Subsidence (S3.5) | Under clause 24(4)(b) of the WHSMP Regulation, when preparing a PHMP, the mine operator must consider "any other matter relevant to managing the risks associated with the principal hazard at the mine". | Extraction Plan and supporting sub-plans<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6)<br>Subsidence and Environmental Risk Assessment (Attachment C)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| Mining Operation as a Risk Control Measure (S3.5.1) | When applying the hierarchy of control measures (refer to section 2.5 above), the mine operator **should consider the underground coal mine, including its rate, method, layout, schedule, or sequence of mining operations, as one of the available risk control measures in accordance with clause 67(2)(a) of the WHSMP Regulation.**<br>It is **important that a PHMP for subsidence incorporates a procedure that activates and implements "controlled mining operation" as a risk control measure.** While using the mining operation to control subsidence hazards can | Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5)<br>Subsidence and Environmental Risk Assessment (Attachment C) |

| Referenced Section | Guideline Requirement | Where Addressed |
|---|---|---|
| | be effective, the implementation of this control measure may require specific and significant planning and preparation. | Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6) |
| Management Status Reporting to Assist with Regular Consultation (S3.5.2) | Appendix B of the guidelines provides an example. No requirement is specified. | Section 5.7 (Reporting and Auditing) |
| Other Examples of Best Industry Practices Relevant to PHMP (S3.5.3) | Appendix C of the guidelines provides an example for managing WHS aspects of dwellings and similar civil structures. No requirement is specified. | Noted in the development of ongoing consultation with relevant stakeholders |
| Review, Audit & Maintenance (Of PHMPs) (S3.6)<br>Review and Maintenance (S3.6.1) | The mine operator must ensure that the PHMP for subsidence is reviewed and as necessary revised in accordance with clause 25 of the WHSMP Regulation. | Section 6.2 (Review of the Extraction Plan) |
| | If the PHMP for subsidence is revised, the mine operator must record the revision, **including any revision of a risk assessment, by amending the plan in writing.** | Section 6.2 (Review of the Extraction Plan) |
| | A PHMP is part of the SMS for a mine (see clause 14(1)(c)(i)), which must be audited under clause 15, maintained under clause 16 and reviewed, and as necessary revised, under clause 17 of the WHSMP Regulation. | Section 6.2 (Review of the Extraction Plan)<br>Airly Mine Safety Management System |
| | For further guidance notes in relation to maintenance and review, refer to sections 2.6 and 2.9 of this guideline. | Refer for s2.6 and 2.9 earlier above |
| Audit (S3.6.2) | The mine operator must audit a PHMP for subsidence as part of auditing the effectiveness of the SMS in accordance with clause 15 of the WHSMP Regulation. | Section 2.1.2 (Work, Health and Safety Laws (subsidence related))<br>Section 5.7 (Reporting and Auditing) |
| | Under clause 15(c) of the WHSMP Regulation, the system for auditing the effectiveness of the SMS must be set against the performance standards for measuring the effectiveness of all aspects of the SMS, including the methods, frequency and results of the audit process. The audit should also consider the following matters:<br>(1) Competency of the auditor,<br>(2) The person responsible for ensuring the audit is conducted, and<br>(3) The person responsible for implementing the results of the audit. | Section 2.1.2 (Work, Health and Safety Laws (subsidence related))<br>Section 5.7 (Reporting and Auditing)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5) |
| High Risk Activity Notification in Relation to Subsidence (S4) | A mine operator must give notice of a HRA to the regulator and ensure that the requirements of clause 33 and Schedule 3 of the WHSMP Regulation are complied with. In Schedule 3 of the WHSMP Regulation, there are three HRAs that relate to subsidence:<br>(1) Clause 16 - Secondary extraction or pillar extraction, splitting or reduction,<br>(2) Clause 17 - Shallow depth of cover mining, and<br>(3) Clause 28 - Highwall mining. | HRA for secondary extraction submitted separately to Extraction Plan (concurrent processes).<br>Extraction Plan and supporting sub-plans<br>Graphical Plans for MW17-18 (Appendix 7)<br>Subsidence and Environmental Risk Assessment (Attachment C) |
| | Specifically, when submitting a HRA notification that involves subsidence, the mine operator must provide:<br>(1) Details of how the risks to the health and safety of workers and other persons from subsidence caused by the activity will be managed - refer to clause 16, Schedule 3 - Secondary extraction or pillar extraction, splitting or reduction, | |

| Referenced Section | Guideline Requirement | Where Addressed |
|---|---|---|
| | (2) Information on how the risks to the health and safety of workers and other persons from the potential formation of sinkholes will be managed - refer to clause 17, Schedule 3 - Shallow depth of cover mining, or<br>*A)* (3) information on how the risks to the health and safety of workers and other persons from subsidence caused by the activity will be managed - refer to clause 28, Schedule 3 - Highwall mining. | |
| | The HRA notification should consider and address all relevant matters set out in section 2 of this guideline, in particular sections 2.2 to 2.9 above. | |
| | The level of detail required for all the relevant matters set out in section 2 of this guideline should be commensurate with the nature, likelihood, potential consequences and complexity of subsidence hazards identified. | |
| Engineering Plans and Drawings (S5) | Engineering plans and drawings are part of the results of the mine operator's investigation, assessment and consideration. The mine operator should refer to the NSW Department of Industry , WHS guideline *"Notifying the regulator of a high risk activity"* for guidance notes on how to prepare and submit the engineering plans and drawings in relation to:<br>(1) Secondary extraction or pillar extraction, splitting or reduction,<br>(2) Shallow depth of cover mining, or<br>(3) Highwall mining. | HRA for secondary extraction submitted separately to Extraction Plan (concurrent processes).<br>Extraction Plan and supporting sub-plans<br>Graphical Plans for MW17-18 (Appendix 7)<br>Subsidence and Environmental Risk Assessment (Attachment C) |
| Notification of Incident or Injury (S6) | For guidance notes on how to notify the regulator of subsidence-related incidents or injuries, refer to the NSW Department of Industry, WHS guide *"Notification of incident and injury* "Accordingly the following is provided:"<br>Under Clause 128 of the WHSMP Regulations (Duty to Notify Regulator):<br>(1) The operator of a mine or petroleum site must take all reasonable steps to ensure that the regulator is notified in accordance with this clause after becoming aware of an incident (other than a notifiable incident) arising out of the carrying out of mining operations or petroleum operations at the mine or petroleum site, but only if the incident:<br>(a) results in illness or injury that requires medical treatment within the meaning of clause 13 of Schedule 9, or<br>(b) is a high potential incident.<br>(6) In this clause: high potential incident means any of the following:<br>(n) any indication from monitoring data of the development of subsidence which may result in any incident referred to in clause:<br>179 (a) (xvi)-a failure of ground, or of slope stability control measures, or<br>179 (a) (xvii) rock falls, instability of cliffs, steep slopes or natural dams, occurrence of sinkholes, development of surface cracking or deformations or release of gas at the surface, due to subsidence. | Section 5.6 (Incidents, Complaints, Exceedances and Non-compliances) |
| Notification of Reportable Events (S7) | For guidance notes on how to notify the regulator of reportable events relevant to subsidence, e.g. commencement of mining operations or proposed material changes in relation PHMP, refer to the NSW Department of Industry, WHS factsheet *"Notifying the regulator of reportable events factsheet".*<br>Accordingly, notification requirements for high potential incidents are as per s6 of guideline immediately above. | Section 5.6 (Incidents, Complaints, Exceedances and Non-compliances) |

***Note**: Section 2 of the Guidelines includes aspects relating to subsidence monitoring which have been listed separately within the Subsidence Monitoring Program document for the Cliff Line Zone of First Workings Extraction Plan.*

# 4 EXTRACTION PLAN GUIDELINES

The Extraction Plan Guidelines (DPE, 2022) identifies typical requirements for the Extraction Plan and supporting management plans. The requirements from the Guideline are presented in **Table 4.1**.

**Table 4.1 Extraction Plan Guidelines Requirements**

| Referenced Section | Guideline Requirement | Section Addressed |
|---|---|---|
| **3.2 Introduction** | The introductory section should include a title page containing the:<br>• extraction plan title, date and version number<br>• name of the mining company<br>• name of the mine<br>• development consent and mining lease reference numbers<br>• signature(s) of person(s) taking responsibility for the accuracy and comprehensiveness of the information contained within the Plan.<br>The introductory section should include an executive summary and a clear and comprehensive table of contents. It should also include background information about the project (including the approvals history) and the scope and structure of the extraction plan. It should also include graphical figures that clearly show the approved development including the approved mining area, the associated surface development and the underground mining area to which the plan applies. | Section 1 (Introduction) |
| **3.3.1 Plan development** | This subsection should describe the process that the mining company took to develop the extraction plan. It should address relevant requirements of the development consent, mining lease, mine safety legislation, mine subsidence compensation legislation, environment protection licence and any other approvals.<br>It should indicate the independent consultants or internal technical specialists engaged in preparing the plan or any specialist assessments that support it, and provide a brief overview of the purpose and content of these specialist assessments.<br>This subsection should describe the process of reviewing and updating previous subsidence predictions used in the environmental impact assessment or in any previous extraction plan. This subsection should also provide assurances that previous predictions remain relevant or have been revised to consider more recent monitoring.<br>Extraction plans should be supported by at least two years of appropriate baseline data. This subsection should summarise the type and extent of baseline data collection undertaken, including whether the two-year standard has been met (or would be met prior to subsidence impacts occurring). If circumstances prevent this standard being met, then justification must be provided.<br>This section should also outline the approach taken by the mining company to risk assessment in developing the plan. Any risk minimisation or avoidance strategies that have resulted from the risk assessment or the decisions of the mining company should also be outlined. | Section 2 (Plan Development and Consultation) |

| Referenced Section | Guideline Requirement | Section Addressed |
|---|---|---|
| **3.3.2 Consultation** | This subsection should address all consultation undertaken by the mining company with relevant agencies and other key stakeholders (such as the owners and/or operators of both publicly and privately owned land and infrastructure and the mine's community consultative committee).<br>Where conditions of consent require consultation with agencies, include or append evidence of this consultation. This evidence should address who was consulted and when, and to what degree the feedback has been incorporated into the plan. | Section 2.6 (Consultation)<br>Stakeholder Consultation (Attachment D) |
| **3.4 Subsidence assessment** | Include a short overview of the subsidence impact assessment in the body of the plan and attach the full subsidence assessment. | Section 3 (Subsidence assessment)<br>Technical Report: Pillar Width Modelling (SCT, 2023) (Attachment E)<br>Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023) (Attachment F) |
| **3.5.1 Subsidence monitoring program** | The subsidence monitoring program should have clearly stated objectives and include:<br>• proposed subsidence monitoring activities, including the use of land-based and/or satellite and other remote survey techniques and the accuracy of proposed techniques<br>• information or subsidence parameters to be obtained from each monitoring activity<br>• proposed locations and/or extents where each monitoring activity will take place – in particular, the proposed layout and/or locations of instrumentation, monitoring points or inspections (including plans)<br>• proposed timing, frequency and duration of each monitoring activity<br>• proposed monitoring methods and technologies and industry standards or codes of practice to be applied<br>• proposed measures and procedures for quality assurance and competence of personnel undertaking monitoring<br>• proposed procedures to record monitoring results<br>• proposed reporting of monitoring results, including the frequency of reporting, which will depend on the nature of the risk<br>• capacity of the program to detect early warning of deviations from the consent's performance measures and associated performance indicators. | Section 4.1 (Subsidence Effects Monitoring Program)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5) |
| **3.5.2 Environmental monitoring program** | This subsection should summarise and consolidate the environmental monitoring programs presented in each of the key sub-plans (see section 3.8.1). The environmental monitoring program should have clearly stated objective(s) and be based on contemporary best practice. It should provide detailed information on the existing baseline and proposed monitoring programs, with a similar level of detail that was suggested for the subsidence monitoring program.<br>This subsection should contain figures showing existing baseline and proposed impact monitoring sites for each of the various monitoring programs, as well as a consolidated figure showing all monitoring sites. | Section 4.2 (Environmental Monitoring Program)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5) |

| Referenced Section | Guideline Requirement | Section Addressed |
|---|---|---|
| **3.5.3 Ongoing baseline data collection program** | This section must outline a data collection program that is designed to collect baseline data for any future extraction plan(s). | Section 4.3 (Ongoing Baseline Data Collection Program)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5) |
| **3.6.1 Performance measures and performance indicators** | Conditions of consent generally require the mining company to develop performance indicators to ensure that the subsidence impact performance measures are not exceeded. Careful selection of performance indicators will provide an early warning mechanism that can lead to successful adaptive management.<br>Wherever possible, performance indicators should be quantitative and not rely on qualitative interpretation. The language used should be clear and straightforward. The subsection should describe how the performance indicators will help achieve the performance measures. This should include a summary table listing the relevant performance measures and the proposed performance indicators and cross-references to where these are discussed in detail. | Section 5.1 (Performance Measures and Indicators) |
| **3.6.2 Management and mitigation measures** | This subsection should set out any subsidence management and mitigation measures that would be implemented in response to predicted subsidence impacts and/or environmental consequences. | Section 5.2 (Management and Mitigation Measures) |
| **3.6.3 Remediation and rehabilitation measures** | This subsection should address the remediation and rehabilitation measures proposed to be implemented in response to predicted subsidence impacts and/or environmental consequences. | Section 5.3 (Remediation and Rehabilitation Measures) |
| **3.6.4 TARPs** | Conditions of consent generally require the use of TARPs within extraction plans and key sub-plans. TARPs are key forward-looking management documents that tabulate what, when and how specified management responses will be implemented if certain triggers are exceeded.<br>TARPs should be aimed at ensuring compliance with all relevant performance measures and other restrictions set within the consent. TARPs may also address achievement of limits that are self-imposed by the mining company to achieve appropriate outcomes (for example reducing damage to built and/or natural features to reduce remediation costs).<br>All TARPS should be presented in table form and include at a minimum:<br>• relevant performance measures and performance indicators<br>• multilevel triggers<br>• containment and remediation measures<br>• actions that will be implemented in response to any triggers (including adaptive management measures and contingency plans).<br>Triggers should generally be set as exceedances of particular performance indicators. However, it may be appropriate to include a trigger level before a performance indicator is exceeded. Any exceedance of a trigger should lead to specific listed actions in response. These may include additional monitoring, reporting, investigation, rehabilitation actions and adaptive management. TARPs should also include the responsible role. | Section 5.4 (Master Trigger Action Response Plan)<br>Master TARP for MW17-18 (MW17-18 Master TARP) (Appendix 6) |

| Referenced Section | Guideline Requirement | Section Addressed |
|---|---|---|
| | TARPs should be easily understood by operational personnel, contractors, regulatory agencies, and the community. They should be self-contained documents that are consistent, comprehensive, and not subject to external variables that may turn particular actions on or off. If they make references to other documents, these references should be transparent and straightforward.<br><br>TARPs should include regular reporting (typically 3 monthly or 6 monthly) of all trigger exceedances and company actions taken in response. TARPs should involve regulatory agencies in discussions about the design and implementation of corrective management actions where applicable. | |
| **3.6.5 Adaptive management and contingency planning** | Adaptive management involves the monitoring and periodic evaluation of environmental consequences against performance measures. Where unpredicted subsidence impacts and/or environmental consequences have occurred, adaptive management requires implementation of measures to prevent their recurrence.<br><br>This subsection should address any specific requirements for adaptive management included in the conditions of consent, particularly regarding TARPs and contingency planning.<br><br>For ease of reference, this information is best presented in a tabulated 'master TARP' that consolidates all TARPs included in the sub-plans. It should also include all specific adaptive management measures aimed at achieving the performance measures and responding to any triggers or potential exceedances of the performance measures.<br><br>Conditions of consent generally require developing a contingency plan. This plan provides for adaptive management when monitoring indicates an exceedance of any of the consent's subsidence impact performance measures, or where any such exceedance appears likely. It should also include an assessment of remediation measure and the capacity to implement those measures.<br><br>At times, mine planning and design must change to avoid repetition of unpredicted subsidence impacts and/or environmental consequences, particularly if these exceed performance measures. If necessary, mitigation measures, mine design and/or mining extent may need to be adjusted to achieve the performance measures. | Section 5.5 (Adaptive Management and Contingency Planning) |
| **3.6.6 Incidents, complaints, exceedances and non-compliances** | This subsection should include procedures for investigating environmental incidents, community complaints, exceedances of performance measures and any non-compliances. It should also outline an appropriate response to these issues. | Section 5.6 (Incidents, Complaints, Exceedances and Non-compliances) |
| **3.6.7 Reporting, review and auditing** | The reporting framework is another important section of the extraction plan. The plan must describe elements of this framework including:<br><br>• environmental incident reporting following any incident (as defined in the consent) in accordance with the conditions of consent and/or environment protection licence<br><br>• any additional requirements for reporting set out within the TARPs (for example, reporting trigger exceedances and company actions taken in response)<br><br>• an annual review of all subsidence impacts, environmental consequences and environmental monitoring results, including:<br><br>o a comprehensive summary of all quantitative and qualitative environmental monitoring results, including landscape | Section 5.7 (Reporting and Auditing) |

| Referenced Section | Guideline Requirement | Section Addressed |
|---|---|---|
| | monitoring, water quality data, water flow and pool level data, piezometer readings and other results<br>o a summary of the results of the subsidence monitoring program<br>o a comprehensive summary of all subsidence impacts and environmental consequences<br>o a full description of subsidence impacts and environmental consequences, including location identification using aerial photos with longwall layout superimposed and characterisation of the impact in accordance with the relevant TARP(s)<br>o clear distinction between impacts and consequences that are within predictions, those that exceed predictions but remain within performance measures and/or performance indicators, and those that exceed performance measures and/or performance indicators<br>o an assessment of compliance with all relevant performance measures and indicators<br>o proposed actions or responses resulting from TARP triggers being exceeded<br>o any other proposed actions or responses.<br>The department may require reporting at more regular intervals than the annual review (for example, biannual, quarterly or monthly reporting) where subsidence impacts and/or environmental consequences are significant or are exceeding predictions.<br>Other agencies may require other regular reports for their own purposes, such as reports to the NSW Resources Regulator or Dams Safety NSW. This may include reports assessing impacts of mining close to sensitive features, such as dams, railways, bridges, pipelines, transmission towers, optic fibre cables and waterfalls. The department expects to receive copies of these reports.<br>Other regular reports, such as regular subsidence management status reports (sometimes required by the NSW Resources Regulator) or end of panel reports (unless separately required by conditions of consent), do not need to be provided to the department.<br>This section of the extraction plan should also set out clearly in a table which agencies will receive copies of each of the types of reports discussed above. The timeframes and means of submission should also be set out. | |
| **3.7.1 Review of other management plans** | Development of an extraction plan may lead to a requirement to review other management plans. This section of the extraction plan should set out the process and general results of this review, but not the proposed revisions themselves. The proposed revisions should be forwarded separately as proposed amendments to the relevant plans. | Section 6.1 (Review Other Management Plans) |

| Referenced Section | Guideline Requirement | Section Addressed |
|---|---|---|
| **3.7.2 Review of the extraction plan** | Processes for the future review of the extraction plan should also be set out. Such reviews should take place:<br>• as required under consent conditions<br>• where the application of adaptive management strategies requires a review (where exceedances are significant and/or are continuing to occur)<br>• where unpredicted subsidence impacts and/or environmental consequences have required implementation of a contingency plan<br>• when preparing a subsequent extraction plan (see section 2.2). | Section 6.2 (Review of the Extraction Plan) |
| **3.7.3 Key responsibilities** | This subsection should set out who is responsible for implementing the extraction plan and its various requirements. It should clearly identify which officers of the mining company have key responsibility for:<br>• ensuring implementation of the extraction plan and its key sub-plans and other elements<br>• incident and other reporting<br>• decisions to activate TARP responses and/or contingency planning<br>• initiating and/or undertaking required or occasional review of the plan or any of its elements. | Section 6.3 (Key Responsibilities) |
| **3.8.1 Key sub-plans** | Key sub-plans are required to support the extraction plan and must be revised during the preparation of each new extraction plan. Sub-plans are generally best presented as Appendices to the main body of the extraction plan. | Airly Mine Water Management Plan (Appendix 1)<br>Land Management Plan for MW17-18 (MW17-18 LMP) (Appendix 2)<br>Biodiversity Management Plan for MW17-18 (MW17-18 BMP) (Appendix 3)<br>Public Safety Management Plan for MW17-18 (MW17-18 PSMP) (Appendix 4)<br>Subsidence Monitoring Program for MW17-18 (MW17-18 SMP) (Appendix 5) |
| **3.8.2 Required figures** | Mining companies must include detailed figures as appendices in the extraction plan. The requirements for these figures are outline in Table 3. Mining companies may be asked to supply any or all of the data incorporated within these figures as geographic information system (GIS) files. | Graphical Plans for MW17-18 (Appendix 7) |

# 5 OTHER RELATED APPROVALS AND GUIDELINES

Preparation of the Extraction Plan and supporting management plans is also directed by compliance with other related approvals and guidelines in accordance with Condition 2 of Schedule 6 of SSD_5581 as outlined below.

## 5.1 Environmental Protection Licenses

Airly Mine operates under Environment Protection Licence (EPL) 12374 (as varied 2018) issued under the Protection of the Environment Operations Act (POEO Act) 1997. EPL12374 permits coal works and mining for coal to a scale of up to 2 million tonnes per annum handled and produced. There are no conditions of EPL 12374 specifically related to mine subsidence and extraction plans, however general and specific environment requirements as relevant to this extraction plan are listed in **Table 5.1** below.

**Table 5.1 Relevant Conditions of EPL12374 Relevant to This Management Plan**

| Clause | Requirement | Section Addressed |
|---|---|---|
| **Condition R2** | | |
| **EPL 12374 Requirements** | R2 Notification of Environmental Harm<br>General Note - The licensee or its employees must notify all relevant authorities of incidents causing or threatening material harm to the environment immediately after the person becomes aware of the incident in accordance with the requirements of Part 5.7 of the Act.<br>R2.1 - Notifications must be made by telephoning the Environment Line service on 131 555<br>R2.2 - The licensee must provide written details of the notification to the EPA within 7 days of the date on which the incident occurred. | Section 5.6 (Incidents, Complaints, Exceedances and Non-compliances) |

## 5.2 EPBC Approval

Conditional approval of referral 2013/7076 was granted by the Commonwealth Department of Environment and Energy for the Airly Mine Extension Project on 18th May 2017 under sections 130(1) and 133 of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Aspects of the approval which are considered relevant to this management plan for the current Extraction Plan are listed in **Table 5.2** below, including conditions relating to bilateral agreement with NSW under Part 5 of the EPBC Act.

**Table 5.2 Relevant EPBC Approval Requirements**

| Clause | Requirement | Section Addressed |
|---|---|---|
| **Schedule 2** | | |
| *(Compliance with Conditions of the NSW development consent (SSD_5581):* | | |
| | For the Protection of matters of national environmental significance, the person taking the action must comply with the following conditions of the New South Wales development consent <SSD5581> : | Extraction Plan and supporting sub-plans |
| **Condition 1** | General obligation to prevent environmental harm. | Refer Tables 1.1, 1.2 |
| **Schedule 3** | | |
| **Condition 1** | Schedule 3, Condition 1:<br>Restrictions on Mining in geologically sensitive areas. | Section 3.1 (Mine Planning and Design) |
| **Condition 2** | Schedule 3, Condition 2:<br>Performance measures for the protection of identified commonwealth natural and heritage features. | Section 5.1 (Performance Measures and Indicators) |

| Clause | Requirement | Section Addressed |
|---|---|---|
| **Condition 7** | Schedule 3, Condition 7:<br>Preparation, approval, and implementation of extraction plans, incorporating a range of relevant management sub-plans1. | Extraction Plan and supporting sub-plans |
| | *Centennial Note: Additional referenced conditions 11-29 in Schedule 4 relate to the general whole of site Management Plans which include aspects not related to subsidence management (e.g. surface facilities). Only aspects and measures relevant to subsidence are applicable to the extraction plan as addressed via Condition 7 above.* | |
| ***Administrative Conditions*** | | |
| **Condition 2** | **Within fourteen days after the commencement of the action[4]**, the person taking the action **must advise the Department[3] in writing of the actual date of commencement of the action**. | Section 5.7 (Reporting and Auditing) |
| **Condition 3** | The person taking the action **must maintain accurate records substantiating all activities** associated with or relevant to the conditions of approval, and make them available upon request to the Department[3]. Such records may be subject to audit by the Department or an independent auditor in accordance with Section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the Departments[3] website. The results of audits may also be publicised through the general media. | Section 5.7 (Reporting and Auditing) |
| **Condition 4** | **Within 3 (three) months of every twelve (12) month anniversary of the commencement of the action[4]**, the person taking the action **must publish a report on their website addressing compliance with each of the conditions of this approval**, including implementation of any management plans as specified in the conditions. Documentary evidence providing proof of date of publication and non-compliance with any of the conditions of this approval must be provided to the Department[3] at the same time as the compliance report is published. | Section 5.7 (Reporting and Auditing) |
| **Condition 5** | Upon the direction of the Minister[2], the person taking the action must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister. The independent auditor must be approved by the Minister prior to commencement of the audit. Audit criteria must be agreed to by the Minister and the audit report must address the criteria to the satisfaction of the Minister. | Section 5.7 (Reporting and Auditing) |
| **Condition 7** | Unless otherwise agreed to in writing by the Minister[2], the person taking the action **must publish all management documents referred to in these conditions of approval on their website**. This includes documents required indirectly through the New South Wales development consent. Each document must be published on the website **within one (1) month of being approved by the Minister[2]**. | Section 5.7 (Reporting and Auditing) |

*Notes:* *1. Refer Table 2 for specific wording of the referenced conditions of NSW Development Consent SSD_5581.*

*2. The Minister means the Australian Government minister responsible for administering the EPBC Act and includes any delegate of the Minister.*

*3. The Department means the Australian Government department responsible for administering the EPBC Act*

*4. Commencement of Action, means the first instance of an activity described in the EIS as being part of the action, or, in relation to Condition 1, has the meaning given through the NSW development consent (SSD_5581).*

# Stature for Risk Management

## Administration:

**Risk Assessment Title:** Pt Hatteras Panel and Pillar Extraction Plan MW17-MW19
**Revision:** 1
**Region:** West
**Site:** Airly
**Department:** ZZZZ Whole Site
**Equipment / Process:** Community
**Stature Risk Assessment No.:** 1001308023
**Study Lifecycle State:** Risk Assessment Made Effective
**Potential Hazard No.:** 56771
**PULSE Actions Required URL:**
**Site Risk Assessment Ref. No. (Optional):**

# Executive Summary of Top 10 Risks

| Background | Potential Incident | RR |
|---|---|---|
| Cliffs and minor cliffs<br>located within Extraction Area (Near-Field / Principal Subsidence management Area) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 9<br>(M) |
| Cliffs and minor cliffs<br>located within Extraction Area (Near-Field / Principal Subsidence management Area) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Public safety hazard (personal injury PI) . | 9<br>(M) |
| Cliffs and minor cliffs<br>located within Extended Monitoring & Management Area (Cliff Line Zone) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 9<br>(M) |
| Cliffs and minor cliffs<br>located within Extended Monitoring & Management Area (Cliff Line Zone) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological | 9<br>(M) |

| Background | Potential Incident | RR |
|---|---|---|
| | anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Public safety hazard (personal injury PI) . | |
| Shear Strain Effects (on Built Features) (particularly to dwellings & infrastructure in deep DOC) | There is a risk to Airly from<br><br>::: Mining induced movements and effects causing impacts to built features (including trig station) within and beyond the EP Area, beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 9<br>(M) |
| Movements and Effects Beyond Predictions within and beyond the EP Area | There is a risk to Airly from<br><br>::: Mining induced movements and effects BEYOND PREDICTIONS potentially causing impacts to natural features (including cliffs, minor cliffs and pagodas) within and beyond the EP Area, beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 9<br>(M) |
| Groundwater- Centennial surface water monitoring bores<br>Located within the EP Area | There is a risk to Airly from<br><br>::: Reduction or loss of monitoring capacity<br>:::<br><br>Caused by:<br>Fire or lightning or Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA or tree fall or Vandilisum<br><br>Resulting in:<br>Non compliance or Reputation or Business interruption.. | 8<br>(M) |
| Geological Structures (including faults, folds, sills or dykes)<br>Located within the EP Area | There is a risk to Airly from<br><br>::: Increased subsidence / impacts arising from potential effects of geological structures (local or | 8<br>(M) |

| Background | Potential Incident | RR |
|---|---|---|
| | regional)<br>:::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | |
| Pagodas / Rock Formations<br>Located within the Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Cracking of pagodas or rock formations<br>:::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 6<br>(L) |
| Pagodas / Rock Formations<br>Located within the Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Cracking of pagodas or rock formations<br>:::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Public safety hazard (personal injury PI) . | 6<br>(L) |
| Steep slopes<br>located within Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip<br>:::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 6<br>(L) |

| Background | Potential Incident | RR |
|---|---|---|
| Steep slopes<br>located within Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip:<br>:::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Public safety hazard (personal injury PI) . | 6<br>(L) |
| Steep slopes<br>located within Extended Monitoring & Management Area | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip<br>:::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 6<br>(L) |
| Steep slopes<br>located within Extended Monitoring & Management Area | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip<br>:::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Public safety hazard (personal injury PI) . | 6<br>(L) |
| Surface Water Courses - Located within the EP Area | There is a risk to Airly from<br><br>:::  Cracking of stream channel / localised loss of water flow<br>:::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage | 6<br>(L) |

| Background | Potential Incident | RR |
|---|---|---|
| | Impact or Reputation or Social impact or Business interruption.. | |
| Surface Water Courses - Located within the EP Area | There is a risk to Airly from<br><br>::: Changes to creek habitat from changes to geomorphology<br>:::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 6<br>(L) |
| Steeply Dipping Terrain Effects<br>- Potential for interaction between workings downslope of the CLZ and extraction within the EP Area | There is a risk to Airly from<br><br>::: impact to cliffs and associated features in steeply dipping terrain:: :::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 6<br>(L) |

# Executive Summary of Top 10 Severities

| Background | Potential Incident | MRC |
|---|---|---|
| Cliffs and minor cliffs<br>located within Extraction Area (Near-Field / Principal Subsidence management Area) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 3 |
| Cliffs and minor cliffs<br>located within Extraction Area (Near-Field / Principal Subsidence management Area) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Public safety hazard (personal injury PI) . | 3 |
| Cliffs and minor cliffs<br>located within Extended Monitoring & Management Area (Cliff Line Zone) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 3 |
| Cliffs and minor cliffs<br>located within Extended Monitoring & Management Area (Cliff Line Zone) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological | 3 |

| Background | Potential Incident | MRC |
|---|---|---|
| | anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Public safety hazard (personal injury PI) . | |
| Pagodas / Rock Formations<br>Located within the Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Cracking of pagodas or rock formations<br>:::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 3 |
| Pagodas / Rock Formations<br>Located within the Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Cracking of pagodas or rock formations<br>:::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Public safety hazard (personal injury PI) . | 3 |
| Steep slopes<br>located within Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip<br>:::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 3 |
| Steep slopes<br>located within Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip:<br>:::<br><br>Caused by: | 3 |

| Background | Potential Incident | MRC |
|---|---|---|
| | Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Public safety hazard (personal injury PI) . | |
| Steep slopes<br>located within Extended Monitoring & Management Area | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip<br>:::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 3 |
| Steep slopes<br>located within Extended Monitoring & Management Area | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip<br>:::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Public safety hazard (personal injury PI) . | 3 |
| Surface Water Courses - Located within the EP Area | There is a risk to Airly from<br><br>::: Cracking of stream channel / localised loss of water flow<br>:::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 3 |
| Surface Water Courses - Located within the EP Area | There is a risk to Airly from<br><br>::: Changes to creek habitat from changes to geomorphology<br>::: | 3 |

| Background | Potential Incident | MRC |
|---|---|---|
| | Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | |
| Shear Strain Effects (on Built Features) (particularly to dwellings & infrastructure in deep DOC) | There is a risk to Airly from<br><br>::: Mining induced movements and effects causing impacts to built features (including trig station) within and beyond the EP Area, beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 3 |
| Movements and Effects Beyond Predictions within and beyond the EP Area | There is a risk to Airly from<br><br>::: Mining induced movements and effects BEYOND PREDICTIONS potentially causing impacts to natural features (including cliffs, minor cliffs and pagodas) within and beyond the EP Area, beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 3 |
| Steeply Dipping Terrain Effects<br>- Potential for interaction between workings downslope of the CLZ and extraction within the EP Area | There is a risk to Airly from<br><br>::: impact to cliffs and associated features in steeply dipping terrain:: :::<br><br>Caused by:<br>Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 3 |

# Study Approval

| Approver | Approved / Rejected | Date | Comments |
|---|---|---|---|
| 1. Brian Nicholls [ Brian.Nicholls ] | Approved | August 04, 2021 | |
| 2. Kyle Egan [ Kyle.Egan ] | Approved | October 11, 2021 | |
| 3. Ryan Davidson [ Ryan.Davidson ] | Approved | July 26, 2022 | |

# 1. Background

The MW17-19 PPMZ Extraction Plan proposes secondary extraction in three miniwall panels (MW17 to MW19) with a mine design to achieve subsidence levels which is consistent with EIS predictions (i.e. maximum vertical subsidence <125mm).
The development of management and monitoring programs for Extraction Plans are required to be risk-based in accordance with development consent Condition 7(i)(i) of SSD_5581, Draft Guidelines for the Preparation of Extraction Plans (DP&E, 2015) and the Managing Risks of Subsidence Guideline (NSW Resources Regulator - Mine Safety, 2017).
This Subsidence and Environmental Risk Assessment is intended to identify the potential risks to sensitive natural and built features, as well as risks to the health and safety of workers and other persons from subsidence caused by the proposed secondary extraction to inform the development of the MW17-19 PPMZ Extraction Plan and the supporting component plans.
Previous and current risk assessments, specialist investigations, ongoing consultation processes with stakeholders, and mining experience using miniwall mining techniques at Airly Mine to date, have all helped to inform the assessment of potential risks

# 2. Objective

The following Hierarchy of Controls offers a framework for considering the effectiveness of controls. Note that the effectiveness of a control that is intended to reduce a risk decreases from top to bottom of the list. In other words, the closer the control type is to the top of the hierarchy, the more potentially effective the control.

·Eliminate the hazard or energy source (do not use the energy)
·Minimise or replace the hazard or energy source (reduce the amount of energy to a less damaging level or replace the energy with another that has less potential negative consequences)
·Control the hazard or energy using engineered devices (ex. Lock outs, chemical containers, mechanical roof support, gas monitors, etc.)
·Control the hazard or energy by using physical barriers (ex. machine guarding, fences or enclosures, etc.)
·Control the hazard or energy with procedures (ex. Isolation procedures, standard operating procedures, etc.)

·Control the hazard or energy with personal protective equipment (ex. hard hats, boots with toe caps, gloves, safety glasses, welding gear, etc.)
·Control the hazard or energy with warnings and awareness (ex. posters, labels, warning signs, verbal warnings, etc.)

The key objectives of this document are to identify, assess and control the potential risks to sensitive natural and built features, as well as risks to the health and safety of workers and other persons on the surface associated with subsidence to safely carry out the MW17-19 PPMZ Extraction Plan. The following process has been undertaken to support this key objective:
-Determine the part of the Extraction Plan Area that will be potentially affected by subsidence within the scope of this risk assessment;
-Define the period of mining and potential subsidence movements/impact within the Extraction Plan Area.
-Develop a register of natural and built features (including public use areas) that would potentially be impacted by subsidence over the Extraction Plan study area; and
-Assess the predicted levels of subsidence and levels of potential impact in the various parts of the study area, including consideration of uncertainty or potential for impacts beyond predictions.
-Determine the level of risk for each identified feature classification for the level of subsidence in the Extraction Plan Area given current controls using the Centennial Risk Matrix.

# 3. Potential Hazards

The natural and built features relevant to the MW17-19 PPMZ Extraction Plan are identified in the checklist provided in *Attachment A - Identification of Natural and Built Features Checklist (see the EP Main Report)*. Further information on these relevant features is provided within the MW17-19 PPMZ Extraction Plan and the supporting component plans.
**The following relevant features within the EP Area have been considered within this risk assessment:**
-Cliffs and Minor Cliffs
-Pagodas and rock formations
-Steep Slopes
-General Land Surface of the Mugii Murum-ban SCA
-Surface Water Courses
-Groundwater (including potential for Groundwater dependant ecosystems, stygofauna and any potential private bores)
-Terrestrial Ecology - including threatened flora and fauna species, populations and ecological communities (or their habitats),occurring in the Extraction Plan Area, as listed under the NSW Biodiversity Conservation Act 2016 (BC Act) and/or listed under the Commonwealth Environment Protection and Biodiversity Act 1999 (EPBC Act)
-Aquatic Ecology - Including threatened species and Key Fish Habitat as listed under the Fisheries Management Act 1994 (FM Act)
-Heritage Sites (Aboriginal and Cultural Heritage sites and Historic Heritage sites) if/where located within the Extraction Plan Area.
-Any Built Features within EP Area including minor unsealed 4WD tracks and trails and related gates.
The location of key sensitive surface features (built and environmental) within and surrounding the EP Area are illustrated in figures considered during the risk assessment.

**Major Potential Hazards Considered:**
-Potential for impacts of greater than predicted subsidence due to factors affecting subsidence and uncertainties.
-Potential for impacts or significant rock falls to cliffs, minor cliffs or pagodas (particularly beyond performance measures prescribed by consent SSD_5581).
-Potential for public safety hazards (primarily due to the above).
-Potential for impacts on built features (SCA management trails and other unsealed 4wd tracks)
-Potential for impacts on threatened biodiversity, including threatened flora and fauna or their habitats occurring within the EP area.
-Potential for impacts on surface water and groundwater (including potential for Groundwater Dependent Ecosystems or stygofauna).
-Potential for impacts on downstream threatened fish habitat such as the Capertee River downstream from the Project area which is mapped as habitat for the Macquarie Perch (*Macquaria australasica*: Threatened species under the FM Act) and the Genowlan Creek, which is mapped as Key Fish Habitat under the FM Act.
-Potential for impacts to heritage sites (Historic Heritage and Aboriginal and Cultural Heritage sites)

# 4a. Risk Assessment Boundary Definition

The scope of this risk assessment is limited as follows:
-Spatial extent is limited to the MW17-19 PPMZ Extraction Plan Area (refer definition below).
-Includes all proposed underground workings (development and secondary extraction) where miniwall operations will take place in the Extraction Plan Area (as defined in the MW17-19 PPMZ Extraction Plan).
-Boundary for risk assessment conservatively includes an extended monitoring and management area beyond the Principal Subsidence Management Area out to the extent of the adjacent CLZ.
-Only aspects potentially affected directly by subsidence are considered, other secondary environmental risks (e.g. associated with coal processing) are beyond the scope of this risk assessment.
-Assesses all surface and sub-surface features, including both natural and built features, that may have the potential to be adversely impacted by subsidence. Features for risk assessment were based upon those identified in the checklist provided in *Attachment A - Identification of Natural and Built Features Checklist (see the EP Main Report).*
-Assesses the potential risks to all personnel underground and any person/s accessing the Extraction Plan (surface) Area, including any members of the public accessing the Mugii Murum-ban State Conservation Area, mine site personnel, contractors working for Airly Mine, National Parks and Wildlife Officers performing their duties.
-The focus is for secondary extraction by miniwall narrow panel extraction techniques which are designed to limit subsidence. Other mining methods approved by consent SSD_5581 are beyond scope

Additional notes for specific exclusions for this Risk Assessment:
-Any lands outside the MW17-19 PPMZ Extraction Plan Area. In particular, this exclusion applies to the eastern area of Genowlan Mountain (i.e. Genowlan Point).
-Existing approved EP Areas (and existing approved mining). Parts of the Extended Monitoring and Management Area overlap with areas of first workings (only) under the approved Cliff Line Zone of First Workings Extraction Plan (ML1331). Mining in the Extended Monitoring and Management Area will be managed in

accordance with the approved Extraction Plan and is excluded from the Risk Assessment.
-Impacts caused by natural (non-mining induced) processes including (but not limited to) erosion by wind or rain or streams, cliff falls not related to mining, impacts of drought or flooding, impacts from users of the SCA.
-Underground mine safety

**MW17-19 PPMZ Extraction Plan Area**
This risk assessment applies to the MW17-19 PPMZ Extraction Plan Area, which is comprised of two key components as defined below:
-Principal Subsidence Management Area
-Proposed mine development (first workings) and second workings associated with miniwall panels MW17-MW19 within the Panel and Pillar Mining Zone beneath Genowlan Mountain, approved under SSD_5581 and located within parts of both Mining Lease ML1331 and ML1814.
-Development of 20mm line on plans showing limit of vertical subsidence
-26.5 degree setback from the tops of cliffs located within the Cliff Line Zone of to all second workings (i.e. miniwall panels MW17-MW19).

**Extended Monitoring and Management Area**
-Monitoring and management area only for this Extraction Plan (no proposed mining within this Extraction Plan)
-This area lies entirely beyond the 26.5 degree setback from the tops of cliffs located within the Cliff Line Zone and Zone of First Workings (CLZ) to all panels MW17-MW19.
-Conservatively monitors sensitive features located beyond the Near-field / Principal Subsidence Management Area for potential subsidence effects further afield.
-Primarily comprises cliffs and pagodas contained within the CLZ surrounding Genowlan Mountain.
-The Extended Monitoring and Management Area is proposed as a precautionary approach to demonstrate the mining methods and involves conservative monitoring and management of sensitive features within this area.

# 5. Risk Assessment Methods

**Risk Assessment Methods:**

**Workplace Risk Assessment and Control (WRAC):** Yes

**Fault Tree Analysis (FTA):**

**Safety Integrity Level Analysis to Australian Standard 61508 (SIL):**

**Bow Tie Analysis (BTA):**

**Failure Modes and Effects Analysis (FMEA):**

**Hazard and Operability Analysis (HAZOP):**

# 6. Previous Risk Assessment and other documents to be used and/or referenced

| Document Name | Title | Version | Referenced Document Date |
|---|---|---|---|

| Document Name | Title | Version | Referenced Document Date |
|---|---|---|---|
| Cliff Line Zone of First Workings Extraction Plan (ML1331) - Subsidence Environmental Risk Assessment (2017) | Risk assessment regarding potential impacts from mining within the Cliff Line Zone of First Workings Extraction Plan of ML1331, parts of which are included in this Extraction Plan Area. | Rev1 | 01-Sep-2017 |
| Mt Airly PPMZ Extraction Plan (ML1331) - Subsidence Environmental Risk Assessment (2019) | Risk assessment regarding potential impacts from miniwall operations in the Panel and Pillar Mining Zone beneath the Mt Airly mesa | Rev1 | 20-Mar-2019 |
| Subsidence and Environmental Risk Assessment: Genowlan PPMZ Stage 1 Area (2019) | The initial risk assessment regarding subsidence and environmental risks for this Extraction Plan to inform development of a baseline monitoring program. | Rev0 | 13-Nov-2019 |
| Airly Mine Subsidence and Pillar Width Modelling Assessment - Point Hatteras Mining Area, Mt Genowlan AIRLY5265 (SCT, 2021) | Modelling assessment for appropriate pillar sizes for the mining operation to control the subsidence to 125mm. | Final | 27-Jul-2021 |
| Airly Mine – Point Hatteras Cliff Impact Assessment Report Due to proposed extraction of Miniwalls 13 to 16 (MSEC, 2021) | Details the site inspection undertaken to supplement the extensive aerial photogrammetry and cliff identification work to verify the cliff mapping being used to inform mine design and assess the stability of cliff, minor cliffs, pagodas or other sensitive surface features based on the subsidence modelling by SCT. | 0 | 01-Jul-2021 |
| Point Hatteras Panel and Pillar Mining Zone: Baseline Ecology Assessment Report (RPS, 2021) | Characterisation of the composition and status of flora and fauna within the Project Area and identification of any data gaps to address during an onsite risk assessment workshop. | V1.0 | 23-Jul-2021 |
| Point Hatteras, Airly: Heritage Baseline Assessment (RPS, 2021) | Full desktop review of the previous field data collected and reports and plans relevant to the project to identify the heritage items within the region and data gaps to be addressed during the proposed onsite risk assessment workshop. | V1.0 | 25-Jun-2021 |
| Pt Hatteras Panel and Pillar Extraction Plan MW13-MW16 | Risk assessment regarding potential impacts from miniwall operations in the Panel and Pillar Mining Zone beneath Pt Hatteras | Rev 0 | 29-Jul-2021 |
| Pt Hatteras Panel and Pillar Extraction Plan MW13-MW16 | Risk assessment regarding potential impacts from miniwall operations in the Panel and Pillar Mining Zone beneath Pt Hatteras | Rev 1 | 08-Oct-2021 |

# 7. Information Required for Risk Assessment

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# 8. Venue and Time

| Date | Description | Location | Start Time | End Time | Comment |
|---|---|---|---|---|---|
| 1. 13-Jul-2022 | Scope, assess and review | Airly Mine | 10:30 AM | 3:00 PM | |

# 9. Risk Assessment Team Selection

| Name | Position | Company | Industry Start Date | E-Mail Address | Role | Experience relevant to the role in the risk assessment | Pulse User No. | Attendance |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 1. 13-Jul-2022 |
| Sam Price | Environment & Community Officer | Airly Coal P/L | 19-Jan-2009 | sam.price@centennialcoal.com.au | Team Member | Site environmental manager G2 Qualification | 90039 | P |
| Anthony Reid | Consultant | Catalyst | | | Consultant | Extraction plan preparation, environmental consultant | | P |
| Jacqueline Cooke RIIRIS402D | Mining Engineer / Compliance Manager | Airly Coal P/L | 12-Feb-2001 | Jacqueline.Cooke@centennialcoal.com.au | Facilitator | +10 Years RA facilitaiton, Mining Engineer | 90030 | P |
| Brett Haddon | Statutory Mine Surveyor | Airly Coal P/L | | brett.haddon@centennialcoal.com.au | | | 90045 | pr |
| Peter Corbett | General Manager Technical Services | Centennial Coal | 11-Mar-1992 | peter.corbett@centennialcoal.com.au | | | 111 | P |
| Martin Kimber | Mining Engineer | Airly Coal P/L | 14-Dec-1970 | | Team Member | + 50 Mining Management | | P |
| Ryan Davidson | Mine Manager | Airly Coal P/L | | | Risk Assessment Owner | Mine Manager, Technical services, Mining Engineer | 0196 | P |

# WRAC Analysis Worksheet

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| 1. **Cliffs and minor cliffs** located within Extraction Area (Near-Field / Principal Subsidence management Area) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 1.1.a. Mine design limits subsidence to level where surface cracking will not occur. | **D** (IF) | 3 (R) | **9 (M)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | **No** |
| | | 1.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 1.1.c. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| | | 1.1.d. Routine high resolution 3D Photogrammetry | | | | | |
| | | 1.1.e. Performance Criteria limits set by SSD_5581 | | | | | |
| | | 1.1.f. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | | |
| | | 1.1.g. Mine design reviewed in the context of subsidence monitoring over Mt Airly. | | | | | |
| | | 1.1.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | | |
| | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or | 1.2.a. Mine design limits subsidence to level where surface cracking will not occur. | **D** (IF) | 3 (PI) | **9 (M)** | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). | **No** |
| | | 1.2.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| | Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | 1.2.c. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 1.2.d. Routine high resolution 3D Photogrammetry | | | | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 1.2.e. Performance Criteria limits set by SSD_5581 | | | | | |
| | | 1.2.f. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | | |
| | | 1.2.g. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | | |
| 2. **Cliffs and minor cliffs** located within Extended Monitoring & Management Area (Cliff Line Zone) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 2.1.a. Mine design limits subsidence to level where surface cracking will not occur. | **D** (IF) | 3 (R) | **9 (M)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 2.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 2.1.c. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| | | 2.1.d. Routine high resolution 3D Photogrammetry | | | | | |
| | | 2.1.e. Performance Criteria limits set by SSD_5581 | | | | | |
| | | 2.1.f. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| | | 2.1.g. Mine design reviewed in the context of subsidence monitoring over Mt Airly. | | | | | |
| | | 2.1.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | | |
| | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | 2.2.a. Mine design limits subsidence to level where surface cracking will not occur. | **D** (IF) | 3 (PI) | **9 (M)** | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). | |
| | | 2.2.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . | |
| | | 2.2.c. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 2.2.d. Routine high resolution 3D Photogrammetry | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 2.2.e. Performance Criteria limits set by SSD_5581 | | | | | |
| | | 2.2.f. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | | |
| | | 2.2.g. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | | |
| 3. **Pagodas** / **Rock Formations** Located within the Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Cracking of pagodas or rock formations :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set | 3.1.a. Pagodas are more stable and capable of resisting subsidence impacts than cliffs | **E** (D) | 3 (R) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 3.1.b. Mine design limits subsidence to level where surface cracking will not occur. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 3.1.c. Subsidence impact review for the | | | | 3. Develop numerical modelling by SCT with a | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| | back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | high level of confidence of meeting the EIS criteria for subsidence | |
| | | 3.1.d. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | | |
| | | 3.1.e. Routine high resolution 3D Photogrammetry | | | | | |
| | | 3.1.f. Performance Criteria limits set by SSD_5581 | | | | | |
| | | 3.1.g. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | | |
| | | 3.1.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | | |
| | There is a risk to Airly from<br><br>::: Cracking of pagodas or rock formations :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | 3.2.a. Pagodas are more stable and capable of resisting subsidence impacts than cliffs | **E** (D) | 3 (R) | **6 (L)** | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). | |
| | | 3.2.b. Mine design limits subsidence to level where surface cracking will not occur. | | | | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . | |
| | | 3.2.c. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 3.2.d. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 3.2.e. Routine high resolution 3D Photogrammetry | | | | | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| | | 3.2.f. Performance Criteria limits set by SSD_5581 | | | | | |
| | | 3.2.g. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | | |
| | | 3.2.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | | |
| 4. **Pagodas** / **Rock Formations** Located within the Extended Monitoring & Management Area | There is a risk to Airly from<br><br>::: Cracking of pagodas or rock formations :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 4.1.a. Pagodas are more stable and capable of resisting subsidence impacts than cliffs | **E** (D) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 4.1.b. Mine design limits subsidence to level where surface cracking will not occur. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 4.1.c. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| | | 4.1.d. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | | |
| | | 4.1.e. Routine high resolution 3D Photogrammetry | | | | | |
| | | 4.1.f. Performance Criteria limits set by SSD_5581 | | | | | |
| | | 4.1.g. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | | |
| | | 4.1.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | | |
| | There is a risk to Airly from | 4.2.a. Pagodas are more stable and | **E** | 1 | **1** | 4. Consult with NPWS on Safety Warning | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| | ::: Cracking of pagodas or rock formations :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | capable of resisting subsidence impacts than cliffs | (D) | (PI) | **(L)** | Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). | |
| | | 4.2.b. Mine design limits subsidence to level where surface cracking will not occur. | | | | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . | |
| | | 4.2.c. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 4.2.d. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| | | 4.2.e. Routine high resolution 3D Photogrammetry | | | | | |
| | | 4.2.f. Performance Criteria limits set by SSD_5581 | | | | | |
| | | 4.2.g. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | | |
| | | 4.2.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | | |
| 5. **Steep slopes** located within Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA | 5.1.a. Rock slopes are more stable and capable of resisting subsidence impacts than cliffs or pagodas | **E** (D) | 3 (E) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 5.1.b. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 5.1.c. No mining-induced change in hydrology expected (no surface cracking, | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| | Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | no significant changes to drainage profile expected) | | | | criteria for subsidence | |
| | | 5.1.d. Mine design limits subsidence to level where surface cracking will not occur. | | | | | |
| | | 5.1.e. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | | |
| | | 5.1.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | | |
| | | 5.1.g. Limited height of fracturing results in small elastic deformations of overburden sandstone units. | | | | | |
| | | 5.1.h. Groundwater impact has been assessed for modified design based on less than 125mm Subsidence | | | | | |
| | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip: :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | 5.2.a. Rock slopes are more stable and capable of resisting subsidence impacts than cliffs or pagodas | **E** (D) | 3 (PI) | **6 (L)** | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . | |
| | | 5.2.b. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 5.2.c. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 5.2.d. Mine design limits subsidence to level where surface cracking will not occur. | | | | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). | |
| | | 5.2.e. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| | | by IEP | | | | | |
| | | 5.2.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | | |
| | | 5.2.g. Limited height of fracturing results in small elastic deformations of overburden sandstone units. | | | | | |
| | | 5.2.h. Groundwater impact has been assessed for modified design based on less than 125mm Subsidence | | | | | |
| 6. **Steep slopes** located within Extended Monitoring & Management Area | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 6.1.a. Rock slopes are more stable and capable of resisting subsidence impacts than cliffs or pagodas | **E** (D) | 3 (E) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 6.1.b. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 6.1.c. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| | | 6.1.d. Mine design limits subsidence to level where surface cracking will not occur. | | | | | |
| | | 6.1.e. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | | |
| | | 6.1.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | | |
| | | 6.1.g. Limited height of fracturing results in small elastic deformations of overburden sandstone units. | | | | | |
| | | 6.1.h. Groundwater impact has been assessed for modified design based on | | | | | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| | | less than 125mm Subsidence | | | | | |
| | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | 6.2.a. Rock slopes are more stable and capable of resisting subsidence impacts than cliffs or pagodas | **E** (Pj) | 3 (PI) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 6.2.b. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 6.2.c. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| | | 6.2.d. Mine design limits subsidence to level where surface cracking will not occur. | | | | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). | |
| | | 6.2.e. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . | |
| | | 6.2.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | | |
| | | 6.2.g. Limited height of fracturing results in small elastic deformations of overburden sandstone units. | | | | | |
| | | 6.2.h. Groundwater impact has been assessed for modified design based on less than 125mm Subsidence | | | | | |
| 7. **Surface Water Courses -** Located within the EP Area | There is a risk to Airly from<br><br>::: Cracking of stream channel / localised loss of water flow :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or | 7.1.a. Water courses on the mountain are ephemeral and 1st or 2nd order within EP Area. | **E** (D) | 3 (E) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 7.1.b. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| | Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | consultation with Regulatory authorities. | | | | | |
| | | 7.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | | | | 7. Update Water management Plan to include EP area and re-submit to Planning. | |
| | | 7.1.d. Mine design limits subsidence to level where surface cracking will not occur. | | | | | |
| | | 7.1.e. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | | |
| | | 7.1.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | | |
| | | 7.1.g. No mining-induced change in hydrology beyond EIS predictions expected (no surface cracking, no significant changes to drainage profile expected) | | | | | |
| | | 7.1.h. Performance Criteria limits set by SSD_5581 | | | | | |
| | There is a risk to Airly from<br><br>::: Changes to creek habitat from changes to geomorphology<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 7.2.a. Water courses on the mountain are ephemeral and 1st or 2nd order within EP Area. | **E** (D) | 3 (E) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | **No** |
| | | 7.2.b. Higher order sections of Gap Creek and Genowlan Creek are located beyond the EP Area | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 7.2.c. No mining-induced change in hydrology beyond EIS predictions expected (no surface cracking, no significant changes to drainage profile expected) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| | | 7.2.d. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | | |
| | | 7.2.e. Performance Criteria limits set by SSD_5581 | | | | | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| | | 7.2.f. Predicted subsidence magnitudes are very small relative to credible values and site specific expereince of associated with the onset of damage | | | | | |
| | | 7.2.g. Mine design limits subsidence to level where surface cracking will not occur. | | | | | |
| | | 7.2.h. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | | |
| | | 7.2.i. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | | |
| | | 7.2.j. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | | |
| 8. **Groundwater** - **Aquifers above Lithgow seam** - (including Shallow Quaternary Alluvial, Triassic | There is a risk to Airly from<br><br>::: Loss of ground water that impacts on ground water dependent eco system or water supply :::<br><br>Caused by:<br>▪ Draw down due to depressurisation of Permian and/or Triassic strata, or Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 8.1.a. Limited height of fracturing does not interact with potential aquifers in sandstone | **D** (Pb) | 2 (E) | **5 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 8.1.b. Sandstones are highly fractured, conduits to side of the mountain | | | | | |
| | | 8.1.c. No alluvial basins within the EP Area | | | | | |
| | | 8.1.d. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | | |
| | | 8.1.e. Performance Criteria limits set by SSD_5581 | | | | | |
| | | 8.1.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | | |
| | | 8.1.g. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | | |
| | | 8.1.h. Demonstration and performance of | | | | | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| | | miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | | |
| | | 8.1.i. Stygofauna monitoring program | | | | | |
| 9. **Groundwater** - **Aquifers in and immediately above Lithgow seam** - Permian and Located within the EP Area | There is a risk to Airly from<br><br>::: Loss of ground water that impacts on ground water dependent eco system or water supply beyond approved impact level<br>:::<br><br>Caused by:<br>▪ Draw down due to depressurisation of Permian and/or Triassic strata, or Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 9.1.a. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | **D** (Pb) | 2 (E) | **5 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 9.1.b. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 9.1.c. Mining and monitoring experience to date shows minimal water make in Permian | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| | | 9.1.d. Impact assessed in EIS and approved by consent SSD_5581 | | | | | |
| | | 9.1.e. No users of upper Perminan aquifers | | | | | |
| | | 9.1.f. No defined GDE's within EP Area. Facultative GDEs occur primarily in the Extended Monitoring and management Area. | | | | | |
| | | 9.1.g. Ground water systems in the EP area and adjacent extended monitoring area are in the Narabeen Sandstone and surface alluvial basins. These are not impacted by Miniwall. | | | | | |
| | | 9.1.h. Stygofauna monitoring program | | | | | |
| | | 9.1.i. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | | |
| | | 9.1.j. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | | |
| | | 9.1.k. Subsidence impact review for the proposed EP Area includes consideration | | | | | |

| Step | Potential Incident | Current Controls | L | MR C | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| | | of all the heads of consideration in the NSWRR guidelines (2017) | | | | | |
| | There is a risk to Airly from<br><br>::: Depressurisation of Permian aquifer leading to ground water inflow to mine workings and subsequent dewatering with potential for water quality impacts<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 9.2.a. Impact assessed in EIS and approved by consent SSD_5581 | **E** (Pb) | 1 (L) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 9.2.b. Mining and monitoring experience to date shows minimal water make in Permian | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 9.2.c. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | | |
| | | 9.2.d. Water balance shows deficit and negligible requirement for discharge | | | | | |
| | | 9.2.e. EPL allows for limits in discharge water quality. | | | | | |
| | | 9.2.f. Mine water inflow water quality to date is within EPL limits. | | | | | |
| | | 9.2.g. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | | |
| | | 9.2.h. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | | |
| | | 9.2.i. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | | |
| 10. **Regional Groundwater** - Regional Aquifers - Permian **below** the Lithgow seam and any associated GDEs<br>Located within the EP Area | There is a risk to Airly from<br><br>::: Loss of ground water that impacts on regional ground water dependent eco system or water supply<br>:::<br><br>Caused by: | 10.1.a. No significant water sources or aquifers in the floor within the zone of influence of the mine workings. | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 10.1.b. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| | ▪ Upwelling of ground water into mine workings due to mining activity<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | consultation with Regulatory authorities. | | | | | |
| | | 10.1.c. No GDE relying on regional ground water system in EP area | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| | | 10.1.d. Mine Design reviewed by IEP | | | | | |
| | | 10.1.e. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | | |
| | There is a risk to Airly from<br><br>::: Depressurisation of Permian aquifer leading to ground water inflow to mine workings<br>:::<br><br>Caused by:<br>▪ Upwelling of ground water into mine workings due to mining activity<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 10.2.a. Impact assessed in EIS and approved by consent SSD_5581 | **E** (Pb) | 1 (Bl) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 10.2.b. Mine Design reviewed by IEP | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| | | 10.2.c. Mining and monitoring experience to date shows minimal water make in the Lower Permian | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| | | 10.2.d. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | | |
| | | 10.2.e. Water balance shows deficit and negligible requirement for discharge | | | | | |
| | | 10.2.f. EPL allows for limits in discharge water quality. | | | | | |
| | | 10.2.g. Mine water inflow water quality to date is within EPL limits. | | | | | |
| 11. **Groundwater- Centennial surface water monitoring bores** Located within the EP Area | There is a risk to Airly from<br><br>::: Reduction or loss of monitoring capacity<br>:::<br><br>Caused by:<br>▪ Fire<br>▪ lightning<br>▪ Mine design LTA (Less Than Adequate), or | 11.1.a. Ground water monitoring network is designed with multi point vibrating wire Piezometers design to accommodate progressive mining in the EP area. | **C** (Pb) | 2 (Bl) | **8 (M)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 11.1.b. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| | Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br>▪ tree fall<br>▪ Vandilisum<br><br>Resulting in:<br>▪ Non compliance or Reputation or Business interruption.. | 11.1.c. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | 8. Review the adequacy of the groundwater monitoring program for the reviewed layout of the mine plan.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| 12. **Groundwater bores - Private bores**<br>Located within or potentially affected by mining in the EP Area | There is a risk to Airly from<br><br>::: **Not Applicable** (none within potentially affected area) :::<br><br>Caused by:<br>▪<br><br>Resulting in:<br>▪ . | 12.1.a. None identified in the EP area.<br>12.1.b. Bores located beyond the EP Area assessed in EIS (no predicted impact)<br>12.1.c. Three private landholder bores outside of EP areas are monitored quarterly for quality | **E** (D) | 2 (L) | **3 (L)** | | |
| 13. **Groundwater Dependent Ecosystems (GDE's)** | There is a risk to Airly from<br><br>::: Refer Groundwater Aquifers information above which includes information on Groundwater Dependent Ecosystems and facultative ecosystems. :::<br><br>Caused by:<br>▪<br><br>Resulting in:<br>▪ . | 13.1.a. No defined GDE's within EP Area. Facultative GDEs occur primarily in the Extended Monitoring and management Area.<br>13.1.b. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities.<br>13.1.c. Site Biodiversity MP | **E** (D) | 2 (E) | **3 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | |
| 14. **Groundwater Stygofauna -**<br>Located within the EP Area | There is a risk to Airly from<br><br>::: Mining related impacts to stygofauna :::<br><br>Caused by:<br>▪ Mining<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 14.1.a. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities.<br>14.1.b. Stygofauna monitoring program<br>14.1.c. Site Biodiversity MP | **D** (Pb) | 2 (E) | **5 (L)** | | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
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| 15. **Threatened AQUATIC FAUNA & potential habitat for threatened fauna and KEY FISH HABITAT (e.g. dragon fly,Macquarie perch)** Located within and downstream of the EP Area | There is a risk to Airly from<br><br>::: Loss of stream flow - degradation or loss of species or habitat :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 15.1.a. None identified in the EP area.<br>15.1.b. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities.<br>15.1.c. Site Biodiversity MP<br>15.1.d. Aquatic ecology monitoring in accordance with the Site WMP.<br>15.1.e. Water courses on the mountain are ephemeral and 1st or 2nd order within EP Area.<br>15.1.f. Higher order sections of Gap Creek and Genowlan Creek are located beyond the EP Area<br>15.1.g. Mine design limits subsidence to level where surface cracking will not occur.<br>15.1.h. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>15.1.i. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| 16. **Threatened terrestrial FAUNA** Located within the EP Area - Threatened birds and habitat for bird species e.g. Hollow dependent owls, Glossy Black Cockatoo, Gang Gang Cockatoo, Flame Robin, Scarlett Robin, Varied Sitella | There is a risk to Airly from<br><br>::: degradation or loss of species or habitat :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or | 16.1.a. Site Biodiversity MP<br>16.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>16.1.c. Mine design limits subsidence to level where surface cracking will not occur.<br>16.1.d. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | **E** (Pb) | 2 (E) | **3 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
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| | Reputation or Social impact or Business interruption.. | 16.1.e. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | | | | | |
| 17. **Threatened terrestrial FAUNA**<br>Located within the EP Area - Threatened mammal species (excluding microbats) and their habitats e.g. Gliders, Koala, Spotted Tail Quoll, Rock Wallaby | There is a risk to Airly from<br><br>::: degradation or loss of species or habitat :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 17.1.a. Site Biodiversity MP<br>17.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>17.1.c. Mine design limits subsidence to level where surface cracking will not occur.<br>17.1.d. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>17.1.e. Mine design limits subsidence to level where surface cracking will not occur. | **E** (Pb) | 1 (R) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| 18. **Threatened terrestrial FAUNA**<br>Located within the EP Area - Threatened Reptile species and their habitats - e.g. broad headed snake | There is a risk to Airly from<br><br>::: degradation or loss of species or habitat :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 18.1.a. Site Biodiversity MP<br>18.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>18.1.c. Mine design limits subsidence to level where surface cracking will not occur.<br>18.1.d. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| 19. **Threatened terrestrial FAUNA**<br>Located within the EP Area - Microbats and their habitats (Cliff rock overhangs and tree hollows) e.g. Eastern False Pipestrelle, Eastern Free Tailed Bat, Large Bent Wing Bat, Large-eared Pied Bat, Little Bent-winged Bat, Little | There is a risk to Airly from<br><br>::: Degradation or loss of species or habitat :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA | 19.1.a. Site Biodiversity MP<br>19.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>19.1.c. Mine design limits subsidence to | **D** (Pb) | 2 (E) | **5 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
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| Pied Bat. | Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | level where surface cracking will not occur.<br>19.1.d. Hollow bearing trees are avoided in installation of subsidence monitoring infrastructure. | | | | | |
| 20. **Threatened FLORA**<br>Threatened flora and fauna located within the EP Area e.g. E Canonii, P Stricta | There is a risk to Airly from<br>::: Degradation or loss of species or habitat :::<br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 20.1.a. Site Biodiversity MP<br>20.1.b. E Canonii and P Stricta not ground or surface water dependent plants.<br>20.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>20.1.d. Ground disturbance permit prior to clearing.<br>20.1.e. Mine design limits subsidence to level where surface cracking will not occur. | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| 21. **Endangered Ecological Communities (EEC)**<br>Located within the EP Area | There is a risk to Airly from<br>::: Changes in species diversity or extent within EECs :::<br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br>Resulting in:<br>▪ Environmental damage / loss of biodiversity or Loss of Intergenerational Equity, or Non compliance or Reputation or Social impact or Business interruption.. | 21.1.a. Site Biodiversity MP<br>21.1.b. Predicted subsidence magnitudes are very small relative to credible values and site specific expereince of associated with the onset of damage<br>21.1.c. Mine design limits subsidence to level where surface cracking will not occur.<br>21.1.d. Not ground or surface water dependent plants.<br>21.1.e. Ground disturbance permit prior to clearing. | **E** (Pb) | 2 (E) | **3 (L)** | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| 22. **Natural vegetation - (General, including sheltered gullies)**<br>Located within the EP Area | There is a risk to Airly from<br>::: Changes in species diversity or extent :::<br>Caused by: | 22.1.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
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| | ▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 22.1.b. Site Biodiversity MP | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| | | 22.1.c. Mine design limits subsidence to level where surface cracking will not occur. | | | | | |
| | | 22.1.d. Not ground or surface water dependent plants. | | | | | |
| | | 22.1.e. Ground disturbance permit prior to clearing. | | | | | |
| 23. **Unsealed Roads, four wheel drive tracks and trails (SCA Management Trails)** Located within the EP Area | There is a risk to Airly from<br><br>::: Damage to road/track/trail surface from cracking or slabbing, or rock fall from adjacent cliffs, pagodas and steep slope areas :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) or Reputation or Social impact.. | 23.1.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | **E** (Pb) | 1 (R) | **1 (L)** | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . | |
| | | 23.1.b. Mine design limits subsidence to level where surface cracking will not occur. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| | | 23.1.c. Agreed road maintenance program for Mt Genowlan with NPWS. | | | | 6. Incorporate Build features within the EP or land management plan | |
| | | | | | | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). | |
| | | | | | | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| 24. **Aboriginal and Cultural Heritage Sites** Located within the EP Area | There is a risk to Airly from<br><br>::: Damage to **Aboriginal and Cultural Heritage Sites** Located within the EP Area :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in: | 24.1.a. Mine design limits subsidence to level where surface cracking will not occur. | **E** (Pb) | 2 (R) | **3 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 24.1.b. Site Aboriginal and Cultural Heritage Management Plan (Site ACHMP) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| | | 24.1.c. Regional Aboriginal and Cultural Heritage Management Plan (Regional ACHMP) | | | | | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
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| | ▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | | | | | | |
| 25. **Historic Heritage** / Sites of Archaeological heritage significance Located within the EP Area (e.g Airly Village ruins sites associated with the former New Hartley Shale Mine) | There is a risk to Airly from<br><br>::: Damage to heritage item as a result of cliff fall from cliffs adjacent to shale mine interaction zone :::<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 25.1.a. No known historic heritage sites in the EP Area.<br>25.1.b. Not Applicable | **E** (Pb) | 1 (R) | **1 (L)** | | |
| 26. **Other Significant Built Features** (e.g. Trig Station etc) located within the Area | There is a risk to Airly from<br><br>::: Mining induced impacts to significant built features :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Damage to built feature, Public safety hazard (personal injury PI) or Reputation or Social impact.. | 26.1.a. Mine design limits subsidence to level where surface cracking will not occur.<br>26.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | **D** (Pb) | 2 (R) | **5 (L)** | 6. Incorporate Build features within the EP or land management plan<br>1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| 27. **Geological Structures** (including faults, folds, sills or dykes)<br>Located within the EP Area | There is a risk to Airly from<br><br>::: Increased subsidence / impacts arising from potential effects of geological structures (local or regional) | 27.1.a. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>27.1.b. Mine design limits subsidence to | **C** (Pb) | 2 (R) | **8 (M)** | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
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| | ::: <br><br> Caused by: <br> ▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA <br><br> Resulting in: <br> ▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | level where surface cracking will not occur. <br> 27.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage <br> 27.1.d. Geotechnical characterisation (GRR) . | | | | | |
| 28. **Far Field Movements and Effects** beyond the EP Area | There is a risk to Airly from <br><br> ::: Mining induced far field movements potentially impacting surface features (eg cliffs and pagodas) beyond approved consent criteria/performance measures, and affecting the extent of the required management area (EP Area) <br> ::: <br><br> Caused by: <br> ▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA <br><br> Resulting in: <br> ▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 28.1.a. Far field movements are limited by the boundary of the mesa <br> 28.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) <br> 28.1.c. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence <br> 28.1.d. Mine design limits subsidence to level where surface cracking will not occur. <br> 28.1.e. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage <br> 28.1.f. Geotechnical characterisation (GRR) . | **E** (Pb) | 2 (L) | **3 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| 29. **Valley Closure or Upsidence Movements and Effects** within and beyond the EP Area (gorges, valleys,creek crossings) | There is a risk to Airly from <br><br> ::: Mining induced valley closure movements potentially causing impacts to natural features such as cliffs, minor cliffs and pagodas within and beyond the EP Area beyond approved consent criteria/performance measures ::: | 29.1.a. Limited height of fracturing results in small elastic deformations of overburden sandstone units. <br> 29.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. <br> 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
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| | Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 29.1.c. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | | |
| | | 29.1.d. Higher order sections of Gap Creek and Genowlan Creek are located beyond the EP Area | | | | | |
| | | 29.1.e. Water courses on the mountain are ephemeral and 1st or 2nd order, such that potential consequences of upsidence would be negligible. | | | | | |
| | | 29.1.f. Geotechnical characterisation (GRR) . | | | | | |
| 30. **Shear Strain Effects (on Built Features)** (particularly to dwellings & infrastructure in deep DOC) | There is a risk to Airly from<br><br>::: Mining induced movements and effects causing impacts to built features (including trig station) within and beyond the EP Area, beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 30.1.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | **D** (Pb) | 3 (F) | **9 (M)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 30.1.b. Mine design limits subsidence to level where surface cracking will not occur. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| | | 30.1.c. Geotechnical characterisation (GRR) . | | | | 9. Reveiw GNSS monitoring system to determine suitable alernative should a single unit or whole system fail. Communicate to TSM and Compliance Manager | |
| | | 30.1.d. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | | |
| 31. **Movements and Effects Beyond Predictions** within and beyond the EP Area | There is a risk to Airly from<br><br>::: Mining induced movements and effects BEYOND PREDICTIONS potentially causing impacts to natural features (including cliffs, minor cliffs and pagodas) within and beyond the EP Area, beyond approved consent | 31.1.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | **D** (Pb) | 3 (F) | **9 (M)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | |
| | | 31.1.b. Mine design limits subsidence to level where surface cracking will not occur. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
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| | criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 31.1.c. Geotechnical characterisation (GRR) .<br>31.1.d. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>31.1.e. Sequential pillar extraction with real time monitoring enables intervention prior to exceding predictions. | | | | criteria for subsidence | |
| | There is a risk to Airly from<br><br>::: Mining induced effects BEYOND PREDICTIONS causing surface cracking and gas release (e.g.with public safety implications) :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 31.2.a. Negligible levels of seam gas<br>31.2.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>31.2.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>31.2.d. Sequential pillar extraction with real time monitoring enables intervention prior to exceding predictions.<br>31.2.e. Mine design limits subsidence to level where surface cracking will not occur.<br>31.2.f. Geotechnical characterisation (GRR) . | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| 32. **Sinkhole development** within or beyond the EP Area | There is a risk to Airly from<br><br>::: Mining induced development of sinkhole(s) with associated potential impact to public safety, drainage and/or surface features (including cliffs, minor cliffs and pagodas) located within or beyond in the EP Area, above approved consent criteria/performance measures ::: | 32.1.a. Not applicable at depths of cover in EP Area | **E** (Pb) | 1 (PI) | **1 (L)** | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
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| | Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | | | | | detect levels of subsidence that cause impact and a TARP. | |
| 33. **Steeply Dipping Terrain Effects**<br>- Potential for interaction between workings downslope of the CLZ and extraction within the EP Area | There is a risk to Airly from<br><br>::: impact to cliffs and associated features in steeply dipping terrain:: :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 33.1.a. Analysis, including numerical modelling for the Panel & Pillar Mining Zone, indicates negligible potential for stress transfer to downslope workings, due to distance between miniwall void area and split and quartered workings.<br>33.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>33.1.c. The Cliff Line Zone forms a barrier<br>33.1.d. Mine design limits subsidence to level where surface cracking will not occur.<br>33.1.e. Geotechnical characterisation (GRR) . | **E** (Pb) | 3 (L) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | |
| 34. **Roof/Floor Conditions** - Potential impacts of low strength roof and/ or low strength floor | There is a risk to Airly from<br><br>::: Pillar punching occurring :::<br><br>Caused by:<br>▪ low strength roof/ floor material<br>▪ Pillar design LTA<br>▪ pillar stress excessively high<br>▪ Water flooding<br><br>Resulting in:<br>▪ Higher than expected subsidence causing | 34.1.a. Mine Design and Subsidence Monitoring Program reviewed by IEP<br>34.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>34.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>34.1.d. Mine design limits subsidence to level where surface cracking will not occur. | **D** (Pb) | 2 (E) | **5 (L)** | | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| | environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 34.1.e. Geotechnical characterisation (GRR) . | | | | | |
| | There is a risk to Airly from<br><br>::: Systemic failure :::<br><br>Caused by:<br>▪ High proportion of low strength roof material<br>▪ Reactive strata (i.e. tuff material)<br>▪ Water flooding<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 34.2.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>34.2.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>34.2.c. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>34.2.d. Mine design limits subsidence to level where surface cracking will not occur.<br>34.2.e. Geotechnical characterisation (GRR) . | **D** (Pb) | 2 (E) | **5 (L)** | | |
| | There is a risk to Airly from<br><br>::: Excessive Pillar Compression :::<br><br>Caused by:<br>▪ High proportion of low strength roof material<br>▪ Pillar design LTA<br>▪ Reactive strata (i.e. tuff material)<br>▪ Water flooding<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 34.3.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>34.3.b. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>34.3.c. Mine design limits subsidence to level where surface cracking will not occur.<br>34.3.d. Geotechnical characterisation (GRR) .<br>34.3.e. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | **D** (Pb) | 2 (E) | **5 (L)** | | |
| 35. **Interaction with old workings** or proposed/future multi seam mining) potentially affecting | There is a risk to Airly from<br><br>::: Not Applicable | 35.1.a. Not Applicable | () | 0 | **0** | | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| subsidence conditions | :::<br><br>Caused by:<br><br>Resulting in:<br>. | | | | | | |
| 36. **Presence of Massive Strata in Roof or Overburden** | There is a risk to Airly from<br><br>::: **Not Applicable** :::<br><br>Caused by:<br>▪<br><br>Resulting in:<br>▪ . | 36.1.a. Not Applicable | () | 0 | **0** | | |
| 37. **Uncertainty** in subsidence predictions, hazard assessment and underlying inputs/assumptions | There is a risk to Airly from<br><br>::: Uncertainty in predictions and/or subsidence hazard analysis<br>:::<br><br>Caused by:<br>▪ Anomolies/complexities or deterioration in geotechnical conditions<br>▪ Discontinuities, heterogeneity effecting subsidence assessment<br>▪ Inadequate assumptions used in subsidence assessment<br>▪ Inadequate or incomplete data used in subsidence assessment<br>▪ Temporal variability in input data or assumptions used for subsidence assessment<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 37.1.a. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>37.1.b. Baseline subsidence estimates assume conservative input parameters<br>37.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>37.1.d. Mine design limits subsidence to level where surface cracking will not occur.<br>37.1.e. Geotechnical characterisation (GRR) .<br>37.1.f. Data obtained from Point Hatteris extration (MW13-MW16) prior to MW17-MW19 commencing and ability to respond to changes outside of expectations. | **D** (Pb) | 2 (L) | **5 (L)** | | |
| 38. **Delayed** / **Long Term Subsidence** (period/duration of | There is a risk to Airly from | 38.1.a. Baseline subsidence estimates assume conservative input parameters | **D** (Pb) | 2 (L) | **5 (L)** | | |

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control | Bow Tie Extension |
|---|---|---|---|---|---|---|---|
| subsidence management) | ::: Development of delayed or long term subsidence movements beyond predictions (affecting timing / duration of subsidence management) :::<br><br>Caused by:<br>▪ Anomolies/complexities or deterioration in roof/floor/ geotechnical conditions (eg due to clay stone bands)<br>▪ climatic conditions<br>▪ Flooded Workings<br>▪ Geological Structures<br>▪ Nature and magnitude of horizontal stress field<br>▪ Overlying or Underlying Workings<br>▪ Topographic terrain<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 38.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>38.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>38.1.d. Mine design limits subsidence to level where surface cracking will not occur.<br>38.1.e. Geotechnical characterisation (GRR) .<br>38.1.f. Survey methods selected for monitoring are well suited to repeatable survey (if required) to be undertaken | | | | | |
| 39. **Future Developments** / **Change** within EP Area affecting subsidence management | There is a risk to Airly from<br><br>::: Future changes or development within the EP Area influencing management requirements (e.g. long term post-mining intention to transition surface lands from from SCA to NP) :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 39.1.a. No current development plans on Genowlan Mountain under the Draft POM<br>39.1.b. Transition to NP would occur post-relinquishment of the ML (post mining/closure) | **E** (Pb) | 1 (L) | **1 (L)** | | |

# WRAC Analysis Sorted by RR

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| 1. **Cliffs and minor cliffs** located within Extraction Area (Near-Field / Principal Subsidence management Area) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 1.1.a. Mine design limits subsidence to level where surface cracking will not occur. | **D** (IF) | 3 (R) | **9 (M)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 1.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 1.1.c. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 1.1.d. Routine high resolution 3D Photogrammetry | | | | |
| | | 1.1.e. Performance Criteria limits set by SSD_5581 | | | | |
| | | 1.1.f. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 1.1.g. Mine design reviewed in the context of subsidence monitoring over Mt Airly. | | | | |
| | | 1.1.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | |
| 1. **Cliffs and minor cliffs** located within Extraction Area (Near-Field / Principal Subsidence management Area) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), | 1.2.a. Mine design limits subsidence to level where surface cracking will not occur. | **D** (IF) | 3 (PI) | **9 (M)** | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). |
| | | 1.2.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . |
| | | 1.2.c. Performance of miniwall mining to date on Mt Airly which showed negligible impacts | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | when measured subsidence meets EIS criteria. | | | | |
| | | 1.2.d. Routine high resolution 3D Photogrammetry | | | | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 1.2.e. Performance Criteria limits set by SSD_5581 | | | | |
| | | 1.2.f. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 1.2.g. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | |
| 2. **Cliffs and minor cliffs** located within Extended Monitoring & Management Area (Cliff Line Zone) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 2.1.a. Mine design limits subsidence to level where surface cracking will not occur. | **D** (IF) | 3 (R) | **9 (M)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 2.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 2.1.c. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 2.1.d. Routine high resolution 3D Photogrammetry | | | | |
| | | 2.1.e. Performance Criteria limits set by SSD_5581 | | | | |
| | | 2.1.f. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 2.1.g. Mine design reviewed in the context of subsidence monitoring over Mt Airly. | | | | |
| | | 2.1.h. Airly Mine Subsidence and Pillar Width | | | | |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | | Assessment for Point Hatteras | | | | |
| 2. **Cliffs and minor cliffs** located within Extended Monitoring & Management Area (Cliff Line Zone) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | 2.2.a. Mine design limits subsidence to level where surface cracking will not occur. | **D** (IF) | 3 (PI) | **9 (M)** | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). |
| | | 2.2.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . |
| | | 2.2.c. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 2.2.d. Routine high resolution 3D Photogrammetry | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 2.2.e. Performance Criteria limits set by SSD_5581 | | | | |
| | | 2.2.f. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 2.2.g. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | |
| 30. **Shear Strain Effects (on Built Features)** (particularly to dwellings & infrastructure in deep DOC) | There is a risk to Airly from<br><br>::: Mining induced movements and effects causing impacts to built features (including trig station) within and beyond the EP Area, beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Higher than expected subsidence | 30.1.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | **D** (Pb) | 3 (F) | **9 (M)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 30.1.b. Mine design limits subsidence to level where surface cracking will not occur. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 30.1.c. Geotechnical characterisation (GRR) . | | | | 9. Reveiw GNSS monitoring system to determine suitable alernative should a single unit or whole system fail. Communicate to TSM and Compliance Manager |
| | | 30.1.d. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | | | | | |
| 31. **Movements and Effects Beyond Predictions** within and beyond the EP Area | There is a risk to Airly from<br><br>::: Mining induced movements and effects BEYOND PREDICTIONS potentially causing impacts to natural features (including cliffs, minor cliffs and pagodas) within and beyond the EP Area, beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 31.1.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>31.1.b. Mine design limits subsidence to level where surface cracking will not occur.<br>31.1.c. Geotechnical characterisation (GRR) .<br>31.1.d. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>31.1.e. Sequential pillar extraction with real time monitoring enables intervention prior to exceding predictions. | **D** (Pb) | 3 (F) | **9 (M)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| 11. **Groundwater- Centennial surface water monitoring bores** Located within the EP Area | There is a risk to Airly from<br><br>::: Reduction or loss of monitoring capacity :::<br><br>Caused by:<br>▪ Fire<br>▪ lightning<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br>▪ tree fall<br>▪ Vandilisum<br><br>Resulting in: | 11.1.a. Ground water monitoring network is designed with multi point vibrating wire Piezometers design to accommodate progressive mining in the EP area.<br>11.1.b. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities.<br>11.1.c. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | **C** (Pb) | 2 (BI) | **8 (M)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining.<br>8. Review the adequacy of the groundwater monitoring program for the reviewed layout of the mine plan.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | ▪ Non compliance or Reputation or Business interruption.. | | | | | |
| 27. **Geological Structures** (including faults, folds, sills or dykes) Located within the EP Area | There is a risk to Airly from<br><br>::: Increased subsidence / impacts arising from potential effects of geological structures (local or regional) :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 27.1.a. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>27.1.b. Mine design limits subsidence to level where surface cracking will not occur.<br>27.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>27.1.d. Geotechnical characterisation (GRR) . | **C** (Pb) | 2 (R) | **8 (M)** | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| 3. **Pagodas** / **Rock Formations** Located within the Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Cracking of pagodas or rock formations :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 3.1.a. Pagodas are more stable and capable of resisting subsidence impacts than cliffs<br>3.1.b. Mine design limits subsidence to level where surface cracking will not occur.<br>3.1.c. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>3.1.d. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria.<br>3.1.e. Routine high resolution 3D Photogrammetry<br>3.1.f. Performance Criteria limits set by SSD_5581<br>3.1.g. Cliff characterisation studies for Pt | **E** (D) | 3 (R) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | | Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 3.1.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | |
| 3. **Pagodas** / **Rock Formations** Located within the Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Cracking of pagodas or rock formations :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | 3.2.a. Pagodas are more stable and capable of resisting subsidence impacts than cliffs | **E** (D) | 3 (R) | **6 (L)** | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). |
| | | 3.2.b. Mine design limits subsidence to level where surface cracking will not occur. | | | | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . |
| | | 3.2.c. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 3.2.d. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 3.2.e. Routine high resolution 3D Photogrammetry | | | | |
| | | 3.2.f. Performance Criteria limits set by SSD_5581 | | | | |
| | | 3.2.g. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 3.2.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | |
| 5. **Steep slopes** located within Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip :::<br> | 5.1.a. Rock slopes are more stable and capable of resisting subsidence impacts than cliffs or pagodas | **E** (D) | 3 (E) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 5.1.b. Demonstration and performance of | | | | 2. Develop and install subsidence monitoring equipment for |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | baseline and maintained for the required period post mining. |
| | | 5.1.c. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 5.1.d. Mine design limits subsidence to level where surface cracking will not occur. | | | | |
| | | 5.1.e. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | |
| | | 5.1.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| | | 5.1.g. Limited height of fracturing results in small elastic deformations of overburden sandstone units. | | | | |
| | | 5.1.h. Groundwater impact has been assessed for modified design based on less than 125mm Subsidence | | | | |
| 5. **Steep slopes** located within Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip:<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | 5.2.a. Rock slopes are more stable and capable of resisting subsidence impacts than cliffs or pagodas | **E** (D) | 3 (PI) | **6 (L)** | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . |
| | | 5.2.b. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 5.2.c. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 5.2.d. Mine design limits subsidence to level where surface cracking will not occur. | | | | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). |
| | | 5.2.e. Mine Design modified following Mt Airly exceedance of subsidence predictions, | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | | modified Mine Design reviewed by IEP | | | | |
| | | 5.2.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| | | 5.2.g. Limited height of fracturing results in small elastic deformations of overburden sandstone units. | | | | |
| | | 5.2.h. Groundwater impact has been assessed for modified design based on less than 125mm Subsidence | | | | |
| 6. **Steep slopes** located within Extended Monitoring & Management Area | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 6.1.a. Rock slopes are more stable and capable of resisting subsidence impacts than cliffs or pagodas | **E** (D) | 3 (E) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 6.1.b. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 6.1.c. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 6.1.d. Mine design limits subsidence to level where surface cracking will not occur. | | | | |
| | | 6.1.e. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | |
| | | 6.1.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| | | 6.1.g. Limited height of fracturing results in small elastic deformations of overburden sandstone units. | | | | |
| | | 6.1.h. Groundwater impact has been assessed for modified design based on less than 125mm Subsidence | | | | |
| 6. **Steep slopes** | There is a risk to Airly from | 6.2.a. Rock slopes are more stable and | **E** | 3 | **6** | 1. Develop an Integrated Subsidence Monitoring Program |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| located within Extended Monitoring & Management Area | ::: Mining-induced surface instability / land slip<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | capable of resisting subsidence impacts than cliffs or pagodas | (Pj) | (PI) | **(L)** | that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 6.2.b. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 6.2.c. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 6.2.d. Mine design limits subsidence to level where surface cracking will not occur. | | | | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). |
| | | 6.2.e. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . |
| | | 6.2.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| | | 6.2.g. Limited height of fracturing results in small elastic deformations of overburden sandstone units. | | | | |
| | | 6.2.h. Groundwater impact has been assessed for modified design based on less than 125mm Subsidence | | | | |
| 7. **Surface Water Courses -** Located within the EP Area | There is a risk to Airly from<br><br>::: Cracking of stream channel / localised loss of water flow<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non | 7.1.a. Water courses on the mountain are ephemeral and 1st or 2nd order within EP Area. | **E** (D) | 3 (E) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 7.1.b. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 7.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | | | | 7. Update Water management Plan to include EP area and re-submit to Planning. |
| | | 7.1.d. Mine design limits subsidence to level where surface cracking will not occur. | | | | |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 7.1.e. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | |
| | | 7.1.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| | | 7.1.g. No mining-induced change in hydrology beyond EIS predictions expected (no surface cracking, no significant changes to drainage profile expected) | | | | |
| | | 7.1.h. Performance Criteria limits set by SSD_5581 | | | | |
| 7. **Surface Water Courses -** Located within the EP Area | There is a risk to Airly from<br><br>::: Changes to creek habitat from changes to geomorphology<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 7.2.a. Water courses on the mountain are ephemeral and 1st or 2nd order within EP Area. | **E** (D) | 3 (E) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 7.2.b. Higher order sections of Gap Creek and Genowlan Creek are located beyond the EP Area | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 7.2.c. No mining-induced change in hydrology beyond EIS predictions expected (no surface cracking, no significant changes to drainage profile expected) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 7.2.d. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | |
| | | 7.2.e. Performance Criteria limits set by SSD_5581 | | | | |
| | | 7.2.f. Predicted subsidence magnitudes are very small relative to credible values and site specific expereince of associated with the onset of damage | | | | |
| | | 7.2.g. Mine design limits subsidence to level where surface cracking will not occur. | | | | |
| | | 7.2.h. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from | | | | |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | | introduction of miniwall on Mt Airly. | | | | |
| | | 7.2.i. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | |
| | | 7.2.j. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| 33. **Steeply Dipping Terrain Effects**<br>- Potential for interaction between workings downslope of the CLZ and extraction within the EP Area | There is a risk to Airly from<br><br>::: impact to cliffs and associated features in steeply dipping terrain:: :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 33.1.a. Analysis, including numerical modelling for the Panel & Pillar Mining Zone, indicates negligible potential for stress transfer to downslope workings, due to distance between miniwall void area and split and quartered workings. | **E** (Pb) | 3 (L) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 33.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 33.1.c. The Cliff Line Zone forms a barrier | | | | |
| | | 33.1.d. Mine design limits subsidence to level where surface cracking will not occur. | | | | |
| | | 33.1.e. Geotechnical characterisation (GRR) . | | | | |
| 8. **Groundwater** - **Aquifers above Lithgow seam** - (including Shallow Quaternary Alluvial, Triassic | There is a risk to Airly from<br><br>::: Loss of ground water that impacts on ground water dependent eco system or water supply<br>:::<br><br>Caused by:<br>▪ Draw down due to depressurisation of Permian and/or Triassic strata, or Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in: | 8.1.a. Limited height of fracturing does not interact with potential aquifers in sandstone | **D** (Pb) | 2 (E) | **5 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 8.1.b. Sandstones are highly fractured, conduits to side of the mountain | | | | |
| | | 8.1.c. No alluvial basins within the EP Area | | | | |
| | | 8.1.d. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | |
| | | 8.1.e. Performance Criteria limits set by SSD_5581 | | | | |
| | | 8.1.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | ▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 8.1.g. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | |
| | | 8.1.h. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | |
| | | 8.1.i. Stygofauna monitoring program | | | | |
| 9. **Groundwater** - **Aquifers in and immediately above Lithgow seam** - Permian and Located within the EP Area | There is a risk to Airly from<br><br>::: Loss of ground water that impacts on ground water dependent eco system or water supply beyond approved impact level :::<br><br>Caused by:<br>▪ Draw down due to depressurisation of Permian and/or Triassic strata, or Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 9.1.a. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | **D** (Pb) | 2 (E) | **5 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 9.1.b. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 9.1.c. Mining and monitoring experience to date shows minimal water make in Permian | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 9.1.d. Impact assessed in EIS and approved by consent SSD_5581 | | | | |
| | | 9.1.e. No users of upper Perminan aquifers | | | | |
| | | 9.1.f. No defined GDE's within EP Area. Facultative GDEs occur primarily in the Extended Monitoring and management Area. | | | | |
| | | 9.1.g. Ground water systems in the EP area and adjacent extended monitoring area are in the Narabeen Sandstone and surface alluvial basins. These are not impacted by Miniwall. | | | | |
| | | 9.1.h. Stygofauna monitoring program | | | | |
| | | 9.1.i. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | |
| | | 9.1.j. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | | 9.1.k. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| 14. **Groundwater Stygofauna -** Located within the EP Area | There is a risk to Airly from<br><br>::: Mining related impacts to stygofauna :::<br><br>Caused by:<br>▪ Mining<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 14.1.a. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities.<br>14.1.b. Stygofauna monitoring program<br>14.1.c. Site Biodiversity MP | **D** (Pb) | 2 (E) | **5 (L)** | |
| 19. **Threatened terrestrial FAUNA** Located within the EP Area - Microbats and their habitats (Cliff rock overhangs and tree hollows) e.g. Eastern False Pipestrelle, Eastern Free Tailed Bat, Large Bent Wing Bat, Large-eared Pied Bat, Little Bent-winged Bat, Little Pied Bat. | There is a risk to Airly from<br><br>::: Degradation or loss of species or habitat :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 19.1.a. Site Biodiversity MP<br>19.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>19.1.c. Mine design limits subsidence to level where surface cracking will not occur.<br>19.1.d. Hollow bearing trees are avoided in installation of subsidence monitoring infrastructure. | **D** (Pb) | 2 (E) | **5 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| 26. **Other Significant Built Features** (e.g. Trig Station etc) located within the Area | There is a risk to Airly from<br><br>::: Mining induced impacts to significant built features :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA | 26.1.a. Mine design limits subsidence to level where surface cracking will not occur.<br>26.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | **D** (Pb) | 2 (R) | **5 (L)** | 6. Incorporate Build features within the EP or land management plan<br>1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | Resulting in:<br>▪ Damage to built feature, Public safety hazard (personal injury PI) or Reputation or Social impact.. | | | | | |
| 34. **Roof/Floor Conditions** - Potential impacts of low strength roof and/ or low strength floor | There is a risk to Airly from<br><br>::: Pillar punching occurring :::<br><br>Caused by:<br>▪ low strength roof/ floor material<br>▪ Pillar design LTA<br>▪ pillar stress excessively high<br>▪ Water flooding<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 34.1.a. Mine Design and Subsidence Monitoring Program reviewed by IEP<br>34.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>34.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>34.1.d. Mine design limits subsidence to level where surface cracking will not occur.<br>34.1.e. Geotechnical characterisation (GRR) . | **D** (Pb) | 2 (E) | **5 (L)** | |
| 34. **Roof/Floor Conditions** - Potential impacts of low strength roof and/ or low strength floor | There is a risk to Airly from<br><br>::: Systemic failure :::<br><br>Caused by:<br>▪ High proportion of low strength roof material<br>▪ Reactive strata (i.e. tuff material)<br>▪ Water flooding<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 34.2.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>34.2.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>34.2.c. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>34.2.d. Mine design limits subsidence to level where surface cracking will not occur.<br>34.2.e. Geotechnical characterisation (GRR) . | **D** (Pb) | 2 (E) | **5 (L)** | |
| 34. **Roof/Floor Conditions** - Potential impacts of low strength roof and/ or low strength floor | There is a risk to Airly from<br><br>::: Excessive Pillar Compression ::: | 34.3.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>34.3.b. Mine design reviewed in the context | **D** (Pb) | 2 (E) | **5 (L)** | |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | Caused by:<br>▪ High proportion of low strength roof material<br>▪ Pillar design LTA<br>▪ Reactive strata (i.e. tuff material)<br>▪ Water flooding<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>34.3.c. Mine design limits subsidence to level where surface cracking will not occur.<br>34.3.d. Geotechnical characterisation (GRR) .<br>34.3.e. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| 37. **Uncertainty** in subsidence predictions, hazard assessment and underlying inputs/assumptions | There is a risk to Airly from<br><br>::: Uncertainty in predictions and/or subsidence hazard analysis<br>:::<br><br>Caused by:<br>▪ Anomolies/complexities or deterioration in geotechnical conditions<br>▪ Discontinuities, heterogeneity effecting subsidence assessment<br>▪ Inadequate assumptions used in subsidence assessment<br>▪ Inadequate or incomplete data used in subsidence assessment<br>▪ Temporal variability in input data or assumptions used for subsidence assessment<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 37.1.a. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>37.1.b. Baseline subsidence estimates assume conservative input parameters<br>37.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>37.1.d. Mine design limits subsidence to level where surface cracking will not occur.<br>37.1.e. Geotechnical characterisation (GRR) .<br>37.1.f. Data obtained from Point Hatteris extration (MW13-MW16) prior to MW17-MW19 commencing and ability to respond to changes outside of expectations. | **D** (Pb) | 2 (L) | **5 (L)** | |
| 38. **Delayed** / **Long Term Subsidence** (period/duration of subsidence management) | There is a risk to Airly from<br><br>::: Development of delayed or long term subsidence movements beyond predictions | 38.1.a. Baseline subsidence estimates assume conservative input parameters<br>38.1.b. Subsidence impact review for the proposed EP Area includes consideration of | **D** (Pb) | 2 (L) | **5 (L)** | |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | (affecting timing / duration of subsidence management) :::<br><br>Caused by:<br>▪ Anomolies/complexities or deterioration in roof/floor/ geotechnical conditions (eg due to clay stone bands)<br>▪ climatic conditions<br>▪ Flooded Workings<br>▪ Geological Structures<br>▪ Nature and magnitude of horizontal stress field<br>▪ Overlying or Underlying Workings<br>▪ Topographic terrain<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | all the heads of consideration in the NSWRR guidelines (2017)<br>38.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>38.1.d. Mine design limits subsidence to level where surface cracking will not occur.<br>38.1.e. Geotechnical characterisation (GRR) .<br>38.1.f. Survey methods selected for monitoring are well suited to repeatable survey (if required) to be undertaken | | | | |
| 12. **Groundwater bores - Private bores**<br>Located within or potentially affected by mining in the EP Area | There is a risk to Airly from<br><br>::: **Not Applicable** (none within potentially affected area) :::<br><br>Caused by:<br>▪<br><br>Resulting in:<br>▪ . | 12.1.a. None identified in the EP area.<br>12.1.b. Bores located beyond the EP Area assessed in EIS (no predicted impact)<br>12.1.c. Three private landholder bores outside of EP areas are monitored quarterly for quality | **E** (D) | 2 (L) | **3 (L)** | |
| 13. **Groundwater Dependent Ecosystems (GDE's)** | There is a risk to Airly from<br><br>::: Refer Groundwater Aquifers information above which includes information on Groundwater Dependent Ecosystems and facultative ecosystems. :::<br><br>Caused by:<br>▪<br><br>Resulting in: | 13.1.a. No defined GDE's within EP Area. Facultative GDEs occur primarily in the Extended Monitoring and management Area.<br>13.1.b. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities.<br>13.1.c. Site Biodiversity MP | **E** (D) | 2 (E) | **3 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | ▪ . | | | | | |
| 16. **Threatened terrestrial FAUNA** Located within the EP Area - Threatened birds and habitat for bird species e.g. Hollow dependent owls, Glossy Black Cockatoo, Gang Gang Cockatoo, Flame Robin, Scarlett Robin, Varied Sitella | There is a risk to Airly from<br><br>::: degradation or loss of species or habitat :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 16.1.a. Site Biodiversity MP<br>16.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>16.1.c. Mine design limits subsidence to level where surface cracking will not occur.<br>16.1.d. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>16.1.e. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | **E** (Pb) | 2 (E) | **3 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| 21. **Endangered Ecological Communities (EEC)** Located within the EP Area | There is a risk to Airly from<br><br>::: Changes in species diversity or extent within EECs :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage / loss of biodiversity or Loss of Intergenerational Equity, or Non compliance or Reputation or Social impact or Business interruption.. | 21.1.a. Site Biodiversity MP<br>21.1.b. Predicted subsidence magnitudes are very small relative to credible values and site specific expereince of associated with the onset of damage<br>21.1.c. Mine design limits subsidence to level where surface cracking will not occur.<br>21.1.d. Not ground or surface water dependent plants.<br>21.1.e. Ground disturbance permit prior to clearing. | **E** (Pb) | 2 (E) | **3 (L)** | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| 24. **Aboriginal and Cultural Heritage Sites** Located within the EP Area | There is a risk to Airly from<br><br>::: Damage to **Aboriginal and Cultural Heritage Sites** Located within the EP Area :::<br><br>Caused by: | 24.1.a. Mine design limits subsidence to level where surface cracking will not occur.<br>24.1.b. Site Aboriginal and Cultural Heritage Management Plan (Site ACHMP)<br>24.1.c. Regional Aboriginal and Cultural | **E** (Pb) | 2 (R) | **3 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | ▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | Heritage Management Plan (Regional ACHMP) | | | | |
| 28. **Far Field Movements and Effects** beyond the EP Area | There is a risk to Airly from<br><br>::: Mining induced far field movements potentially impacting surface features (eg cliffs and pagodas) beyond approved consent criteria/performance measures, and affecting the extent of the required management area (EP Area)<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 28.1.a. Far field movements are limited by the boundary of the mesa<br>28.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>28.1.c. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>28.1.d. Mine design limits subsidence to level where surface cracking will not occur.<br>28.1.e. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>28.1.f. Geotechnical characterisation (GRR) . | **E** (Pb) | 2 (L) | **3 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| 4. **Pagodas** / **Rock Formations** Located within the Extended Monitoring & Management Area | There is a risk to Airly from<br><br>::: Cracking of pagodas or rock formations<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or | 4.1.a. Pagodas are more stable and capable of resisting subsidence impacts than cliffs<br>4.1.b. Mine design limits subsidence to level where surface cracking will not occur.<br>4.1.c. Subsidence impact review for the proposed EP Area includes consideration of | **E** (D) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| | | 4.1.d. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | |
| | | 4.1.e. Routine high resolution 3D Photogrammetry | | | | |
| | | 4.1.f. Performance Criteria limits set by SSD_5581 | | | | |
| | | 4.1.g. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 4.1.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | |
| 4. **Pagodas** / **Rock Formations** Located within the Extended Monitoring & Management Area | There is a risk to Airly from<br><br>::: Cracking of pagodas or rock formations :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | 4.2.a. Pagodas are more stable and capable of resisting subsidence impacts than cliffs | **E** (D) | 1 (PI) | **1 (L)** | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). |
| | | 4.2.b. Mine design limits subsidence to level where surface cracking will not occur. | | | | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . |
| | | 4.2.c. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 4.2.d. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 4.2.e. Routine high resolution 3D Photogrammetry | | | | |
| | | 4.2.f. Performance Criteria limits set by SSD_5581 | | | | |
| | | 4.2.g. Cliff characterisation studies for Pt Hatteras including ground truthing and | | | | |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | | surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 4.2.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | |
| 9. **Groundwater** - **Aquifers in and immediately above Lithgow seam** - Permian and Located within the EP Area | There is a risk to Airly from<br><br>::: Depressurisation of Permian aquifer leading to ground water inflow to mine workings and subsequent dewatering with potential for water quality impacts<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 9.2.a. Impact assessed in EIS and approved by consent SSD_5581 | **E** (Pb) | 1 (L) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 9.2.b. Mining and monitoring experience to date shows minimal water make in Permian | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 9.2.c. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | |
| | | 9.2.d. Water balance shows deficit and negligible requirement for discharge | | | | |
| | | 9.2.e. EPL allows for limits in discharge water quality. | | | | |
| | | 9.2.f. Mine water inflow water quality to date is within EPL limits. | | | | |
| | | 9.2.g. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| | | 9.2.h. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | |
| | | 9.2.i. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | |
| 10. **Regional Groundwater** - Regional Aquifers - Permian **below** the Lithgow seam and any associated GDEs Located within the EP Area | There is a risk to Airly from<br><br>::: Loss of ground water that impacts on regional ground water dependent eco system or water supply<br>::: | 10.1.a. No significant water sources or aquifers in the floor within the zone of influence of the mine workings. | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 10.1.b. Site Water Management Plan incorporating surface and ground water | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | Caused by:<br>▪ Upwelling of ground water into mine workings due to mining activity<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | monitoring program. Developed in consultation with Regulatory authorities. | | | | |
| | | 10.1.c. No GDE relying on regional ground water system in EP area | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 10.1.d. Mine Design reviewed by IEP | | | | |
| | | 10.1.e. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | |
| 10. **Regional Groundwater** - Regional Aquifers - Permian **below** the Lithgow seam and any associated GDEs<br>Located within the EP Area | There is a risk to Airly from<br><br>::: Depressurisation of Permian aquifer leading to ground water inflow to mine workings<br>:::<br><br>Caused by:<br>▪ Upwelling of ground water into mine workings due to mining activity<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 10.2.a. Impact assessed in EIS and approved by consent SSD_5581 | **E** (Pb) | 1 (BI) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 10.2.b. Mine Design reviewed by IEP | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 10.2.c. Mining and monitoring experience to date shows minimal water make in the Lower Permian | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 10.2.d. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | |
| | | 10.2.e. Water balance shows deficit and negligible requirement for discharge | | | | |
| | | 10.2.f. EPL allows for limits in discharge water quality. | | | | |
| | | 10.2.g. Mine water inflow water quality to date is within EPL limits. | | | | |
| 15. **Threatened AQUATIC FAUNA & potential habitat for threatened fauna and KEY FISH HABITAT (e.g. dragon fly,Macquarie perch)**<br>Located within and downstream of the EP Area | There is a risk to Airly from<br><br>::: Loss of stream flow - degradation or loss of species or habitat :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA | 15.1.a. None identified in the EP area. | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 15.1.b. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 15.1.c. Site Biodiversity MP | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 15.1.d. Aquatic ecology monitoring in | | | | |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | accordance with the Site WMP.<br>15.1.e. Water courses on the mountain are ephemeral and 1st or 2nd order within EP Area.<br>15.1.f. Higher order sections of Gap Creek and Genowlan Creek are located beyond the EP Area<br>15.1.g. Mine design limits subsidence to level where surface cracking will not occur.<br>15.1.h. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>15.1.i. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | | | | |
| 17. **Threatened terrestrial FAUNA** Located within the EP Area - Threatened mammal species (excluding microbats) and their habitats e.g. Gliders, Koala, Spotted Tail Quoll, Rock Wallaby | There is a risk to Airly from<br>::: degradation or loss of species or habitat :::<br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 17.1.a. Site Biodiversity MP<br>17.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>17.1.c. Mine design limits subsidence to level where surface cracking will not occur.<br>17.1.d. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>17.1.e. Mine design limits subsidence to level where surface cracking will not occur. | **E** (Pb) | 1 (R) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| 18. **Threatened terrestrial FAUNA** Located within the EP Area - Threatened Reptile species and their habitats - e.g. broad headed snake | There is a risk to Airly from<br>::: degradation or loss of species or habitat :::<br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or | 18.1.a. Site Biodiversity MP<br>18.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>18.1.c. Mine design limits subsidence to level where surface cracking will not occur.<br>18.1.d. Mine design reviewed in the context of subsidence monitoring over Mt Airly and | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |

Instructions:

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| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | | | | |
| 20. **Threatened FLORA**<br>Threatened flora and fauna located within the EP Area e.g. E Canonii, P Stricta | There is a risk to Airly from<br><br>::: Degradation or loss of species or habitat :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 20.1.a. Site Biodiversity MP | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 20.1.b. E Canonii and P Stricta not ground or surface water dependent plants. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 20.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | | | | |
| | | 20.1.d. Ground disturbance permit prior to clearing. | | | | |
| | | 20.1.e. Mine design limits subsidence to level where surface cracking will not occur. | | | | |
| 22. **Natural vegetation - (General, including sheltered gullies)**<br>Located within the EP Area | There is a risk to Airly from<br><br>::: Changes in species diversity or extent :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 22.1.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 22.1.b. Site Biodiversity MP | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 22.1.c. Mine design limits subsidence to level where surface cracking will not occur. | | | | |
| | | 22.1.d. Not ground or surface water dependent plants. | | | | |
| | | 22.1.e. Ground disturbance permit prior to clearing. | | | | |
| 23. **Unsealed Roads, four wheel drive tracks and trails (SCA Management Trails)**<br>Located within the EP Area | There is a risk to Airly from<br><br>::: Damage to road/track/trail surface from cracking or slabbing, or rock fall from adjacent cliffs, pagodas and steep slope areas | 23.1.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | **E** (Pb) | 1 (R) | **1 (L)** | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . |
| | | 23.1.b. Mine design limits subsidence to | | | | 3. Develop numerical modelling by SCT with a high level of |

Instructions:

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| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | ::: | level where surface cracking will not occur. | | | | confidence of meeting the EIS criteria for subsidence |
| | Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) or Reputation or Social impact.. | 23.1.c. Agreed road maintenance program for Mt Genowlan with NPWS. | | | | 6. Incorporate Build features within the EP or land management plan |
| | | | | | | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). |
| | | | | | | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| 25. **Historic Heritage** / Sites of Archaeological heritage significance Located within the EP Area (e.g Airly Village ruins sites associated with the former New Hartley Shale Mine) | There is a risk to Airly from<br><br>::: Damage to heritage item as a result of cliff fall from cliffs adjacent to shale mine interaction zone :::<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 25.1.a. No known historic heritage sites in the EP Area. | **E** (Pb) | 1 (R) | **1 (L)** | |
| | | 25.1.b. Not Applicable | | | | |
| 29. **Valley Closure or Upsidence Movements and Effects** within and beyond the EP Area (gorges, valleys,creek crossings) | There is a risk to Airly from<br><br>::: Mining induced valley closure movements potentially causing impacts to natural features such as cliffs, minor cliffs and pagodas within and beyond the EP Area beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), | 29.1.a. Limited height of fracturing results in small elastic deformations of overburden sandstone units. | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 29.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 29.1.c. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |

Instructions:

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| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 29.1.d. Higher order sections of Gap Creek and Genowlan Creek are located beyond the EP Area<br>29.1.e. Water courses on the mountain are ephemeral and 1st or 2nd order, such that potential consequences of upsidence would be negligible.<br>29.1.f. Geotechnical characterisation (GRR) . | | | | |
| 31. **Movements and Effects Beyond Predictions** within and beyond the EP Area | There is a risk to Airly from<br><br>::: Mining induced effects BEYOND PREDICTIONS causing surface cracking and gas release (e.g.with public safety implications) :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 31.2.a. Negligible levels of seam gas<br>31.2.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>31.2.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>31.2.d. Sequential pillar extraction with real time monitoring enables intervention prior to exceding predictions.<br>31.2.e. Mine design limits subsidence to level where surface cracking will not occur.<br>31.2.f. Geotechnical characterisation (GRR) . | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| 32. **Sinkhole development** within or beyond the EP Area | There is a risk to Airly from<br><br>::: Mining induced development of sinkhole(s) with associated potential impact to public safety, drainage and/or surface features (including cliffs, minor cliffs and pagodas) located within or beyond in the EP Area, above approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or | 32.1.a. Not applicable at depths of cover in EP Area | **E** (Pb) | 1 (PI) | **1 (L)** | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | | | | | |
| 39. **Future Developments / Change** within EP Area affecting subsidence management | There is a risk to Airly from<br><br>::: Future changes or development within the EP Area influencing management requirements (e.g. long term post-mining intention to transition surface lands from from SCA to NP)<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 39.1.a. No current development plans on Genowlan Mountain under the Draft POM<br>39.1.b. Transition to NP would occur post-relinquishment of the ML (post mining/closure) | **E** (Pb) | 1 (L) | **1 (L)** | |
| 35. **Interaction with old workings** or proposed/future multi seam mining) potentially affecting subsidence conditions | There is a risk to Airly from<br><br>::: Not Applicable<br>:::<br><br>Caused by:<br><br>Resulting in:<br>. | 35.1.a. Not Applicable | () | 0 | **0** | |
| 36. **Presence of Massive Strata in Roof or Overburden** | There is a risk to Airly from | 36.1.a. Not Applicable | () | 0 | **0** | |

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | ::: **Not Applicable** :::<br><br>Caused by:<br>▪<br><br>Resulting in:<br>▪ . | | | | | |

# WRAC Analysis Sorted by Consequence

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| 1. **Cliffs and minor cliffs** located within Extraction Area (Near-Field / Principal Subsidence management Area) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 1.1.a. Mine design limits subsidence to level where surface cracking will not occur. | **D** (IF) | 3 (R) | **9 (M)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 1.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 1.1.c. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 1.1.d. Routine high resolution 3D Photogrammetry | | | | |
| | | 1.1.e. Performance Criteria limits set by SSD_5581 | | | | |
| | | 1.1.f. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 1.1.g. Mine design reviewed in the context of subsidence monitoring over Mt Airly. | | | | |
| | | 1.1.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | |
| 2. **Cliffs and minor cliffs** located within Extended Monitoring & Management Area (Cliff Line Zone) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or | 2.1.a. Mine design limits subsidence to level where surface cracking will not occur. | **D** (IF) | 3 (R) | **9 (M)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 2.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 2.1.c. Performance of miniwall mining to | | | | 3. Develop numerical modelling by SCT with a high |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | level of confidence of meeting the EIS criteria for subsidence |
| | | 2.1.d. Routine high resolution 3D Photogrammetry | | | | |
| | | 2.1.e. Performance Criteria limits set by SSD_5581 | | | | |
| | | 2.1.f. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 2.1.g. Mine design reviewed in the context of subsidence monitoring over Mt Airly. | | | | |
| | | 2.1.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | |
| 3. **Pagodas** / **Rock Formations**<br>Located within the Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Cracking of pagodas or rock formations :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 3.1.a. Pagodas are more stable and capable of resisting subsidence impacts than cliffs | **E** (D) | 3 (R) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 3.1.b. Mine design limits subsidence to level where surface cracking will not occur. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 3.1.c. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 3.1.d. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | |
| | | 3.1.e. Routine high resolution 3D Photogrammetry | | | | |
| | | 3.1.f. Performance Criteria limits set by SSD_5581 | | | | |
| | | 3.1.g. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project | | | | |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | | area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 3.1.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | |
| 3. **Pagodas** / **Rock Formations** Located within the Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Cracking of pagodas or rock formations :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | 3.2.a. Pagodas are more stable and capable of resisting subsidence impacts than cliffs | **E** (D) | 3 (R) | **6 (L)** | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). |
| | | 3.2.b. Mine design limits subsidence to level where surface cracking will not occur. | | | | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . |
| | | 3.2.c. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 3.2.d. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 3.2.e. Routine high resolution 3D Photogrammetry | | | | |
| | | 3.2.f. Performance Criteria limits set by SSD_5581 | | | | |
| | | 3.2.g. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 3.2.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | |
| 1. **Cliffs and minor cliffs** located within Extraction Area (Near-Field / Principal Subsidence management Area) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved | 1.2.a. Mine design limits subsidence to level where surface cracking will not occur. | **D** (IF) | 3 (PI) | **9 (M)** | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). |
| | | 1.2.b. Subsidence impact review for the proposed EP Area includes consideration of | | | | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | all the heads of consideration in the NSWRR guidelines (2017) | | | | relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . |
| | | 1.2.c. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 1.2.d. Routine high resolution 3D Photogrammetry | | | | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 1.2.e. Performance Criteria limits set by SSD_5581 | | | | |
| | | 1.2.f. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 1.2.g. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | |
| 2. **Cliffs and minor cliffs** located within Extended Monitoring & Management Area (Cliff Line Zone) | There is a risk to Airly from<br><br>::: Mining induced impacts to cliffs, minor cliffs and pagodas in the EP Area (and/or adjacent to the EP Area) beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | 2.2.a. Mine design limits subsidence to level where surface cracking will not occur. | **D** (IF) | 3 (PI) | **9 (M)** | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). |
| | | 2.2.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . |
| | | 2.2.c. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 2.2.d. Routine high resolution 3D Photogrammetry | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 2.2.e. Performance Criteria limits set by SSD_5581 | | | | |
| | | 2.2.f. Cliff characterisation studies for Pt Hatteras including ground truthing and | | | | |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | | surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 2.2.g. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | |
| 5. **Steep slopes** located within Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip:<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | 5.2.a. Rock slopes are more stable and capable of resisting subsidence impacts than cliffs or pagodas | **E** (D) | 3 (PI) | **6 (L)** | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . |
| | | 5.2.b. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 5.2.c. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 5.2.d. Mine design limits subsidence to level where surface cracking will not occur. | | | | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). |
| | | 5.2.e. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 5.2.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| | | 5.2.g. Limited height of fracturing results in small elastic deformations of overburden sandstone units. | | | | |
| | | 5.2.h. Groundwater impact has been assessed for modified design based on less than 125mm Subsidence | | | | |
| 6. **Steep slopes** located within Extended Monitoring & Management Area | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip | 6.2.a. Rock slopes are more stable and capable of resisting subsidence impacts than cliffs or pagodas | **E** (Pj) | 3 (PI) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | ::: | | | | | TARP. |
| | Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | 6.2.b. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 6.2.c. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 6.2.d. Mine design limits subsidence to level where surface cracking will not occur. | | | | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). |
| | | 6.2.e. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . |
| | | 6.2.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| | | 6.2.g. Limited height of fracturing results in small elastic deformations of overburden sandstone units. | | | | |
| | | 6.2.h. Groundwater impact has been assessed for modified design based on less than 125mm Subsidence | | | | |
| 33. **Steeply Dipping Terrain Effects**<br>- Potential for interaction between workings downslope of the CLZ and extraction within the EP Area | There is a risk to Airly from<br><br>::: impact to cliffs and associated features in steeply dipping terrain:: :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business | 33.1.a. Analysis, including numerical modelling for the Panel & Pillar Mining Zone, indicates negligible potential for stress transfer to downslope workings, due to distance between miniwall void area and split and quartered workings. | **E** (Pb) | 3 (L) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 33.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 33.1.c. The Cliff Line Zone forms a barrier | | | | |
| | | 33.1.d. Mine design limits subsidence to level where surface cracking will not occur. | | | | |
| | | 33.1.e. Geotechnical characterisation (GRR) | | | | |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | interruption, or social impact.. | . | | | | |
| 30. **Shear Strain Effects (on Built Features)** (particularly to dwellings & infrastructure in deep DOC) | There is a risk to Airly from<br><br>::: Mining induced movements and effects causing impacts to built features (including trig station) within and beyond the EP Area, beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 30.1.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | **D** (Pb) | 3 (F) | **9 (M)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 30.1.b. Mine design limits subsidence to level where surface cracking will not occur. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 30.1.c. Geotechnical characterisation (GRR) . | | | | 9. Reveiw GNSS monitoring system to determine suitable alernative should a single unit or whole system fail. Communicate to TSM and Compliance Manager |
| | | 30.1.d. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| 31. **Movements and Effects Beyond Predictions** within and beyond the EP Area | There is a risk to Airly from<br><br>::: Mining induced movements and effects BEYOND PREDICTIONS potentially causing impacts to natural features (including cliffs, minor cliffs and pagodas) within and beyond the EP Area, beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 31.1.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | **D** (Pb) | 3 (F) | **9 (M)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 31.1.b. Mine design limits subsidence to level where surface cracking will not occur. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 31.1.c. Geotechnical characterisation (GRR) . | | | | |
| | | 31.1.d. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| | | 31.1.e. Sequential pillar extraction with real time monitoring enables intervention prior to exceding predictions. | | | | |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| 5. **Steep slopes** located within Extraction Area (Near Field) | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 5.1.a. Rock slopes are more stable and capable of resisting subsidence impacts than cliffs or pagodas | **E** (D) | 3 (E) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 5.1.b. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 5.1.c. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 5.1.d. Mine design limits subsidence to level where surface cracking will not occur. | | | | |
| | | 5.1.e. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | |
| | | 5.1.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| | | 5.1.g. Limited height of fracturing results in small elastic deformations of overburden sandstone units. | | | | |
| | | 5.1.h. Groundwater impact has been assessed for modified design based on less than 125mm Subsidence | | | | |
| 6. **Steep slopes** located within Extended Monitoring & Management Area | There is a risk to Airly from<br><br>::: Mining-induced surface instability / land slip<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA | 6.1.a. Rock slopes are more stable and capable of resisting subsidence impacts than cliffs or pagodas | **E** (D) | 3 (E) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 6.1.b. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 6.1.c. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | expected)<br>6.1.d. Mine design limits subsidence to level where surface cracking will not occur.<br>6.1.e. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP<br>6.1.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>6.1.g. Limited height of fracturing results in small elastic deformations of overburden sandstone units.<br>6.1.h. Groundwater impact has been assessed for modified design based on less than 125mm Subsidence | | | | |
| 7. **Surface Water Courses -** Located within the EP Area | There is a risk to Airly from<br><br>::: Cracking of stream channel / localised loss of water flow<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 7.1.a. Water courses on the mountain are ephemeral and 1st or 2nd order within EP Area.<br>7.1.b. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities.<br>7.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>7.1.d. Mine design limits subsidence to level where surface cracking will not occur.<br>7.1.e. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP<br>7.1.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>7.1.g. No mining-induced change in hydrology beyond EIS predictions expected | **E**<br>(D) | 3<br>(E) | **6**<br>**(L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>7. Update Water management Plan to include EP area and re-submit to Planning. |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | | (no surface cracking, no significant changes to drainage profile expected) | | | | |
| | | 7.1.h. Performance Criteria limits set by SSD_5581 | | | | |
| 7. **Surface Water Courses -** Located within the EP Area | There is a risk to Airly from<br><br>::: Changes to creek habitat from changes to geomorphology<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 7.2.a. Water courses on the mountain are ephemeral and 1st or 2nd order within EP Area. | **E** (D) | 3 (E) | **6 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 7.2.b. Higher order sections of Gap Creek and Genowlan Creek are located beyond the EP Area | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 7.2.c. No mining-induced change in hydrology beyond EIS predictions expected (no surface cracking, no significant changes to drainage profile expected) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 7.2.d. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | |
| | | 7.2.e. Performance Criteria limits set by SSD_5581 | | | | |
| | | 7.2.f. Predicted subsidence magnitudes are very small relative to credible values and site specific expereince of associated with the onset of damage | | | | |
| | | 7.2.g. Mine design limits subsidence to level where surface cracking will not occur. | | | | |
| | | 7.2.h. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | |
| | | 7.2.i. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | |
| | | 7.2.j. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| 24. **Aboriginal and Cultural Heritage** | There is a risk to Airly from | 24.1.a. Mine design limits subsidence to | **E** | 2 | **3** | 1. Develop an Integrated Subsidence Monitoring |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| **Sites** Located within the EP Area | ::: Damage to **Aboriginal and Cultural Heritage Sites** Located within the EP Area :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | level where surface cracking will not occur.<br>24.1.b. Site Aboriginal and Cultural Heritage Management Plan (Site ACHMP)<br>24.1.c. Regional Aboriginal and Cultural Heritage Management Plan (Regional ACHMP) | (Pb) | (R) | **(L)** | Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| 26. **Other Significant Built Features** (e.g. Trig Station etc) located within the Area | There is a risk to Airly from<br><br>::: Mining induced impacts to significant built features :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Damage to built feature, Public safety hazard (personal injury PI) or Reputation or Social impact.. | 26.1.a. Mine design limits subsidence to level where surface cracking will not occur.<br>26.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | **D** (Pb) | 2 (R) | **5 (L)** | 6. Incorporate Build features within the EP or land management plan<br>1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| 27. **Geological Structures** (including faults, folds, sills or dykes) Located within the EP Area | There is a risk to Airly from<br><br>::: Increased subsidence / impacts arising from potential effects of geological structures (local or regional) :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or | 27.1.a. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>27.1.b. Mine design limits subsidence to level where surface cracking will not occur.<br>27.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>27.1.d. Geotechnical characterisation (GRR) | **C** (Pb) | 2 (R) | **8 (M)** | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | . | | | | |
| 12. **Groundwater bores - Private bores** Located within or potentially affected by mining in the EP Area | There is a risk to Airly from<br><br>::: **Not Applicable** (none within potentially affected area) :::<br><br>Caused by:<br>▪<br><br>Resulting in:<br>▪ . | 12.1.a. None identified in the EP area.<br>12.1.b. Bores located beyond the EP Area assessed in EIS (no predicted impact)<br>12.1.c. Three private landholder bores outside of EP areas are monitored quarterly for quality | **E** (D) | 2 (L) | **3 (L)** | |
| 28. **Far Field Movements and Effects** beyond the EP Area | There is a risk to Airly from<br><br>::: Mining induced far field movements potentially impacting surface features (eg cliffs and pagodas) beyond approved consent criteria/performance measures, and affecting the extent of the required management area (EP Area)<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 28.1.a. Far field movements are limited by the boundary of the mesa<br>28.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>28.1.c. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>28.1.d. Mine design limits subsidence to level where surface cracking will not occur.<br>28.1.e. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>28.1.f. Geotechnical characterisation (GRR) . | **E** (Pb) | 2 (L) | **3 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| 37. **Uncertainty** in subsidence predictions, hazard assessment and underlying inputs/assumptions | There is a risk to Airly from<br><br>::: Uncertainty in predictions and/or | 37.1.a. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the | **D** (Pb) | 2 (L) | **5 (L)** | |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | subsidence hazard analysis<br>:::<br><br>Caused by:<br>▪ Anomolies/complexities or deterioration in geotechnical conditions<br>▪ Discontinuities, heterogeneity effecting subsidence assessment<br>▪ Inadequate assumptions used in subsidence assessment<br>▪ Inadequate or incomplete data used in subsidence assessment<br>▪ Temporal variability in input data or assumptions used for subsidence assessment<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | NSWRR guidelines (2017)<br>37.1.b. Baseline subsidence estimates assume conservative input parameters<br>37.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>37.1.d. Mine design limits subsidence to level where surface cracking will not occur.<br>37.1.e. Geotechnical characterisation (GRR) .<br>37.1.f. Data obtained from Point Hatteris extration (MW13-MW16) prior to MW17-MW19 commencing and ability to respond to changes outside of expectations. | | | | |
| 38. **Delayed** / **Long Term Subsidence** (period/duration of subsidence management) | There is a risk to Airly from<br><br>::: Development of delayed or long term subsidence movements beyond predictions (affecting timing / duration of subsidence management) :::<br><br>Caused by:<br>▪ Anomolies/complexities or deterioration in roof/floor/ geotechnical conditions (eg due to clay stone bands)<br>▪ climatic conditions<br>▪ Flooded Workings<br>▪ Geological Structures<br>▪ Nature and magnitude of horizontal stress field<br>▪ Overlying or Underlying Workings<br>▪ Topographic terrain<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety | 38.1.a. Baseline subsidence estimates assume conservative input parameters<br>38.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>38.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>38.1.d. Mine design limits subsidence to level where surface cracking will not occur.<br>38.1.e. Geotechnical characterisation (GRR) .<br>38.1.f. Survey methods selected for monitoring are well suited to repeatable survey (if required) to be undertaken | **D** (Pb) | 2 (L) | **5 (L)** | |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | | | | | |
| 8. **Groundwater** - **Aquifers above Lithgow seam** - (including Shallow Quaternary Alluvial, Triassic | There is a risk to Airly from<br><br>::: Loss of ground water that impacts on ground water dependent eco system or water supply<br>:::<br><br>Caused by:<br>▪ Draw down due to depressurisation of Permian and/or Triassic strata, or Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 8.1.a. Limited height of fracturing does not interact with potential aquifers in sandstone | **D** (Pb) | 2 (E) | **5 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 8.1.b. Sandstones are highly fractured, conduits to side of the mountain | | | | |
| | | 8.1.c. No alluvial basins within the EP Area | | | | |
| | | 8.1.d. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | |
| | | 8.1.e. Performance Criteria limits set by SSD_5581 | | | | |
| | | 8.1.f. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| | | 8.1.g. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | |
| | | 8.1.h. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | |
| | | 8.1.i. Stygofauna monitoring program | | | | |
| 9. **Groundwater** - **Aquifers in and immediately above Lithgow seam** - Permian and Located within the EP Area | There is a risk to Airly from<br><br>::: Loss of ground water that impacts on ground water dependent eco system or water supply beyond approved impact level<br>:::<br><br>Caused by:<br>▪ Draw down due to depressurisation of Permian and/or Triassic strata, or Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA | 9.1.a. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | **D** (Pb) | 2 (E) | **5 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 9.1.b. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 9.1.c. Mining and monitoring experience to date shows minimal water make in Permian | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 9.1.d. Impact assessed in EIS and approved | | | | |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | by consent SSD_5581 | | | | |
| | | 9.1.e. No users of upper Perminan aquifers | | | | |
| | | 9.1.f. No defined GDE's within EP Area. Facultative GDEs occur primarily in the Extended Monitoring and management Area. | | | | |
| | | 9.1.g. Ground water systems in the EP area and adjacent extended monitoring area are in the Narabeen Sandstone and surface alluvial basins. These are not impacted by Miniwall. | | | | |
| | | 9.1.h. Stygofauna monitoring program | | | | |
| | | 9.1.i. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | |
| | | 9.1.j. Mine Design modified following Mt Airly exceedance of subsidence predictions, modified Mine Design reviewed by IEP | | | | |
| | | 9.1.k. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| 13. **Groundwater Dependent Ecosystems (GDE's)** | There is a risk to Airly from<br><br>::: Refer Groundwater Aquifers information above which includes information on Groundwater Dependent Ecosystems and facultative ecosystems. :::<br><br>Caused by:<br>▪<br><br>Resulting in:<br>▪ . | 13.1.a. No defined GDE's within EP Area. Facultative GDEs occur primarily in the Extended Monitoring and management Area. | **E** (D) | 2 (E) | **3 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 13.1.b. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 13.1.c. Site Biodiversity MP | | | | |
| 14. **Groundwater Stygofauna -** Located within the EP Area | There is a risk to Airly from<br><br>::: Mining related impacts to stygofauna :::<br><br>Caused by: | 14.1.a. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | **D** (Pb) | 2 (E) | **5 (L)** | |
| | | 14.1.b. Stygofauna monitoring program | | | | |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | ▪ Mining<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 14.1.c. Site Biodiversity MP | | | | |
| 16. **Threatened terrestrial FAUNA**<br>Located within the EP Area - Threatened birds and habitat for bird species e.g. Hollow dependent owls, Glossy Black Cockatoo, Gang Gang Cockatoo, Flame Robin, Scarlett Robin, Varied Sitella | There is a risk to Airly from<br><br>::: degradation or loss of species or habitat :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 16.1.a. Site Biodiversity MP<br>16.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>16.1.c. Mine design limits subsidence to level where surface cracking will not occur.<br>16.1.d. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>16.1.e. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | **E** (Pb) | 2 (E) | **3 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| 19. **Threatened terrestrial FAUNA**<br>Located within the EP Area - Microbats and their habitats (Cliff rock overhangs and tree hollows) e.g. Eastern False Pipestrelle, Eastern Free Tailed Bat, Large Bent Wing Bat, Large-eared Pied Bat, Little Bent-winged Bat, Little Pied Bat. | There is a risk to Airly from<br><br>::: Degradation or loss of species or habitat :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 19.1.a. Site Biodiversity MP<br>19.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>19.1.c. Mine design limits subsidence to level where surface cracking will not occur.<br>19.1.d. Hollow bearing trees are avoided in installation of subsidence monitoring infrastructure. | **D** (Pb) | 2 (E) | **5 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| 21. **Endangered Ecological Communities (EEC)**<br>Located within the EP Area | There is a risk to Airly from<br><br>::: Changes in species diversity or extent within EECs<br>::: | 21.1.a. Site Biodiversity MP<br>21.1.b. Predicted subsidence magnitudes are very small relative to credible values and site specific expereince of associated with the onset of damage | **E** (Pb) | 2 (E) | **3 (L)** | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage / loss of biodiversity or Loss of Intergenerational Equity, or Non compliance or Reputation or Social impact or Business interruption.. | 21.1.c. Mine design limits subsidence to level where surface cracking will not occur.<br>21.1.d. Not ground or surface water dependent plants.<br>21.1.e. Ground disturbance permit prior to clearing. | | | | |
| 34. **Roof/Floor Conditions** - Potential impacts of low strength roof and/ or low strength floor | There is a risk to Airly from<br><br>::: Pillar punching occurring :::<br><br>Caused by:<br>▪ low strength roof/ floor material<br>▪ Pillar design LTA<br>▪ pillar stress excessively high<br>▪ Water flooding<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 34.1.a. Mine Design and Subsidence Monitoring Program reviewed by IEP<br>34.1.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>34.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>34.1.d. Mine design limits subsidence to level where surface cracking will not occur.<br>34.1.e. Geotechnical characterisation (GRR) . | **D** (Pb) | 2 (E) | **5 (L)** | |
| 34. **Roof/Floor Conditions** - Potential impacts of low strength roof and/ or low strength floor | There is a risk to Airly from<br><br>::: Systemic failure :::<br><br>Caused by:<br>▪ High proportion of low strength roof material<br>▪ Reactive strata (i.e. tuff material)<br>▪ Water flooding<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business | 34.2.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>34.2.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>34.2.c. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>34.2.d. Mine design limits subsidence to level where surface cracking will not occur. | **D** (Pb) | 2 (E) | **5 (L)** | |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | interruption, or social impact.. | 34.2.e. Geotechnical characterisation (GRR) . | | | | |
| 34. **Roof/Floor Conditions** - Potential impacts of low strength roof and/ or low strength floor | There is a risk to Airly from<br><br>::: Excessive Pillar Compression :::<br><br>Caused by:<br>▪ High proportion of low strength roof material<br>▪ Pillar design LTA<br>▪ Reactive strata (i.e. tuff material)<br>▪ Water flooding<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | 34.3.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>34.3.b. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>34.3.c. Mine design limits subsidence to level where surface cracking will not occur.<br>34.3.d. Geotechnical characterisation (GRR) .<br>34.3.e. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | **D** (Pb) | 2 (E) | **5 (L)** | |
| 11. **Groundwater- Centennial surface water monitoring bores** Located within the EP Area | There is a risk to Airly from<br><br>::: Reduction or loss of monitoring capacity :::<br><br>Caused by:<br>▪ Fire<br>▪ lightning<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br>▪ tree fall<br>▪ Vandilisum<br><br>Resulting in:<br>▪ Non compliance or Reputation or Business interruption.. | 11.1.a. Ground water monitoring network is designed with multi point vibrating wire Piezometers design to accommodate progressive mining in the EP area.<br>11.1.b. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities.<br>11.1.c. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | **C** (Pb) | 2 (BI) | **8 (M)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining.<br>8. Review the adequacy of the groundwater monitoring program for the reviewed layout of the mine plan.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| 17. **Threatened terrestrial FAUNA** Located within the EP Area - Threatened mammal species (excluding microbats) and their habitats e.g. Gliders, Koala, Spotted Tail Quoll, Rock Wallaby | There is a risk to Airly from<br><br>::: degradation or loss of species or habitat ::: | 17.1.a. Site Biodiversity MP<br>17.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>17.1.c. Mine design limits subsidence to | **E** (Pb) | 1 (R) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | level where surface cracking will not occur.<br>17.1.d. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>17.1.e. Mine design limits subsidence to level where surface cracking will not occur. | | | | |
| 23. **Unsealed Roads, four wheel drive tracks and trails (SCA Management Trails)**<br>Located within the EP Area | There is a risk to Airly from<br><br>::: Damage to road/track/trail surface from cracking or slabbing, or rock fall from adjacent cliffs, pagodas and steep slope areas<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) or Reputation or Social impact.. | 23.1.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>23.1.b. Mine design limits subsidence to level where surface cracking will not occur.<br>23.1.c. Agreed road maintenance program for Mt Genowlan with NPWS. | **E** (Pb) | 1 (R) | **1 (L)** | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area .<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence<br>6. Incorporate Build features within the EP or land management plan<br>4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan).<br>1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| 25. **Historic Heritage** / Sites of Archaeological heritage significance<br>Located within the EP Area (e.g Airly Village ruins sites associated with the former New Hartley Shale Mine) | There is a risk to Airly from<br><br>::: Damage to heritage item as a result of cliff fall from cliffs adjacent to shale mine interaction zone :::<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA | 25.1.a. No known historic heritage sites in the EP Area.<br>25.1.b. Not Applicable | **E** (Pb) | 1 (R) | **1 (L)** | |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | | | | | |
| 4. **Pagodas** / **Rock Formations**<br>Located within the Extended Monitoring & Management Area | There is a risk to Airly from<br><br>::: Cracking of pagodas or rock formations :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Public safety hazard (personal injury PI) . | 4.2.a. Pagodas are more stable and capable of resisting subsidence impacts than cliffs | **E** (D) | 1 (PI) | **1 (L)** | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). |
| | | 4.2.b. Mine design limits subsidence to level where surface cracking will not occur. | | | | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . |
| | | 4.2.c. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 4.2.d. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 4.2.e. Routine high resolution 3D Photogrammetry | | | | |
| | | 4.2.f. Performance Criteria limits set by SSD_5581 | | | | |
| | | 4.2.g. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 4.2.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | |
| 32. **Sinkhole development** within or beyond the EP Area | There is a risk to Airly from<br><br>::: Mining induced development of sinkhole(s) with associated potential impact | 32.1.a. Not applicable at depths of cover in EP Area | **E** (Pb) | 1 (PI) | **1 (L)** | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | to public safety, drainage and/or surface features (including cliffs, minor cliffs and pagodas) located within or beyond in the EP Area, above approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | | | | | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| 9. **Groundwater** - **Aquifers in and immediately above Lithgow seam** - Permian and Located within the EP Area | There is a risk to Airly from<br><br>::: Depressurisation of Permian aquifer leading to ground water inflow to mine workings and subsequent dewatering with potential for water quality impacts<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 9.2.a. Impact assessed in EIS and approved by consent SSD_5581 | **E** (Pb) | 1 (L) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 9.2.b. Mining and monitoring experience to date shows minimal water make in Permian | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 9.2.c. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | |
| | | 9.2.d. Water balance shows deficit and negligible requirement for discharge | | | | |
| | | 9.2.e. EPL allows for limits in discharge water quality. | | | | |
| | | 9.2.f. Mine water inflow water quality to date is within EPL limits. | | | | |
| | | 9.2.g. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| | | 9.2.h. Mine Design modified following Mt Airly exceedance of subsidence predictions, | | | | |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | | modified Mine Design reviewed by IEP<br>9.2.i. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | |
| 39. **Future Developments** / **Change** within EP Area affecting subsidence management | There is a risk to Airly from<br><br>::: Future changes or development within the EP Area influencing management requirements (e.g. long term post-mining intention to transition surface lands from from SCA to NP)<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 39.1.a. No current development plans on Genowlan Mountain under the Draft POM<br>39.1.b. Transition to NP would occur post-relinquishment of the ML (post mining/closure) | **E** (Pb) | 1 (L) | **1 (L)** | |
| 4. **Pagodas** / **Rock Formations** Located within the Extended Monitoring & Management Area | There is a risk to Airly from<br><br>::: Cracking of pagodas or rock formations<br>:::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Heritage Impact or Reputation or Social impact or Business interruption.. | 4.1.a. Pagodas are more stable and capable of resisting subsidence impacts than cliffs<br>4.1.b. Mine design limits subsidence to level where surface cracking will not occur.<br>4.1.c. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017)<br>4.1.d. Performance of miniwall mining to date on Mt Airly which showed negligible impacts when measured subsidence meets EIS criteria. | **E** (D) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | | 4.1.e. Routine high resolution 3D Photogrammetry | | | | |
| | | 4.1.f. Performance Criteria limits set by SSD_5581 | | | | |
| | | 4.1.g. Cliff characterisation studies for Pt Hatteras including ground truthing and surface feature impact assessment, project area and in the adjacent cliff zone, rank cliffs in terms of height, identify top and toe of cliffs | | | | |
| | | 4.1.h. Airly Mine Subsidence and Pillar Width Assessment for Point Hatteras | | | | |
| 10. **Regional Groundwater** - Regional Aquifers - Permian **below** the Lithgow seam and any associated GDEs Located within the EP Area | There is a risk to Airly from<br><br>::: Loss of ground water that impacts on regional ground water dependent eco system or water supply<br>:::<br><br>Caused by:<br>▪ Upwelling of ground water into mine workings due to mining activity<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 10.1.a. No significant water sources or aquifers in the floor within the zone of influence of the mine workings. | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 10.1.b. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 10.1.c. No GDE relying on regional ground water system in EP area | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 10.1.d. Mine Design reviewed by IEP | | | | |
| | | 10.1.e. Demonstration and performance of miniwall mining to date (in regards to avoiding impacts to sensitive features) from introduction of miniwall on Mt Airly. | | | | |
| 15. **Threatened AQUATIC FAUNA & potential habitat for threatened fauna and KEY FISH HABITAT (e.g. dragon fly,Macquarie perch)** Located within and downstream of the EP Area | There is a risk to Airly from<br><br>::: Loss of stream flow - degradation or loss of species or habitat :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in: | 15.1.a. None identified in the EP area. | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 15.1.b. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 15.1.c. Site Biodiversity MP | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for |
| | | 15.1.d. Aquatic ecology monitoring in | | | | |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | ▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | accordance with the Site WMP.<br>15.1.e. Water courses on the mountain are ephemeral and 1st or 2nd order within EP Area.<br>15.1.f. Higher order sections of Gap Creek and Genowlan Creek are located beyond the EP Area<br>15.1.g. Mine design limits subsidence to level where surface cracking will not occur.<br>15.1.h. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>15.1.i. No mining-induced change in hydrology expected (no surface cracking, no significant changes to drainage profile expected) | | | | subsidence |
| 18. **Threatened terrestrial FAUNA**<br>Located within the EP Area - Threatened Reptile species and their habitats - e.g. broad headed snake | There is a risk to Airly from<br><br>::: degradation or loss of species or habitat :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 18.1.a. Site Biodiversity MP<br>18.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage<br>18.1.c. Mine design limits subsidence to level where surface cracking will not occur.<br>18.1.d. Mine design reviewed in the context of subsidence monitoring over Mt Airly and numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| 20. **Threatened FLORA**<br>Threatened flora and fauna located within the EP Area e.g. E Canonii, P Stricta | There is a risk to Airly from<br><br>::: Degradation or loss of species or habitat :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA | 20.1.a. Site Biodiversity MP<br>20.1.b. E Canonii and P Stricta not ground or surface water dependent plants.<br>20.1.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP.<br>3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| | Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 20.1.d. Ground disturbance permit prior to clearing. | | | | |
| | | 20.1.e. Mine design limits subsidence to level where surface cracking will not occur. | | | | |
| 22. **Natural vegetation - (General, including sheltered gullies)** Located within the EP Area | There is a risk to Airly from<br><br>::: Changes in species diversity or extent :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 22.1.a. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 22.1.b. Site Biodiversity MP | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 22.1.c. Mine design limits subsidence to level where surface cracking will not occur. | | | | |
| | | 22.1.d. Not ground or surface water dependent plants. | | | | |
| | | 22.1.e. Ground disturbance permit prior to clearing. | | | | |
| 29. **Valley Closure or Upsidence Movements and Effects** within and beyond the EP Area (gorges, valleys,creek crossings) | There is a risk to Airly from<br><br>::: Mining induced valley closure movements potentially causing impacts to natural features such as cliffs, minor cliffs and pagodas within and beyond the EP Area beyond approved consent criteria/performance measures :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Public safety hazard (personal injury PI) or Heritage Impact or Reputation or Social impact or Business interruption.. | 29.1.a. Limited height of fracturing results in small elastic deformations of overburden sandstone units. | **E** (Pb) | 1 (E) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 29.1.b. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 29.1.c. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | |
| | | 29.1.d. Higher order sections of Gap Creek and Genowlan Creek are located beyond the EP Area | | | | |
| | | 29.1.e. Water courses on the mountain are ephemeral and 1st or 2nd order, such that potential consequences of upsidence would be negligible. | | | | |
| | | 29.1.f. Geotechnical characterisation (GRR) . | | | | |
| 31. **Movements and Effects Beyond** | There is a risk to Airly from | 31.2.a. Negligible levels of seam gas | **E** | 1 | **1** | 1. Develop an Integrated Subsidence Monitoring |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| **Predictions** within and beyond the EP Area | ::: Mining induced effects BEYOND PREDICTIONS causing surface cracking and gas release (e.g.with public safety implications) :::<br><br>Caused by:<br>▪ Mine design LTA (Less Than Adequate), or Mining method implementation LTA, or geological anomaly, or Monitoring LTA, or Set back distance LTA<br><br>Resulting in:<br>▪ Higher than expected subsidence causing environmental damage or public safety hazard (personal injury) or non-compliance or damage to reputation or business interruption, or social impact.. | | (Pb) | (E) | **(L)** | Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 31.2.b. Subsidence impact review for the proposed EP Area includes consideration of all the heads of consideration in the NSWRR guidelines (2017) | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 31.2.c. Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage | | | | |
| | | 31.2.d. Sequential pillar extraction with real time monitoring enables intervention prior to exceding predictions. | | | | |
| | | 31.2.e. Mine design limits subsidence to level where surface cracking will not occur. | | | | |
| | | 31.2.f. Geotechnical characterisation (GRR) . | | | | |
| 10. **Regional Groundwater** - Regional Aquifers - Permian **below** the Lithgow seam and any associated GDEs Located within the EP Area | There is a risk to Airly from<br><br>::: Depressurisation of Permian aquifer leading to ground water inflow to mine workings<br>:::<br><br>Caused by:<br>▪ Upwelling of ground water into mine workings due to mining activity<br><br>Resulting in:<br>▪ Environmental damage or Non compliance or Reputation or Social impact or Business interruption.. | 10.2.a. Impact assessed in EIS and approved by consent SSD_5581 | **E** (Pb) | 1 (Bl) | **1 (L)** | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 10.2.b. Mine Design reviewed by IEP | | | | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. |
| | | 10.2.c. Mining and monitoring experience to date shows minimal water make in the Lower Permian | | | | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence |
| | | 10.2.d. Site Water Management Plan incorporating surface and ground water monitoring program. Developed in consultation with Regulatory authorities. | | | | |
| | | 10.2.e. Water balance shows deficit and negligible requirement for discharge | | | | |
| | | 10.2.f. EPL allows for limits in discharge water quality. | | | | |
| | | 10.2.g. Mine water inflow water quality to date is within EPL limits. | | | | |

Instructions:

WRAC Analysis Sorted by Consequence (hover for instructions):

| Step | Potential Incident | Current Controls | L | MRC | RR | Recommended Control |
|---|---|---|---|---|---|---|
| 35. **Interaction with old workings** or proposed/future multi seam mining) potentially affecting subsidence conditions | There is a risk to Airly from<br><br>::: Not Applicable<br>:::<br><br>Caused by:<br><br>Resulting in:<br>. | 35.1.a. Not Applicable | () | 0 | **0** | |
| 36. **Presence of Massive Strata in Roof or Overburden** | There is a risk to Airly from<br><br>::: **Not Applicable** :::<br><br>Caused by:<br>▪<br><br>Resulting in:<br>▪ . | 36.1.a. Not Applicable | () | 0 | **0** | |

# Recommended Controls

| Recommended Controls | Place(s) Used | Risk Ranking | | | Allocated To | Required By Date | Control Importance | Pulse User No. | PULSE Ref. No. |
|---|---|---|---|---|---|---|---|---|---|
| | | L | C | RR | | | | | |
| 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | Events: 1.1, 1.2, 2.1, 2.2, 3.1, 3.2, 4.1, 5.1, 5.2, 6.1, 6.2, 7.1, 7.2, 8.1, 9.1, 9.2, 10.1, 10.2, 11.1, 13.1, 15.1, 16.1, 17.1, 18.1, 19.1, 20.1, 22.1, 23.1, 24.1, 26.1, 28.1, 29.1, 30.1, 31.1, 31.2, 32.1, 33.1 | D | 3 | 9 (M) | Jacqueline Cooke RIIRIS402D | 01-Sep-2022 | 2 | 90030 | 56771.153951 |
| 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | Events: 1.1, 1.2, 2.1, 2.2, 3.1, 3.2, 4.1, 4.2, 5.1, 5.2, 6.1, 6.2, 7.2, 9.1, 9.2, 10.1, 10.2, 11.1, 13.1, 15.1 | D | 3 | 9 (M) | Jacqueline Cooke RIIRIS402D | 15-Dec-2022 | 2 | 90030 | 56771.153952 |
| 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | Events: 1.1, 2.1, 3.1, 4.1, 4.2, 5.1, 5.2, 6.1, 6.2, 7.1, 7.2, 9.1, 10.1, 10.2, 11.1, 15.1, 19.1, 20.1, 21.1, 22.1, 23.1, 24.1, 26.1, 27.1, 29.1, 30.1, 31.1, 31.2, 32.1, 33.1 | D | 3 | 9 (M) | Jacqueline Cooke RIIRIS402D | 01-Sep-2022 | 2 | 90030 | 56771.153953 |
| 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). | Events: 1.2, 2.2, 3.2, 4.2, 5.2, 6.2, 23.1 | D | 3 | 9 (M) | Sam Price | 01-Sep-2022 | 2 | 90039 | 56771.153954 |
| 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . | Events: 1.2, 2.2, 3.2, 4.2, 5.2, 6.2, 23.1 | D | 3 | 9 (M) | Jacqueline Cooke RIIRIS402D | 01-Sep-2022 | 2 | 90030 | 56771.153955 |
| 6. Incorporate Build features within the EP or land management plan | Events: 23.1, 26.1 | D | 2 | 5 (L) | Jacqueline Cooke RIIRIS402D | 01-Sep-2022 | 2 | 90030 | 56771.153956 |

| Recommended Controls | Place(s) Used | Risk Ranking | | | Allocated To | Required By Date | Control Importance | Pulse User No. | PULSE Ref. No. |
|---|---|---|---|---|---|---|---|---|---|
| | | L | C | RR | | | | | |
| 7. Update Water management Plan to include EP area and re-submit to Planning. | Events: 7.1 | **E** | 3 | 6 (L) | Sam Price | 15-Dec-2022 | 2 | 90039 | 56771.153957 |
| 8. Review the adequacy of the groundwater monitoring program for the reviewed layout of the mine plan. | Events: 11.1 | **C** | 2 | 8 (M) | Sam Price | 15-Dec-2022 | 2 | 90039 | 56771.153958 |
| 9. Reveiw GNSS monitoring system to determine suitable alernative should a single unit or whole system fail. Communicate to TSM and Compliance Manager | Events: 30.1 | **D** | 3 | 9 (M) | Brett Haddon | 01-Sep-2022 | 2 | 90045 | 56771.153959 |

# Controls Completion Details

| PULSE Ref. No. | Recommended Controls | Risk Ranking | | | Allocated To | Required By Date | Control Importance | Controls Completion Details | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | L | C | RR | | | | Action Completion Comments | Action Completed By | Completed Date |
| 56771.153951 | 1. Develop an Integrated Subsidence Monitoring Program that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. | D | 3 | 9 (M) | Jacqueline Cooke RIIRIS402D | 01-Sep-2022 | 2 | | | |
| 56771.153952 | 2. Develop and install subsidence monitoring equipment for baseline and maintained for the required period post mining. | D | 3 | 9 (M) | Jacqueline Cooke RIIRIS402D | 15-Dec-2022 | 2 | | | |
| 56771.153953 | 3. Develop numerical modelling by SCT with a high level of confidence of meeting the EIS criteria for subsidence | D | 3 | 9 (M) | Jacqueline Cooke RIIRIS402D | 01-Sep-2022 | 2 | | | |
| 56771.153954 | 4. Consult with NPWS on Safety Warning Signage (Rock Fall risk area) to be erected on mountain (Mt Genwolan). | D | 3 | 9 (M) | Sam Price | 01-Sep-2022 | 2 | | | |
| 56771.153955 | 5. Develop a Public Safety Management Plan in accordance with consent and in consultation with relevant stake holders that includes: identification of areas of elevated risk, management and monitoring actions to minimise risks to others accessing the project area . | D | 3 | 9 (M) | Jacqueline Cooke RIIRIS402D | 01-Sep-2022 | 2 | | | |
| 56771.153956 | 6. Incorporate Build features within the EP or land management plan | D | 2 | 5 (L) | Jacqueline Cooke RIIRIS402D | 01-Sep-2022 | 2 | | | |
| 56771.153957 | 7. Update Water management Plan to include EP area and re-submit to Planning. | E | 3 | 6 (L) | Sam Price | 15-Dec-2022 | 2 | | | |
| 56771.153958 | 8. Review the adequacy of the groundwater monitoring program for the reviewed layout of the mine plan. | C | 2 | 8 (M) | Sam Price | 15-Dec-2022 | 2 | | | |

| PULSE Ref. No. | Recommended Controls | Risk Ranking | | | Allocated To | Required By Date | Control Importance | Controls Completion Details | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | L | C | RR | | | | Action Completion Comments | Action Completed By | Completed Date |
| 56771.153959 | 9. Reveiw GNSS monitoring system to determine suitable alernative should a single unit or whole system fail. Communicate to TSM and Compliance Manager | **D** | 3 | 9 (M) | Brett Haddon | 01-Sep-2022 | 2 | | | |

# CEY Risk Matrix Page 1

| CENTENNIAL RISK MATRIX | | | | | | | Likelihood | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | A Certain | B Probable | C Possible | D Remote | E Improbable | Description (D) |
| Rating | Consequence<br>Note: Consequence may result from a single event or may represent a cumulative impact over a period of 12 months. Use the worst case reasonable consequence if there is more than one. | | | | | | Common | Has Happened within Centennial | Could Happen & has happened in non-CEY operations | Not Likely | Practically impossible | Probability (Pb) |
| | Financial Impact to Annual Business Plan (F) | Personal Injury (PI) | Business Interruption (BI) | Legal (L) | Reputation (R) | Environment (E) | Frequent incidents | Regular incidents | Infrequent incidents | Unlikely to occur. Very few recorded or known incidents | May occur in exceptional circumstances. Almost no recorded incidents. | Incident Frequency (IF) |
| | | | | | | | Operations – within 3 months | Operations – within 2 years | Operations – within 5 years | Operations – within 10 years | Operations – within 30 years | Operations (Op) |
| | | | | | | | Project – Every project | Project – Every 2 projects | Project – Every 5 projects | Project – Every 10 projects | Project – Every 30 projects | Project (Pr) |
| 5. Catastrophic | >$50m | Multiple Fatalities | > 1month | Prolonged litigation, heavy fines, potential jail term | Prolonged International media attention | Long term impairment habitats/ ecosystem | 25 (E) | 24 (E) | 21 (H) | 19 (H) | 15 (S) | |
| 4. Major | $10m - $50m | Single Fatality | 1 week to 1 month | Major breach/ major litigation | International media attention | Long term effects of ecosystem | 23 (E) | 22 (E) | 18 (H) | 14 (S) | 10 (M) | |
| 3. Moderate | $1m - $10m | Serious/ Disabling Injury | 1 day to 1 week | Serious breach of regulation. prosecution/ fine | National media attention | Serious medium term environmental effects | 20 (H) | 17 (H) | 13 (S) | 9 (M) | 6 (L) | |
| 2. Minor | $100k - $1m | Lost Time Injury | 12 hrs to 1 day | Non-compliance, breaches in regulation | Adverse local public attention | Minor effects to physical environment | 16 (S) | 12 (S) | 8 (M) | 5 (L) | 3 (L) | |
| 1. Insignificant | <$100k | First Aid Treatment Only | < 12 hrs | Low level compliance issue | Local complaints | Limited physical damage | 11 (S) | 7 (M) | 4 (L) | 2 (L) | 1 (L) | |

# CEY Risk Matrix Page 2

| Risk Rating | Risk Category | | Generic Management Actions |
|---|---|---|---|
| 22 to 25 | E | Extreme | Action is required to eliminate or reduce the risk. If the risk is considered to be ALARP then the decision to accept the risk is to be made by Centennial Coal Chief Executive |
| 17 to 21 | H | High | Action is required to eliminate or reduce the risk. If the risk is considered to be ALARP then the decision to accept the risk is to be made by the relevant Centennial Coal Executive General Manager |
| 11 to 16 | S | Significant | Action is required to eliminate or reduce the risk. If the risk is considered to be ALARP then the decision to accept the risk is to be made by the Manager of the Centennial Coal Operation |
| 7 to 10 | M | Moderate | Action is required to eliminate or reduce the risk. If the risk is considered to be ALARP then the decision to accept the risk is to be made by the Manager of the Centennial Coal Operation |
| 1 to 6 | L | Low | Actions to eliminate or further reduce the risk should be considered. If risk is considered to be ALARP then the decision to accept the risk is to be made by the risk assessment owner (no recommended control is required to be created for this) |

# CEY Risk Matrix Page 3

| BOW TIE ANALYSIS - Control Effectiveness Matrix | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| TYPE OF CONTROL | Examples | Description | Rank | Control Category | CONTROL – Impact / Status / Quality | | | | |
| | | | | | A >= 80% | B 50 – 80% | C 50 / 50% | D 50 – 20% | E <= 20% |
| | Replace electric hand tools with compressed air alternatives in wet conditions | Eliminates a hazard by removal | 1. | Elimination of hazard | 100 | 45.0 | 40.0 | 14.0 | 10.0 |
| | Replace large diameter, heavy cables with smaller ones that are easier to handle manually | Replace element with less risky alternative | 2. | Substitution | 85.0 | 40.0 | 35.0 | 13.0 | 8.5 |
| | Automatic fire fighting sprinkler systems, Earth Leakage protection devices | An automatic device that operates without intervention by personnel | 3. | Engineered without people | 70.0 | 30.0 | 25.0 | 12.0 | 7.0 |
| | Fire alarm that sounds & the operator then has to initiate an evacuation | A device that requires personnel to respond to a stimulus | 4. | Engineered with people | 50.0 | 20.0 | 14.0 | 10.0 | 5.0 |
| | Inspection, maintenance and repair of machinery | A process carried out by personnel | 5. | Procedural | 20.0 | 15.0 | 10.0 | 6.5 | 2.0 |
| | Employee made aware of dangers of large moving equipment where the operators have limited vision | Induction training programs | 6. | Awareness | 5.0 | 3.0 | 2.5 | 1.5 | 1.0 |

# Attachment D

# STAKEHOLDER CONSULTATION & CORRESPONDANCE

## for the MW17-18 Panel & Pillar Mining Zone Extraction Plan

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# 1 SUMMARY OF STAKEHOLDER CONSULTATION

**Table 1.1** provides a summary of stakeholder consultation specifically undertaken for the current Extraction Plan and supporting reports, and where those have been addressed. It is noted that this consultation is in addition to and builds upon previous and ongoing consultation with various stakeholders for the approved Airly EIS (2014) for SSD_5581, previously approved extraction plans, and during existing operations at the mine. Copies of written correspondence with each stakeholder for the current Extraction Plan is also provided as appendices.

It is noted that stakeholder consultation for separate sub-plans for the Environmental Management Plans supporting the Extraction Plan (including the Airly Mine WMP) is described separately within each of those documents and is not included below.

**Table 1.1: Summary of Stakeholder Consultation Outcomes for the Extraction Plan**

| Stakeholder | Consultation | Comment | Response |
|---|---|---|---|
| DPE | **6/9/22** Letter from Centennial Airly seeking endorsement of Project Team | **21/9/22** Letter from DPE endorsing the Project Team (refer Appendix 1 A) | **Nil required** |
| DPE | **7/9/22** Centennial Airly supplied an overview presentation of the MW17-19 Extraction Plan (refer Appendix 1 B) | Refinements options discussed during meeting. No further written comments received. | Noted during development of Extraction Plan. |
| DPE, IEP | **7/11/22** Centennial Airly supplied an update presentation of the MW17-19 Extraction Plan (refer Appendix 1 C) | Refinements options discussed during meeting. No further written comments received. | Noted during development of Extraction Plan. |
| DPE, IEP | **13/2/23** Centennial Airly supplied an update presentation of the MW17-19 Extraction Plan prior to submission of the Revision 0 draft for consultation (refer Appendix 1 D) | Refinements options discussed during meeting. No further written comments received. | Noted during development of Extraction Plan. |
| DPE, IEP | **23/2/23** Centennial Airly supplied draft MW17-19 | **Nil received** | **Nil required** |

| Stakeholder | Consultation | Comment | Response |
|---|---|---|---|
| | Extraction Plan documents for review, including:<br>• Subsidence Monitoring Program for the MW17-19 Extraction Plan<br>• Public Safety Management Plan for the MW17-19 Extraction Plan.<br>• Land Management Plan for the MW17-19 Extraction Plan.<br>• Biodiversity Management Plan for the MW17-19 Extraction Plan. | | |
| BCS | **23/2/23** Centennial Airly supplied draft MW17-19 Extraction Plan documents for review, including:<br>• Subsidence Monitoring Program for the MW17-19 Extraction Plan<br>• Public Safety Management Plan for the MW17-19 Extraction Plan.<br>• Land Management Plan for the MW17-19 Extraction Plan.<br>• Biodiversity Management Plan for the MW17-19 Extraction Plan. | **27/3/23** Response received from BCS with recommendations to be addressed (refer Appendix 1 E); including:<br>1. Revise the proposed mine design to a layout which has a higher likelihood of remaining within the 125 mm subsidence threshold<br>2. Review, and where required, revise the outcomes and determinations of all risk assessments and management plans which are predicated on the 125mm threshold not being exceeded.<br>3. Consult with the National Parks and Wildlife Service Area Manager, providing them the full extraction plan and sub-management plans to review<br>4. Provide the extraction plan main report, including the master TARP, for BCS review | 1. SCT (2023) were engaged to advise on a revision to the pillar and panel layout to limit the maximum predicted subsidence to a chosen upper design limit of 95mm (+/-20mm) aligning with a precautionary approach.<br>2. The *Subsidence and Environmental Risk Assessment (Attachment C)* includes assessment of the potential for subsidence beyond predictions with avoidance, mitigation, and monitoring strategies incorporated in the Extraction Plan and sub-management plans.<br>3. Revision 1 of the MW17-18 Extraction Plan and sub-management plans to be provided to NPWS.<br>4. Consultation for Revision 1 of the MW17-18 Extraction Plan and sub-management plans will include the main report and all attachments and appendices. |

| Stakeholder | Consultation | Comment | Response |
|---|---|---|---|
| NSW RR | **3/3/23** Centennial Airly supplied draft MW17-19 Extraction Plan documents for review, including:<br>• Subsidence Monitoring Program for the MW17-19 Extraction Plan<br>• Public Safety Management Plan for the MW17-19 Extraction Plan.<br>• Land Management Plan for the MW17-19 Extraction Plan. | **14/3/23** Response received from NSW RR. No comments needing to be addressed were received (refer Appendix 1 F) | **Nil required** |
| DPE - Water | **23/2/23** Centennial Airly supplied a revised version of the Airly Mine Water Management Plan (WMP) for review. | **31/3/23** Response received from DPE - Water with recommendations to be addressed prior to submitting for approval (refer Appendix 1 G). | *Consultation and approval of the Airly Mine WMP is undertaken separate to the Extraction Plan. Consultation including the recommendations received is detailed within the Airly Mine WMP* |
| DoEE | **23/2/23** Centennial Airly supplied a draft Biodiversity Management Plan for the MW17-19 Extraction Plan for review. | **Nil received** | **Nil required** |
| DPE, IEP | **14/7/23** Centennial Airly supplied revised draft MW17-18 Extraction Plan (entire report including all attachments and appendices) for review | **28/7/23** Response received from IEP with recommendations to be addressed (refer Appendix 1 H); including:<br>The GNSS units planned above MW17 and MW18 should be installed well before MW17 commences. | A Review of Environmental Factors (REF) for the installation of GNSS units was submitted 15 August 2023. Installation to be undertaken ASAP after approval is received – target October/November 2023, providing adequate baseline prior to extraction of MW17 which is scheduled to commence in April 2024. |
| | | The depth of overburden strata above these panels ranges from 215 m to 290 m (noting a discrepancy between Page 35 of the main | **Section 2.2.2**, **Section 3.1.1** and **Section 3.2.1** of the *Extraction Plan Main Report* have been updated to clarify comments on the depth of overburden strata above these panels. |

| Stakeholder | Consultation | Comment | Response |
|---|---|---|---|
| | | report, which indicates 240-280 m and Figure 3.4, which indicates 215-290 m). | |
| | | Update the subsidence assessment report of MSEC (2023) to recognise that maximum subsidence measured so far over MW13-15A is 89mm (given 15 mm of subsidence occurred before GN32 was installed) with an additional 5 mm subsidence expected from residual subsidence. | *Attachment F – Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023)* has been updated to include adjustments for subsidence estimated to have been measured where GNSS units were installed after the extraction of MW13. |
| | | Consider further controls in the Public Safety Management Plan, including potential edits to the TARP for Condition Amber (controlling access to the public in around the EP zone until the area is inspected) and Condition Red (barricade the area until miniwall extraction has ceased and the entire area is inspected) | **Section 5.2** of the *Public Safety Management Plan for MW17-18* (Appendix 4 of the EP Main Report) has been amended to include controls for public safety which will be determined in consultation with the NPWS. |
| NPWS | **14/7/23** Centennial Airly supplied revised draft MW17-18 Extraction Plan (entire report including all attachments and appendices) for review | **31/7/23** Response received from NPWS with recommendations to be addressed (refer Appendix 1 I); including: | |
| | | 1.1 provide justification that the mine design divergence is for the purposes of the existing consent "substantially the same" and considers significant geological formations in accordance with the provisions of condition 7 of the Development Consent as issued by the Planning Assessment Commission for the State Significant Development 5581 – Airly Mine Extension Project – 15 December 2016 (SSD Approval), include validation of performance measures prior to proceeding into areas of higher geological sensitivity, this shall be based on preceding subsidence and geological formation data.<br><br>1.2 maintain the SSD Approved panel width of 61m and panel height of 2.8m not increasing by 17.5% as proposed.<br><br>1.3 apply the proposed barrier pillar width of 70m to reduce risk of adverse damage to the SCA as part of the conservative approach | The proposed MW17-18 is "substantially the same" as the subsidence outcomes and predicted impacts assessed in the EIS are the same (or less).<br><br>The mine design is informed by a calibrated model for predictive purposes with the layout chosen to limit the maximum predicted subsidence to a chosen upper design limit of 95mm (+/-20mm) aligning with a precautionary approach (i.e. less than the EIS predicted limit of 125mm).<br><br>Current GNSS monitoring over MW13 to MW16 has also validated the numerical models with measured subsidence closely matching modelled predicted subsidence as shown below:<br><br>Geometry / Modelled Subsidence / Measured Subsidence<br>MW13 and MW14 / 63mm / 62mm<br>MW13, MW14 and MW15A / 93mm / 90mm |

| Stakeholder | Consultation | Comment | Response |
|---|---|---|---|
| | | | Consultation has been undertaken with the IEP for the MW17-18 mine design. The IEP considers:<br>• The proposed geometry is likely to achieve Centennial Airly's commitment to maximum subsidence of less than 125mm<br>• Subsidence monitoring is suitable to confirm the low levels of subsidence expected<br>• Surface impacts from this mining are expected to be imperceptible<br>• All cliff formations within the Cliff Line Zone are protected by an angle of draw of greater than 26.5° and by the low levels of subsidence over the mining area |
| | | 1.4 update the referencing to the revised Water Management Plan to support the extraction planning, providing a link to the current version located on the Centennial Airly website. | As discussed in **Section 5.2** of the *Extraction Plan Main Report* the Airly Mine WMP is developed in accordance with SSD_5581 Schedule 4 Condition 13. Consultation for, and approval of, the Airly Mine WMP is being undertaken concurrently but separately to the Extraction Plan. A revised version (Version 8 dated July 2023) was submitted to DPE for approval on 1 August 2023 and included revisions and consultation for this Extraction Plan.<br>Multiple revisions have been completed by Centennial Airly and submitted to DPE for approval. Consultation for the WMP is detailed in Appendix A and Appendix B in the Airly Mine WMP. The version on the Centennial Airly website (Version 3 dated July 2018) is the existing approved version of the Water Management Plan. The Centennial Airly website will be updated once the revised version is approved. |

| Stakeholder | Consultation | Comment | Response |
|---|---|---|---|
| | | 2.1 provide a justification that extrapolating of the model well outside the range of previous empirical subsidence data held for Airly is considered fit for purpose for any deviation proposed under the extraction plan subject to the SSD Approval under Schedule 3. | As noted by SCT (2023), no modelling had previously been conducted for panel widths greater than 60m so a multistage work program including empirical pillar load calculations, back analysis of existing modelling data and the refinement of new numerical models was conducted.<br><br>Back analysis of previous Airly numerical models and the use of empirical abutment load methodology was applied to refine the pillar size requirements for both a 70.5m and 80m miniwall void width. The models were run with a range in joint and bedding properties of the overburden to improve the model output of the magnitude and shape of the observed subsidence profile. Joint and bedding cohesion, friction angle, frequency and length, are varied in a parametric assessment. Variations in stress and depth of weathering were also modelled to assess their impact on subsidence.<br><br>The model was calibrated with the subsidence and surface crack observations of the 6 miniwall panels MW2-MW7. Figure 2.1 (*Extraction Plan Main Report*) shows the comparisons of the magnitude and profile shape of surveyed and modelled subsidence for MW2-MW7.<br><br>The empirical abutment load methodology including empirical load calculations is an accepted industry standard that incorporates panel geometries outside of Airly historical workings.<br><br>Current GNSS monitoring over MW13 to MW16 has also validated the numerical models with measured subsidence closely matching modelled predicted subsidence as shown below:<br><br>Geometry / Modelled Subsidence / Measured Subsidence<br>MW13 and MW14 / 63mm / 62mm<br>MW13, MW14 and MW15A / 93mm / 90mm |

| Stakeholder | Consultation | Comment | Response |
|---|---|---|---|
| | | 2.2 ensure the variability in mining height is considered as part of the non-controlled extraction due to spall, cavities, or operational variation during mining operations is included in the model | SCT (2023) modelled a mining height of 3.2m for the same proposed geometry for subsidence sensitivity (see *Attachment E – Technical Report: Pillar Width Modelling (SCT, 2023)*). The mining height subsidence sensitivity assessment resulted in 95mm (+/-20mm) of surface subsidence which is at the chosen upper design limit aligning with a precautionary approach (and less than the EIS predicted limit of 125mm).<br><br>Potential additional subsidence from variability in mining height due to spall, cavities, or operational variation during mining operations would not be expected to reach the modelled scenario (which considers a mining height of 3.2m across the entire panel). |
| | | 2.3 document uncertainty held around the analysis, providing for calculated error margins for the subsidence predictions based on the identify likely variation or potential deviations , indicating the level of any uncertainty held about the model outputs or assumptions. | Uncertainty is documented in the Subsidence and Environmental Risk Assessment and is considered to be a low risk (see *Attachment C – Subsidence and Environmental Risk Assessment*). Predicted subsidence magnitudes are very small relative to credible values associated with the onset of damage. SCT have recommended a subsidence tolerance / natural variability of +/-20mm is applied to the modelled subsidence.<br><br>The mine design is informed by a calibrated model for predictive purposes with the layout chosen to limit the maximum predicted subsidence to a chosen upper design limit of 95mm (+/-20mm) aligning with a precautionary approach.<br><br>The MW17-18 Extraction Plan includes a *Subsidence Monitoring Program for MW17-18* (Appendix 5 of the EP Main Report) that includes: definition of critical items to be monitored, appropriate levels of accuracy to detect levels of subsidence that cause impact and a TARP. |
| | | 3.1 provide confirmed fault mapping with an explanation of the known and potential increased subsidence risk as it relates to the MW17 & 18 beyond what is calculated as part of the model, providing for a risk margin. | Identified geological structures underground are provided in Fig. 2.8 (MSEC 2023) (see *Attachment F – Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023)*). |

| Stakeholder | Consultation | Comment | Response |
|---|---|---|---|
| | | | The effect of faults is included in the calibrations of the SCT modelling. The models were run with a range in joint and bedding properties of the overburden to improve the model output of the magnitude and shape of the observed subsidence profile. Joint and bedding cohesion, friction angle, frequency and length, are varied in a parametric assessment. Variations in stress and depth of weathering were also modelled to assess their impact on subsidence. |
| | | 3.2 provide a discussion on adequate and preferred subsidence monitoring configuration to measure subsidence associated with the faults through and above MW 17 & 18.<br><br>4.1 recognise the fault mapped as crossing directly through and above MW 17 & 18, justifying that the subsidence monitoring network is adequate for identifying areas of vertical subsidence as part of an enhanced early warning system.<br><br>4.2 increase in the number of GNSS units measuring subsidence directly above, and between the narrow longwalls for the south-eastern part of Genowlan Mountain and concentrate more GNSS units in areas predicted to experience higher levels of subsidence. | Features expressed by SRK aeromag have not been seen at that orientation in underground mapping. The mapping of geological features in MW13, 14 and 15 resembling the projection are more N-S trending shear zones.<br><br>These consistently find expression as closely spaced joints over a narrow distance with signs of strike-slip movement (slickensides) with little to no displacement. Where intersected these features only have limited impact and are adequately supported with the current support plans and TARPs<br><br>Consultation has been undertaken with the IEP for the MW17-18 mine design. The IEP considers:<br><br>• The proposed geometry is likely to achieve Centennial Airly's commitment to maximum subsidence of less than 125mm<br><br>• Subsidence monitoring is suitable to confirm the low levels of subsidence expected<br><br>Notwithstanding, up to two additional GNSS units are proposed to be added to the monitoring network, increasing the total to 18 (11 of which are monitoring subsidence directly above, and between the narrow longwalls for the south-eastern part of Genowlan Mountain) (see *Subsidence Monitoring Program for MW17-18* (Appendix 5 of the EP Main Report)) |

| Stakeholder | Consultation | Comment | Response |
|---|---|---|---|
| | | 4.3 require an early warning system, supported by clear reporting operations will potentially exceed subsidence thresholds, with a robust framework for identifying and responding to subsidence trends. | Airly Mine will monitor the incremental subsidence for each panel extracted to validate the model and to ensure the subsidence is within the progressive modelled subsidence. The *Master Trigger Action Response Plan for MW17-18* (Appendix 6 of the EP Main Report) includes triggers related to the modelled subsidence, with actions/responses to be undertaken if subsidence thresholds are exceeded.<br>Consultation has been undertaken with the IEP for the MW17-18 mine design. The IEP considers:<br>• Subsidence monitoring is suitable to confirm the low levels of subsidence expected |
| | | 4.4 provide raw subsidence data for Mt Genowlan extraction area should be provided to NPWS quarterly (3 monthly) basis. | Section 4.2.2 and Section 6.2 of the *Subsidence Monitoring Program for MW17-18* (Appendix 5 of the EP Main Report) have been updated to include this requirement. |
| | | 5.1 include as part of the Extraction Plan a review of the adequacy and functionality of the piezometers and the monitoring configuration under the Extraction Plan, as only piezometers ARP06 and ARP15SP in the Narrabeen Sandstone aquifers appear operational and relevant | Table 4.3 of the Airly Mine WMP states the status of the groundwater monitoring network (i.e., obsolete, dry or functioning). Locations deemed obsolete are no longer required as mining activities in those locations have ceased and subsidence impacts are at maximum.<br>The remaining network suffices monitoring requirements considering:<br>• Mining the Lithgow Seam has produced negligible inflows (rock groundwater sources are ow yielding / less productive)<br>• Risk to dewatering of overlying alluvials relates solely to subsidence impacts and future mining limited to <125mm subsidence<br>• Future mining does not present risk to regional aquifers that occur within the Shoalhaven Group and lower Devonian being below the target coal seam. |

<table>
<tr><th>Stakeholder</th><th>Consultation</th><th>Comment</th><th>Response</th></tr>
<tr><td></td><td></td><td></td><td>Installation of new monitoring points is not required however, would be prevented by a lack of access given steep terrain and vegetation coverage.</td></tr>
<tr><td></td><td></td><td>5.2 revise the water management plan, to include reporting on, and provision of the groundwater piezometer and stream level/flow data collected for the Airly Mine (in an excel spreadsheet file(s) format) to NPWS on a quarterly (3 month basis) to support its land management role.</td><td>As discussed in Section 5.2 of the Extraction Plan Main Report the Airly Mine WMP is developed in accordance with SSD_5581 Schedule 4 Condition 13. Consultation for, and approval of, the Airly Mine WMP is being undertaken concurrently but separately to the Extraction Plan.<br><br>Surface water flow and groundwater level data will be provided to NPWS in an excel spreadsheet on a quarterly basis (April, July, October and January).<br><br>A revised version of the Airly Mine WMP will be submitted to include this requirement.</td></tr>
<tr><td>BCS</td><td>14/7/23 Centennial Airly supplied revised draft MW17-18 Extraction Plan (entire report including all attachments and appendices) for review</td><td>31/7/23 Response received from BCS with recommendations to be addressed (refer Appendix 1 J); including:<br><br>1.1. Centennial Coal maintain the panel width approved in the EIS and not increase it by 17.5% as proposed.<br><br>1.2. Centennial Coal maintain the extraction height of 2.8m and not increase it to 3m as proposed.</td><td>The proposed MW17-18 is “substantially the same” as the subsidence outcomes and predicted impacts assessed in the EIS are the same (or less).<br><br>The mine design is informed by a calibrated model for predictive purposes with the layout chosen to limit the maximum predicted subsidence to a chosen upper design limit of 95mm (+/-20mm) aligning with a precautionary approach (i.e. less than the EIS predicted limit of 125mm).<br><br>Current GNSS monitoring over MW13 to MW16 has also validated the numerical models with measured subsidence closely matching modelled predicted subsidence as shown below:<br><br><table><tr><td>Geometry</td><td>Modelled Subsidence</td><td>Measured Subsidence</td></tr><tr><td>MW13 and MW14</td><td>63mm</td><td>62mm</td></tr><tr><td>MW13, MW14 and MW15A</td><td>93mm</td><td>90mm</td></tr></table><br>Consultation has been undertaken with the IEP for the MW17-18 mine design. The IEP considers:</td></tr>
</table>

| Stakeholder | Consultation | Comment | Response |
|---|---|---|---|
| | | | • The proposed geometry is likely to achieve Centennial Airly's commitment to maximum subsidence of less than 125mm<br>• Subsidence monitoring is suitable to confirm the low levels of subsidence expected<br>• Surface impacts from this mining are expected to be imperceptible<br>All cliff formations within the Cliff Line Zone are protected by an angle of draw of greater than 26.5° and by the low levels of subsidence over the mining area |
| | | 1.3. A detailed subsidence monitoring program be conducted around the fault mapped as bisecting MW17-18. | Features expressed by SRK aeromag have not been seen at that orientation in underground mapping. The mapping of geological features in MW13, 14 and 15 resembling the projection are more N-S trending shear zones.<br>These consistently find expression as closely spaced joints over a narrow distance with signs of strike-slip movement (slickensides) with little to no displacement. Where intersected these features only have limited impact and are adequately supported with the current support plans and TARPs<br>Consultation has been undertaken with the IEP for the MW17-18 mine design. The IEP considers:<br>• The proposed geometry is likely to achieve Centennial Airly's commitment to maximum subsidence of less than 125mm<br>• Subsidence monitoring is suitable to confirm the low levels of subsidence expected<br>Notwithstanding, up to two additional GNSS units are proposed to be added to the monitoring network, increasing the total to 18 (11 of which are monitoring subsidence directly above, and between the narrow longwalls for the south-eastern part of |

| Stakeholder | Consultation | Comment | Response |
|---|---|---|---|
| | | | Genowlan Mountain) (see *Subsidence Monitoring Program for MW17-18* (Appendix 5 of the EP Main Report)) |
| | | 1.4. Install at least additional 9 GNSS units directly above and in-between MW 17-18, with specific focus in the areas with 280m depth of cover. | Areas of 280m depth of cover in the Extraction Plan Area are limited, generally single panel (MW17) with only a very small bit of MW18 (and subsidence will be less due to end effects).<br>Consultation has been undertaken with the IEP for the MW17-18 mine design. The IEP considers:<br>• The proposed geometry is likely to achieve Centennial Airly's commitment to maximum subsidence of less than 125mm<br>• Subsidence monitoring is suitable to confirm the low levels of subsidence expected<br>Notwithstanding, up to two additional GNSS units are proposed to be added to the monitoring network, increasing the total to 18 (11 of which are monitoring subsidence directly above, and between the narrow longwalls for the south-eastern part of Genowlan Mountain) (see *Subsidence Monitoring Program for MW17-18* (Appendix 5 of the EP Main Report)). |
| | | 1.5. No secondary extraction to take place until there is an adequate number of GNSS units installed to establish an appropriate baseline. | A Review of Environmental Factors (REF) for the installation of GNSS units was submitted 15 August 2023. Installation to be undertaken ASAP after approval is received – target October/November 2023, providing adequate baseline prior to extraction of MW17 which is scheduled to commence in April 2024. |
| DPE Water | **14/7/23** Centennial Airly supplied revised draft MW17-18 Extraction Plan (entire report including all attachments and appendices) for review | **10/8/23** Response received from DPE Water with recommendations to be addressed (refer Appendix 1 K); including:<br>The MW17-18 Extraction Plan includes a link to a Water Management Plan dated September 2018. This is not a current document and does not address DPE Water's comments on the MW17-19 Extraction Plan. | As discussed in **Section 5.2** of the *Extraction Plan Main Report* the Airly Mine WMP is developed in accordance with SSD_5581 Schedule 4 Condition 13. Consultation for, and approval of, the Airly Mine WMP is being undertaken concurrently but separately to the Extraction Plan. A revised version (Version 8 dated July |

| Stakeholder | Consultation | Comment | Response |
|---|---|---|---|
| | | DPE Water recommends that an updated Water Management Plan be provided in support of the MW17-18 Extraction Plan to enable our review of the proposed monitoring, management and mitigation for the Extraction Plan impacts. The updated plan should:<br>• address the comments made by DPE Water in OUT23/4966 dated 31 March 2023 on the MW17-19 Extraction Plan and Water Management Plan. | 2023) was submitted to DPE for approval on 1 August 2023 and included revisions and consultation for this Extraction Plan (including comments made by DPE Water in OUT23/4966 dated 31 March 2023).<br>Multiple revisions have been completed by Centennial Airly and submitted to DPE for approval. Consultation for the WMP is detailed in Appendix A and Appendix B in the Airly Mine WMP. The version on the Centennial Airly website (Version 3 dated July 2018) is the existing approved version of the Water Management Plan. The Centennial Airly website will be updated once the revised version is approved. |
| | | • outline the studies undertaken to assess the impacts on natural springs and seeps predicted to occur due the extraction proposed for MW17 and MW18. | No natural springs and seeps occur in the vicinity of MW17 and MW18.<br>The Grotto, which is located near to but beyond the Extraction Plan Area, is an ephemeral, rainfall induced source point for Genowlan Creek. Monitoring of the Grotto has indicated it is largely dry except following periods of rain when surface runoff drains to it. Detrimental impact to the Grotto from the extraction of MW17 and MW18, and any associated dewatering, could occur through subsidence and loss of alluvial cover.<br>SCT (2023) have predicted, for the proposed geometry of MW17 and MW18, the caving height above the miniwall panels would reach 80-90m. This should restrict caving and fracturing to the Permian overburden and avoid deformation within the overlying Narrabeen Sandstone (and alluvium). It is expected that no fracturing of the bedrock is likely to be observed over the miniwalls and beneath the sections of the streams that are located directly above and adjacent to the proposed miniwalls (MSEC, 2023), and therefore are not anticipated to impact surface water accumulation in the Grotto. |

| Stakeholder | Consultation | Comment | Response |
|---|---|---|---|
| DPE Water | **24/8/23** Centennial Airly supplied revised MW17-18 Extraction Plan (entire report including all attachments and appendices) for approval | **28/9/23** Response received from DPE Water with recommendations to be addressed (refer Appendix 1 L). | As discussed in **Section 5.2** of the Extraction Plan Main Report the Airly Mine WMP is developed in accordance with SSD_5581 Schedule 4 Condition 13.<br>Consultation for, and approval of, the Airly Mine WMP is being undertaken concurrently but separately to the Extraction Plan. A revised version of the Airly Mine WMP is being prepared to include address these recommendations. |
| NPWS | **24/8/23** Centennial Airly supplied revised MW17-18 Extraction Plan (entire report including all attachments and appendices) for approval | **28/9/23** Response received from NPWS with recommendations to be addressed (refer Appendix 1 M). | On 19 October, a technical meeting was undertaken with stakeholders from Airly Mine, NPWS, BCS, IEP and DPE to provide additional detail following submission of the MW17-18 Extraction Plan and address any outstanding subsidence issues and risk concerns, including advice and recommendations on the revised MW17-18 Extraction Plan (Rev2) provided by NPWS (28 September 2023, their ref: DOC23/823898) and BCS (5 October 2023, their ref: DOC23/875989).<br>All issues were addressed via presentations provided by Airly Mine and the IEP (Appendix 1 O). Airly Mine provided a commitment to install two additional GNSS units recommended by NPWS located in areas of greatest DOC in the extraction area (sites labelled 19 and 20), and to relocate the proposed site labelled 18 as near as possible to the area of maximum predicted subsidence. Ground truthing of these locations was undertaken on 2 November, with suitable locations found in very close proximity to recommended locations.<br>A minor revision of the MW17-18 Extraction Plan (Rev3) will be submitted to include the updated subsidence monitoring layout and summarise the additional stakeholder consultation. |
| BCS | **24/8/23** Centennial Airly supplied revised MW17-18 Extraction Plan (entire report including all attachments and appendices) for approval | **5/10/23** Response received from BCS with recommendations to be addressed (refer Appendix 1 N). | |

# APPENDIX 1: STAKEHOLDER CORRESPONDENCE AND PRESENTATIONS

## Appendix 1 A: Letter from DPE providing Endorsement of Project Team (dated 21/9/22)

Department of Planning and Environment

Our ref: SSD-5581-PA-53

Ms Veronica Howat
Assurance Specialist
Centennial Airly Pty Limited
Via email: dpiepostapproval@centennialcoal.com.au

21/09/2022

**Subject: Airy Mine - Endorsement of Project Team – MW17-19 and Cliff Line Zone First Workings Extraction Plans**

Dear Ms Howat

I refer to your request dated 6 September 2022 for the Planning Secretary's endorsement of a team of suitably qualified persons to prepare two Extraction Plans in accordance with Condition 7 of Schedule 3 of Development Consent SSD 5581. The proposed Extaction Plans relate to secondary extraction of MW17-19 in the south-eastern part of Genowlan Mountain and first workings in the Cliff Line Zone (CLZ) in Mining Lease 1814.

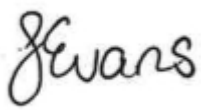
The Department has reviewed the nominations and information you have provided and is satisfied that these experts are suitably qualified and experienced. Accordingly, I can advise that the Planning Secretary endorses the appointment of the following team to prepare the Extraction Plans for MW17-19 and first workings in the CLZ.

**Table 1: MW17-19 and CLZ first workings Extraction Plan Team**

| Team Member | Role |
|---|---|
| Anthony Reid - Catalyst Environmental Managment | Lead consultant and project management<br><br>Author - Extraction Plan Main Report |
| Yvette Heritage - SCT Operations | Technical Specialist - Mine Design and Subsidence Predictions |
| Don Kay - MSEC | Technical Specialist - Subsidence Impact Assessment and Cliff Stability Assessment |
| Ian Gilmore - GHD<br><br>Dr Stuart Gray - GHD | Technical Specialists - Water Management Plan |
| Susan Kennedy - RPS | Technical Specialist - Heritage Management Plan |
| Mark Aitkens - RPS | Technical Specialist - Biodiversity Management Plan |
| Michael Nicholson - Michael Nicholson Consulting | Technical Specialist - Subsidence Monitoring Program |

If you wish to discuss the matter further, please contact Gabrielle Allan on 9585 6078.

Yours sincerely



Jessie Evans
Director, Resource Assessments
Resource Assessments

As nominee of the Planning Secretary

## Appendix 1 B: Presentation by Centennial Airly providing Project Overview (dated 7/9/22)

*Note, only slides within this presentation relating to the MW17-18 Panel and Pillar Mining Zone Extraction Plan have been provided in this attachment.*

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# CEY-DPE

## Quarterly Update

## 7th September 2022

OUR WAY IN ENERGY

# Overview

- **Airly Mine is currently preparing two extraction plans**

- **MW17-19**
  - 3 miniwall panels in the south-eastern part of Genowlan Mountain
  - MW17 currently scheduled to commence extraction in Q1 2024 (and development completed in 2023)

- **Cliff Line Zone of First Workings in Mining Lease 1814**
  - First workings only
  - Currently schedule to commence Q1 2024

- **The planning for the extraction plans is well underway with submission expected to be completed in Q4 2022 (for both Extraction Plans)**

- **Approvals ideally received by mid 2023**

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# MW17-19

## South-eastern part of Genowlan Mountain

OUR WAY IN ENERGY

# Proposed MW17-19 Mining Strategy

- **Use 26.5 degree setback angle to miniwall mining from cliffs in the EIS Cliff Line Zone**

- **Implement <125mm subsidence mine design based on SCT modelling**
  - Pt Hatteras modelled four miniwall panels with 60m voids and 70m pillars
  - Maximum of three miniwall panels can fit within setback constraints
  - Proposed mine layout dimensions with 56m voids and 50m pillars

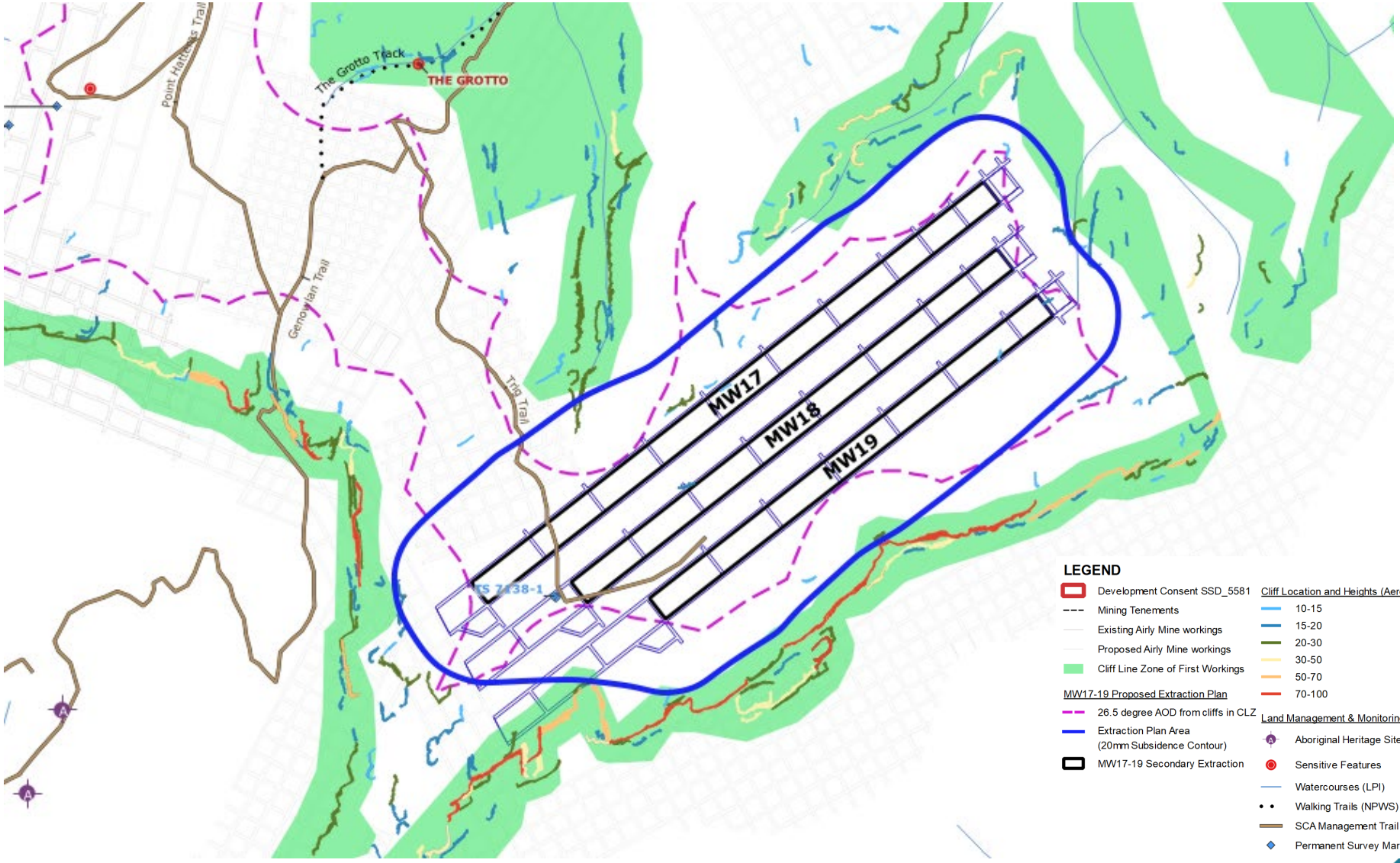
- **Conduct detailed specialist (MSEC) assessment of cliffs within 26.5 degree setback angle from proposed mine workings**

- **Continue fully remote subsidence monitoring system**

# Subsidence Modelling (SCT)

- **SCT have developed a calibrated model for predictive purposes (used previously by Airly Mine with results closely related to the observed subsidence)**
- **Modelling assessment aimed to provide a pillar width design to control subsidence to 125mm**
- **Based on SCT modelling it is predicted the mine design (56m voids / 50m pillars) will limit subsidence to less than 125mm**
- **Subsidence magnitude estimates (after miniwall extraction):**
  - *MW17: -27mm*
  - *MW18: -63mm*
  - *MW19: -118mm*

# Proposed Extraction Plan Area



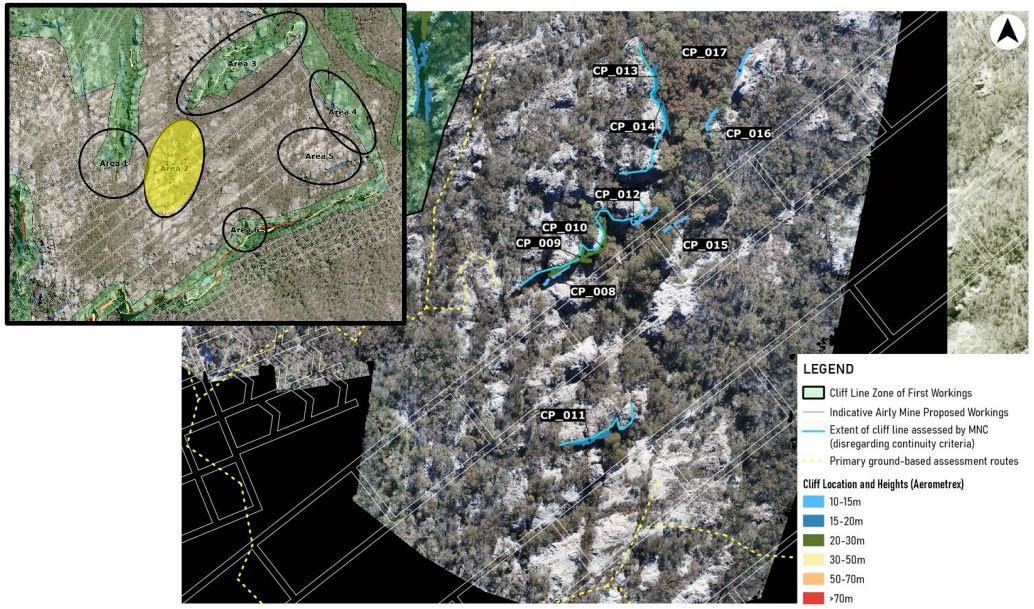
# Relevant Features and Component Plans

| Consent Conditions | Key Features Managed and Monitored |
|---|---|
| **(i) Subsidence Monitoring Program** | Remote techniques only<br>GNSS units at key locations (refer further slide)<br>Vertical photogrammetry over EP area over entire EP area<br>Oblique photogrammetry - monitoring for rock falls |
| ***(ii) Built Features Management Plan*** | *No significant infrastructure items are located within the Extraction Plan Area.*<br>*Minor infrastructure such as the Trig Station, tracks and trails are proposed to be managed within the Extraction Plan Main Report, Land Management Plan and Public Safety Management Plan.* |
| **(iii) Water Management Plan** | Surface Water Courses (there are 3 mapped drainage lines within the Project area)<br>Groundwater (including potential for Groundwater dependent ecosystems, stygofauna and any potential private bores) |
| **(iv) Biodiversity Management Plan** | Threatened flora and fauna species, populations and ecological communities (or their habitats), with potential of occurring in the Extraction Plan Area, as listed under the NSW Biodiversity Conservation Act 2016 (BC Act) and/or listed under the Commonwealth Environment Protection and Biodiversity Act 1999 (EPBC Act) |
| **(v) Land Management Plan** | Cliffs, Minor Cliffs, Pagodas and rock formations<br>Steep Slopes<br>General Land Surface of the Mugii Murum-ban SCA<br>Minor infrastructure such as tracks and trails |
| ***(vi) Heritage Management Plan*** | *No Aboriginal or historic heritage sites have been identified within the Extraction Plan Area.*<br>*No Heritage Management Plan is proposed to be submitted with the Extraction Plan.* |
| **(vii) Public Safety Management Plan** | Public Safety / Safety of 'others' associated with potential for subsidence.<br>Publicly accessible sections of the Extraction Plan Area within Mugii Murum-ban SCA. |

# Cliff Mapping – Cliff Zone and Panel and Pillar Zone

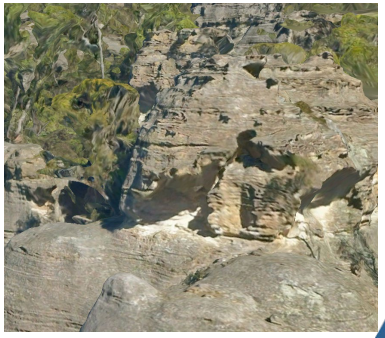
- **Aerometrex cliff identification based on SSD5581 cliff definition**
- **Site inspection and ground truthing completed by MNC, key findings included:**
  - Good positional correlation between MNC and Aerometrex process
  - MNC supports using the cliff mapping provided by Aerometrex for developing setbacks to secondary extraction
  - There were no particularly vulnerable features (of the balancing boulder type that was identified for MW13-16), however a few sensitive features have been highlighted within the report that will be specifically assessed within the subsidence predictions and impact assessment report
  - There were three features identified which were not originally mapped by Aerometrex
    - Two in the PPMZ over or near MW19 (MNC_001 and MNC_002), and one in the CLZ northeast of MW17 (MNC_003).
    - MNC_001 and MNC_002 are typical of the features generally in the area.
    - MNC_003 is an isolated pinnacle / pagoda feature considerably undercut at the base, this feature will be protected by >26.5deg offset.

# Cliff Site Inspection and Ground Truthing



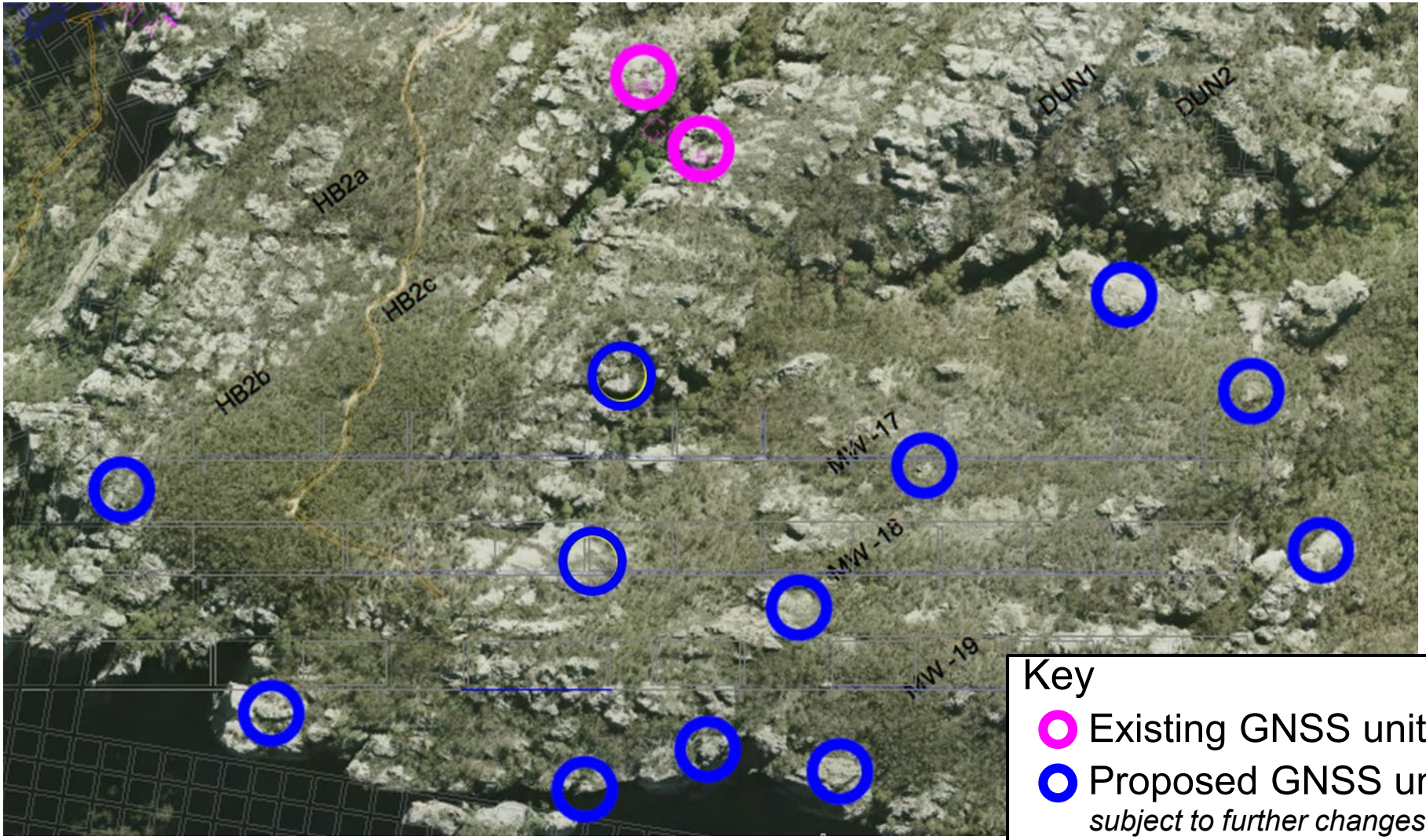
CP_008 looking West

CP_013 – looking WSW



CP_009 – looking West

# Proposed Subsidence Monitoring / GNSS Unit Locations



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## Appendix 1 C: Presentation by Centennial Airly providing Extraction Plan Project Update (dated 7/11/22)

*Note, only slides within this presentation relating to the MW17-18 Panel and Pillar Mining Zone Extraction Plan have been provided in this attachment.*

# Airly Mine Extraction Plan Update

Consultation with Airly IEP and DPE

7th November 2022

OUR WAY IN ENERGY

# Presentation Overview

- **Point Hatteras (MW13-16) update**

**New proposed extraction plans:**

- **MW17-19**
  - 3 miniwall panels in the south-eastern part of Genowlan Mountain
  - MW17 currently scheduled to commence extraction in Q1 2024 (and development commenced in 2023)

- **Cliff Line Zone of First Workings in Mining Lease 1814**
  - First workings only
  - Currently schedule to commence Q1 2024

- **The planning for the extraction plans is well underway with submission expected to be completed in Q4 2022 (MW17-19) / Q1 2023 (CLZ)**

- **Approvals ideally received by mid 2023**

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# MW17-19

South-eastern part of Genowlan Mountain

OUR WAY IN ENERGY

# Proposed MW17-19 Mining Strategy

- **Use 26.5 degree setback angle to miniwall mining from cliffs in the EIS Cliff Line Zone**

- **Implement <125mm subsidence mine design based on SCT modelling**
  - Pt Hatteras modelled four miniwall panels with 60m voids and 70m pillars
  - Maximum of three miniwall panels can fit within setback constraints
  - Proposed mine layout dimensions with 56m voids and 50m pillars

- **Conduct detailed specialist (MSEC) assessment of cliffs within 26.5 degree setback angle from proposed mine workings**

- **Continue fully remote subsidence monitoring system**

# Subsidence Modelling (SCT)

- **SCT have developed a calibrated model for predictive purposes (used previously by Airly Mine with results closely related to the observed subsidence)**
- **Modelling assessment aimed to provide a pillar width design to control subsidence to 125mm**
- **Based on SCT modelling it is predicted the mine design (56m voids / 50m pillars) will limit subsidence to less than 125mm**
- **Subsidence magnitude estimates (after miniwall extraction):**
  - *MW17: -27mm*
  - *MW18: -63mm*
  - *MW19: -118mm*
- **Modelled DoC was 280m, the majority of mining where three panels are side by side occurs at depths of 260m or less, therefore the subsidence magnitudes are considered a conservative maximum estimate**

# Predicted Subsidence Contours

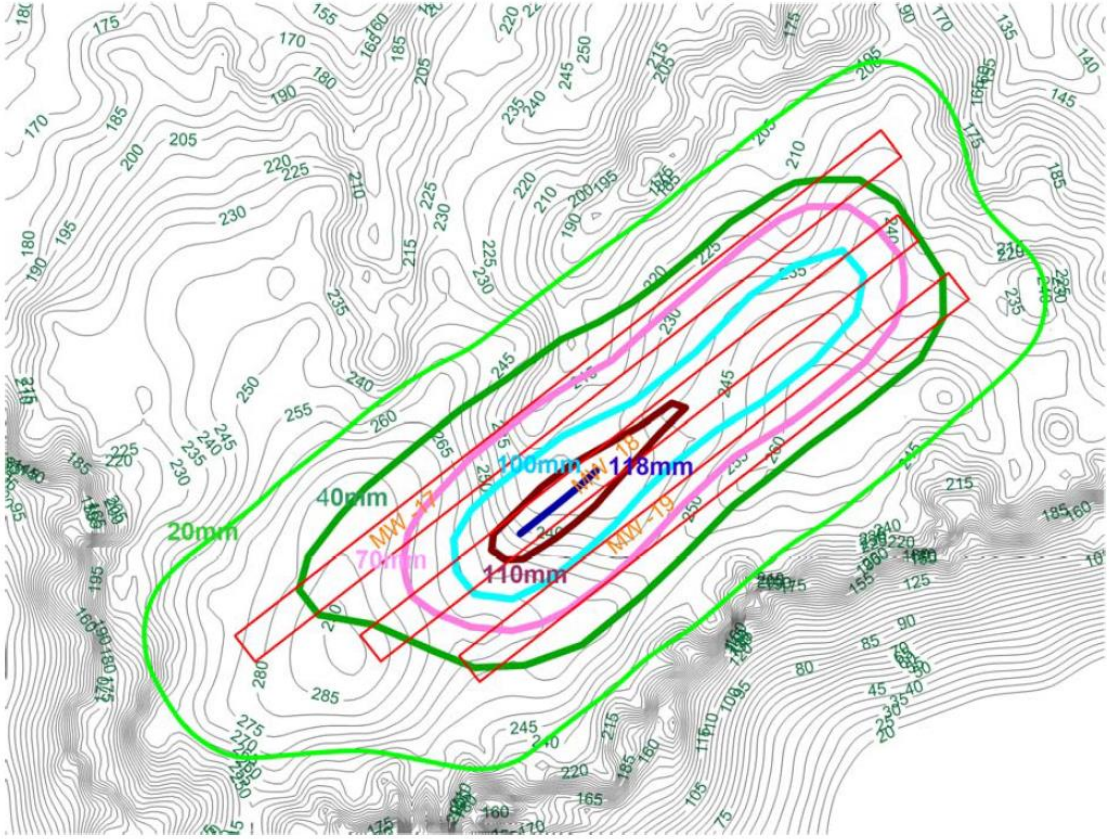
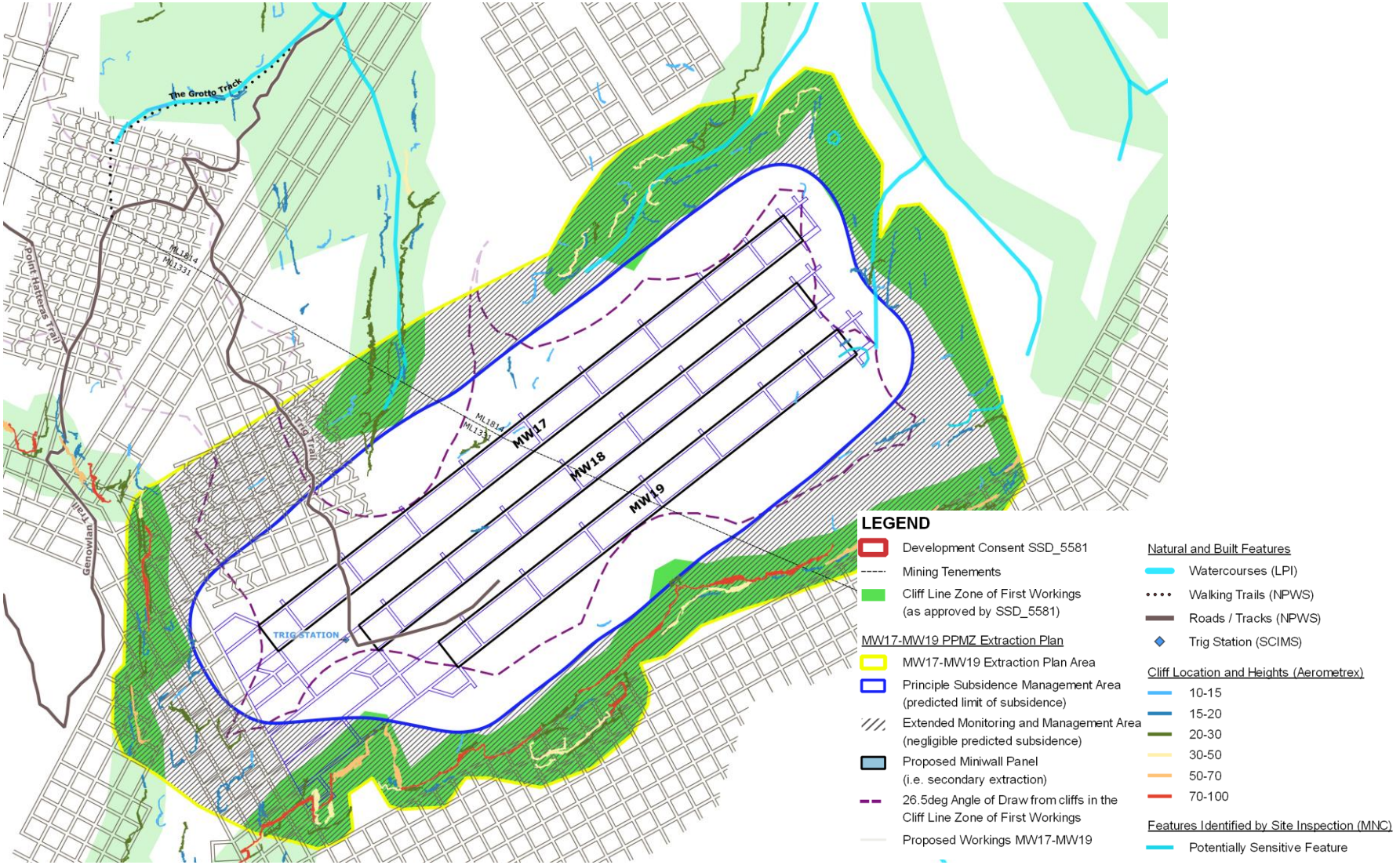



**Fig. 3.9** **Predicted subsidence contour levels (using 26.5° AoD) overlain over DoC contours and panel boundaries for MWs 17 to 19 (MSEC after SCT, 2022)**

# Proposed Extraction Plan Area



# Relevant Features and Component Plans

| Consent Conditions | Key Features Managed and Monitored |
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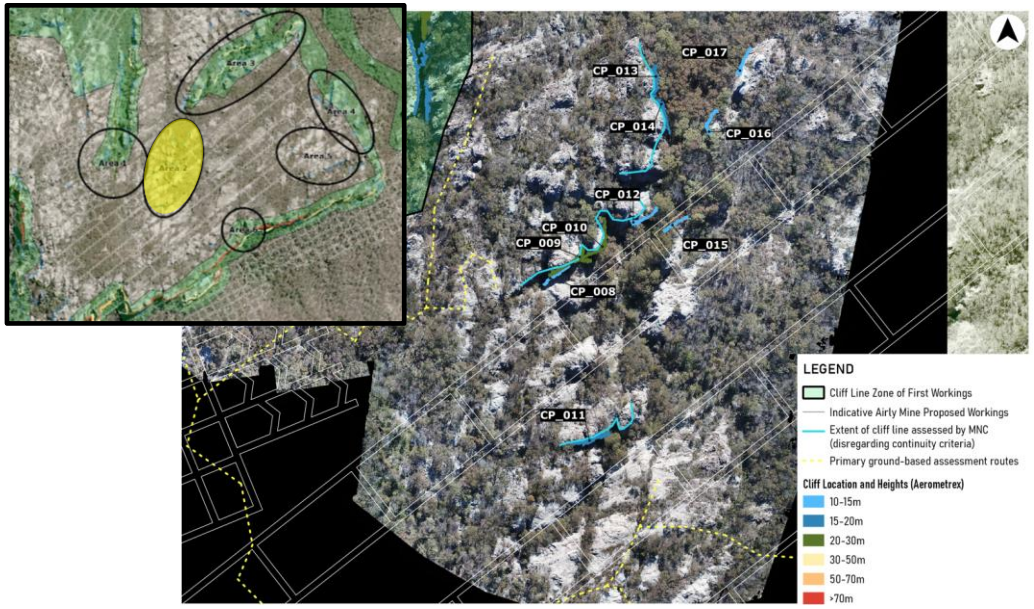
| **(i) Subsidence Monitoring Program** | Remote techniques only<br>GNSS units at key locations (refer further slide)<br>Vertical photogrammetry over EP area over entire EP area<br>Oblique photogrammetry - monitoring for rock falls |
| ***(ii) Built Features Management Plan*** | *No significant infrastructure items are located within the Extraction Plan Area.*<br>*Minor infrastructure such as the Trig Station, tracks and trails are proposed to be managed within the Extraction Plan Main Report, Land Management Plan and Public Safety Management Plan.* |
| **(iii) Water Management Plan** | Surface Water Courses (there are 3 mapped drainage lines within the Project area)<br>Groundwater (including potential for Groundwater dependent ecosystems, stygofauna and any potential private bores) |
| **(iv) Biodiversity Management Plan** | Threatened flora and fauna species, populations and ecological communities (or their habitats), with potential of occurring in the Extraction Plan Area, as listed under the NSW Biodiversity Conservation Act 2016 (BC Act) and/or listed under the Commonwealth Environment Protection and Biodiversity Act 1999 (EPBC Act) |
| **(v) Land Management Plan** | Cliffs, Minor Cliffs, Pagodas and rock formations<br>Steep Slopes<br>General Land Surface of the Mugii Murum-ban SCA<br>Minor infrastructure such as tracks and trails |
| ***(vi) Heritage Management Plan*** | *No Aboriginal or historic heritage sites have been identified within the Extraction Plan Area.*<br>*No Heritage Management Plan is proposed to be submitted with the Extraction Plan.* |
| **(vii) Public Safety Management Plan** | Public Safety / Safety of 'others' associated with potential for subsidence.<br>Publicly accessible sections of the Extraction Plan Area within Mugii Murum-ban SCA. |

# Cliff Mapping – Cliff Zone and Panel and Pillar Zone

- **Aerometrex cliff identification based on SSD5581 cliff definition**
- **Site inspection and ground truthing completed by MNC, key findings included:**
  - Good positional correlation between MNC and Aerometrex process
  - MNC supports using the cliff mapping provided by Aerometrex for developing setbacks to secondary extraction
  - There were no particularly vulnerable features (of the balancing boulder type that was identified for MW13-16), however a few sensitive features have been highlighted within the report that will be specifically assessed within the subsidence predictions and impact assessment report
  - There were three features identified which were not originally mapped by Aerometrex
    - Two in the PPMZ over or near MW19 (MNC_001 and MNC_002), and one in the CLZ northeast of MW17 (MNC_003).
    - MNC_001 and MNC_002 are typical of the features generally in the area.
    - MNC_003 is an isolated pinnacle / pagoda feature considerably undercut at the base, this feature will be protected by >26.5deg offset.

# Cliff Site Inspection and Ground Truthing



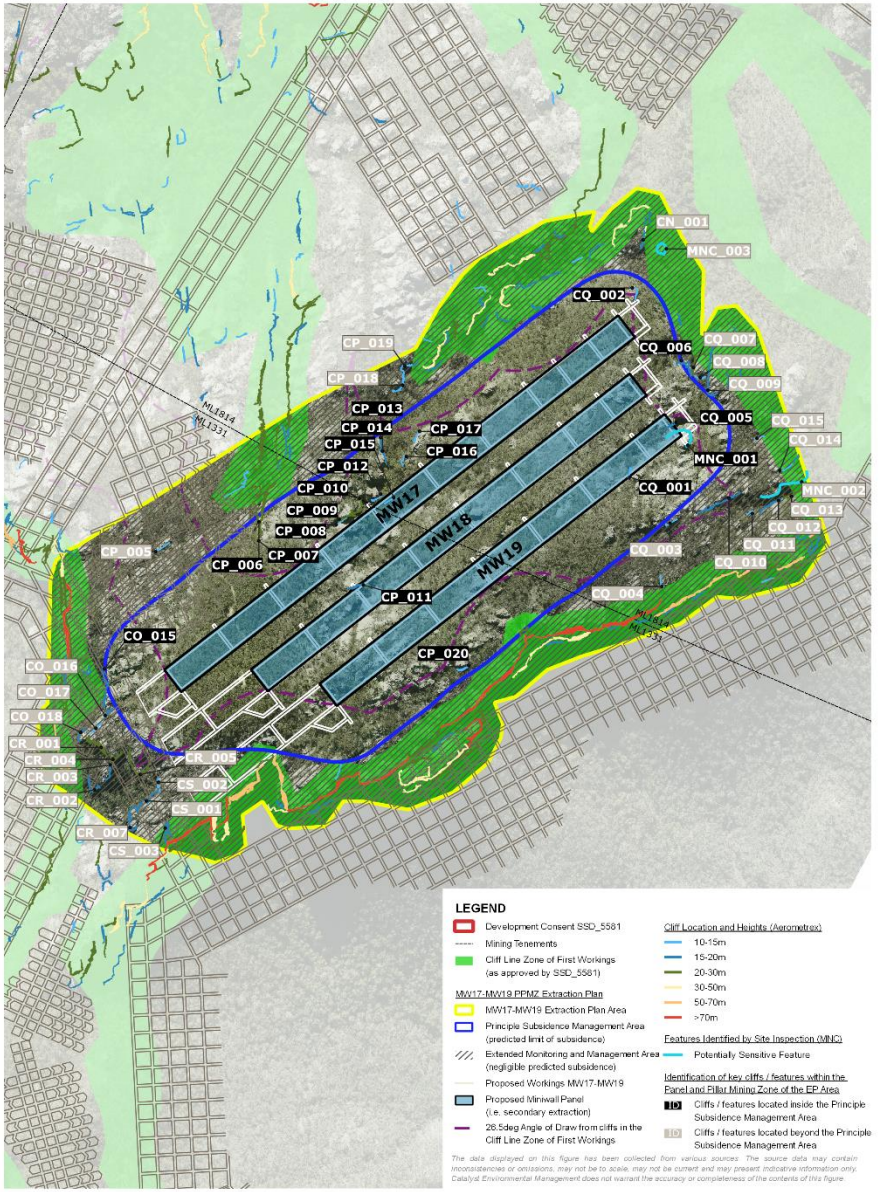
CP_008 looking West

CP_013 – looking WSW

CP_009 – looking West

# Cliff Impact Assessment

- **Identified cliffs have been assessed by MSEC, including subsidence predictions for each cliff within the principal subsidence management area**
- **The maximum predicted subsidence at the identified cliff sites over or near MWs 17 to 19 is less than 110 mm,**
- **The report concludes that there should be little chance of exceedance of the conditions of approval for the cliffs that have been identified over the proposed MWs 17 to 19**

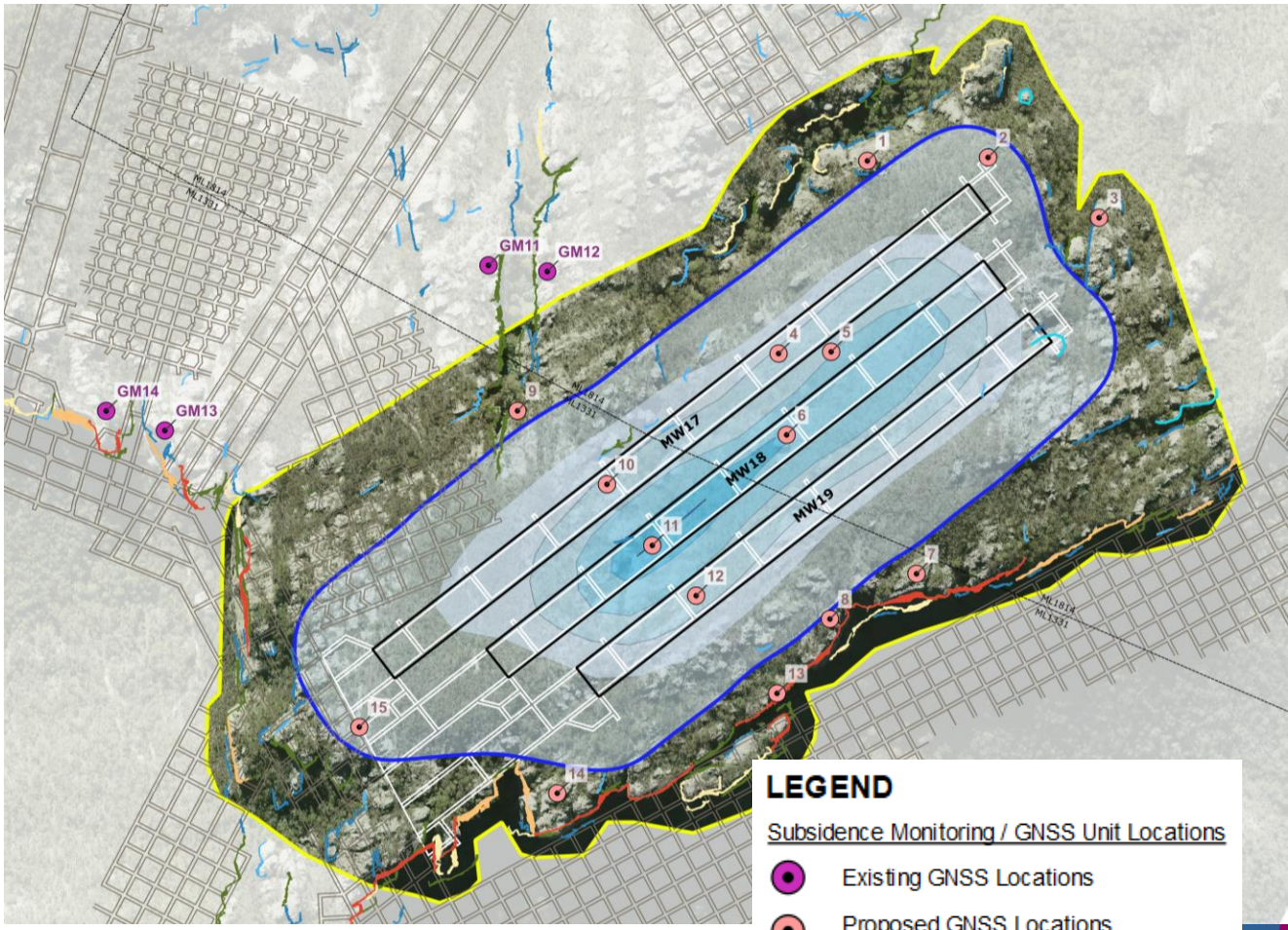



**Key Cliffs / Features Located within the Panel and Pillar Mining Zone**

MW17-MW19 PPMZ Extraction Plan

# Proposed Subsidence Monitoring / GNSS Unit Locations

- GNSS units labelled 4, 5 and 6 are ideally located for subsidence modelling validation
- GNSS units labelled 9 to 13 provide a pseudo subsidence line through the area of predicted maximum subsidence
- GNSS units labelled 10 and 11 also provide redundancy and record natural variability for points 4 and 6.
- The remaining proposed units are measuring potentially sensitive features, or at cliffs in the cliff line zone for potential movements beyond predictions.



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## Appendix 1 D: Presentation by Centennial Airly providing Extraction Plan Project Update (prior to submission of first draft for external consultation) (dated 13/2/23)

*Note, only slides within this presentation relating to the MW17-18 Panel and Pillar Mining Zone Extraction Plan have been provided in this attachment.*

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# Airly Mine Extraction Plan Update

## Consultation with Airly IEP and DPE

13 February 2023

OUR WAY IN ENERGY

# Presentation Overview

- **Update on mining and monitoring**
  - Update on monitoring for the Mt Airly  PPMZ EP Area (MW02-12)
  - Progress on mining and monitoring for the Pt Hatteras PPMZ EP Area (MW13-16)

- **Cliff Line Zone of First Workings EP - Mod to include ML1814**
  - Respond and provide greater clarity around the matters raised
  - Airly to provide details of the proposed approach for further consideration

- **MW17-19 Submission**
  - 3 miniwall panels in the south-eastern part of Genowlan Mountain
  - MW17 currently scheduled to commence extraction in ~Q1 2024 (and development commenced in mid 2023)
  - Provide an overview of the MW17-19 Extraction Plan and the draft documents provided for consultation prior to submission
  - Identify/discuss if there are any queries

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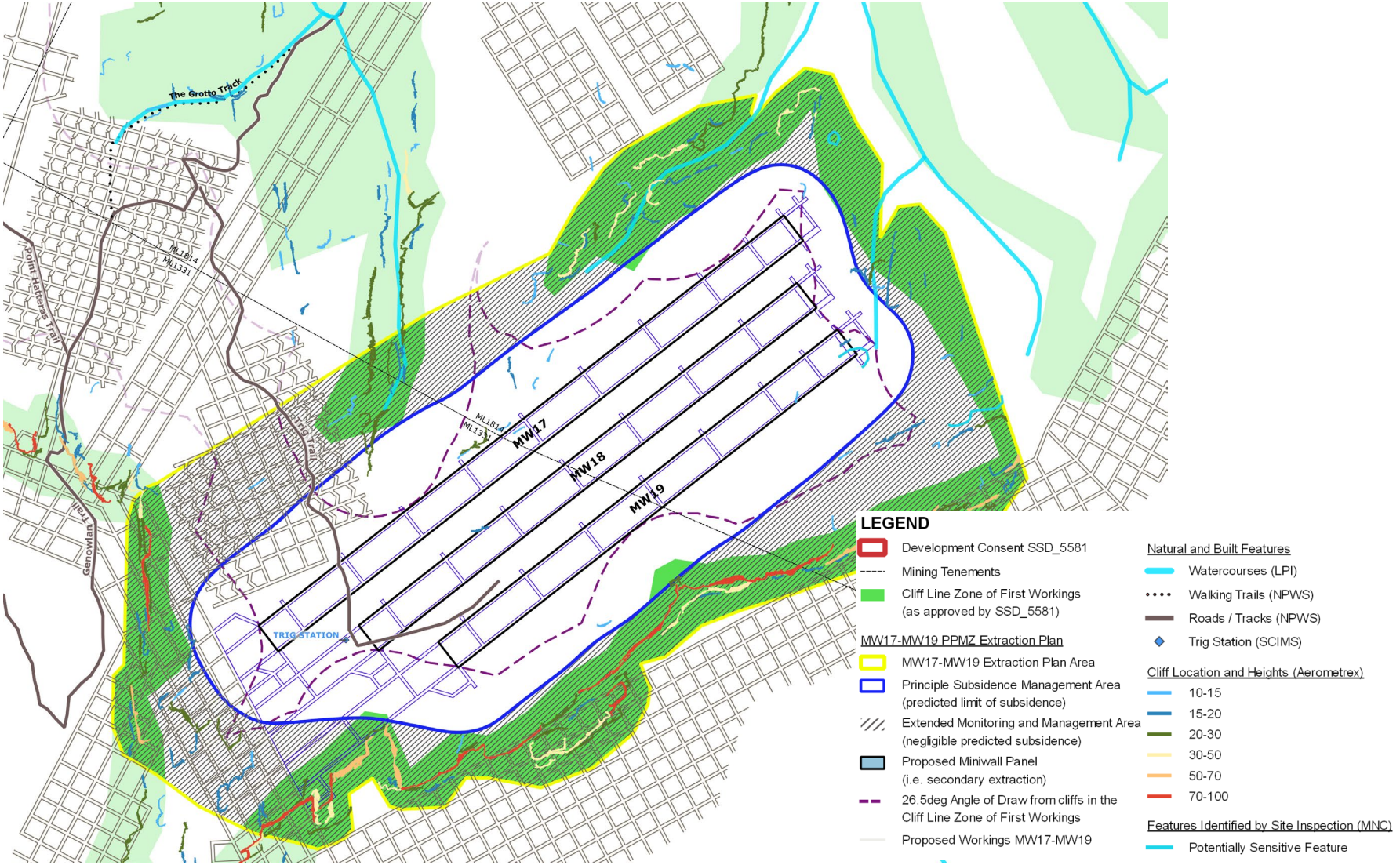
# MW17-19 PPMZ Extraction Plan

## South-eastern part of Genowlan Mountain

OUR WAY IN ENERGY

# Extraction Plan Area



# Subsidence Modelling (SCT)

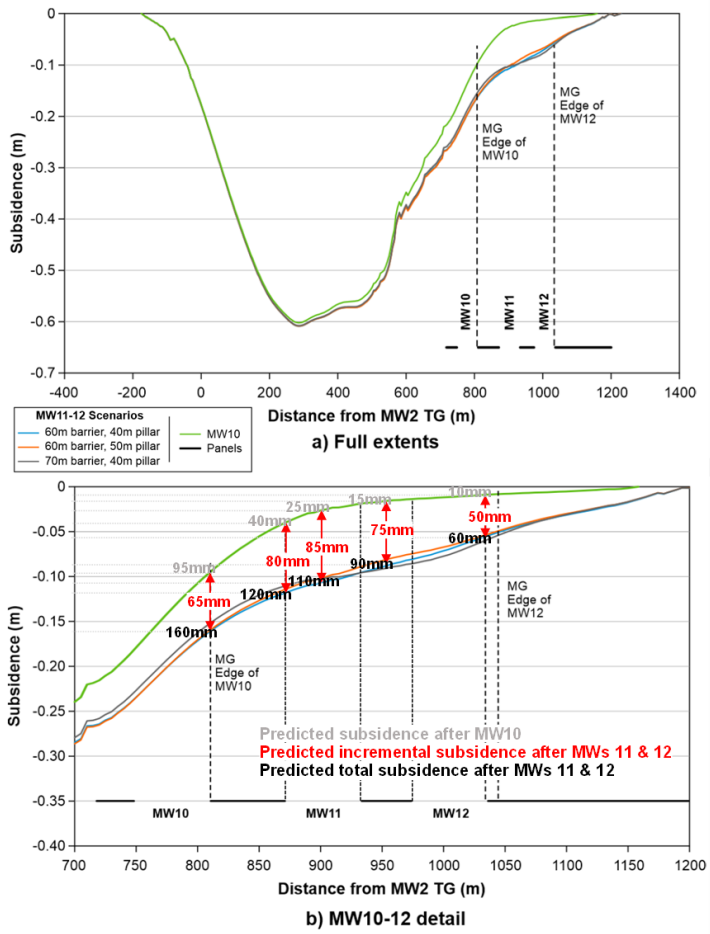
- **SCT have developed a calibrated model for predictive purposes (used previously by Airly Mine)**

- **A comparison of the measured vertical subsidence data following extraction against the SCT model predictions has been undertaken for MW11 & MW12 and MW13 & MW14 by MSEC (2023)**

- **These comparisons *(discussed on next slides)* confirm that measured subsidence levels are within the range predicted by the SCT subsidence model and indicate the SCT modelling can be relied on with a reasonable confidence for predicting subsidence from miniwall mining at Airly Mine**

# Comparison of subsidence monitoring results for MW11 & MW12 against predictions

## Predicted




## Observed

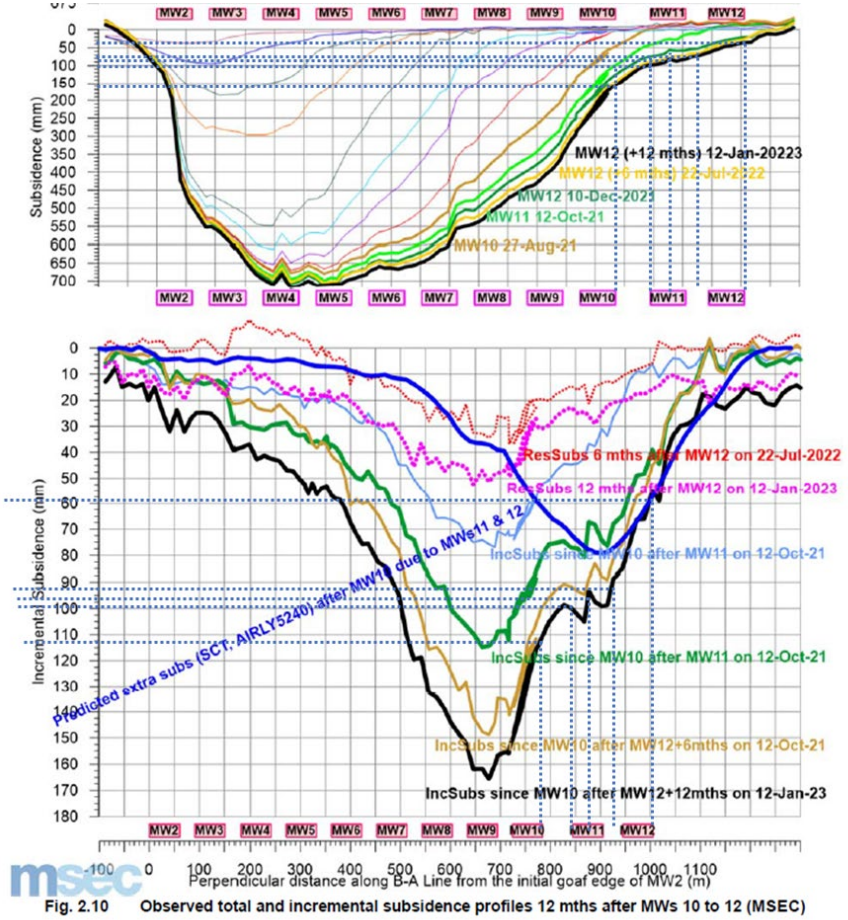



Fig. 2.10 Observed total and incremental subsidence profiles 12 mths after MWs 10 to 12 (MSEC)

# Comparison of subsidence monitoring results for MW11 & MW12 against predictions

| Location | Predicted total subsidence after MW12 is extracted | Predicted incremental subsidence due to the extraction of MWs 11 and 12 | Observed total subsidence after MW12 is extracted (+12months) |
|---|---|---|---|
| **tailgate goaf edge of miniwall panel MW11** | 120 mm | 80mm<br>(120 mm – 40 mm) | 105mm |
| **over the MW11 panel** | 105 mm | 85mm<br>(110 mm – 25 mm) | 90mm |
| **over the chain pillar between MWs 11 and 12** | 90 mm | 75mm<br>(90 mm – 15 mm) | 75mm |
| **over the main gate edge of MW12** | 60 mm | 50mm<br>(60 mm – 10 mm) | 40mm |

# Comparison of subsidence monitoring results for MW13 & MW14 against predictions

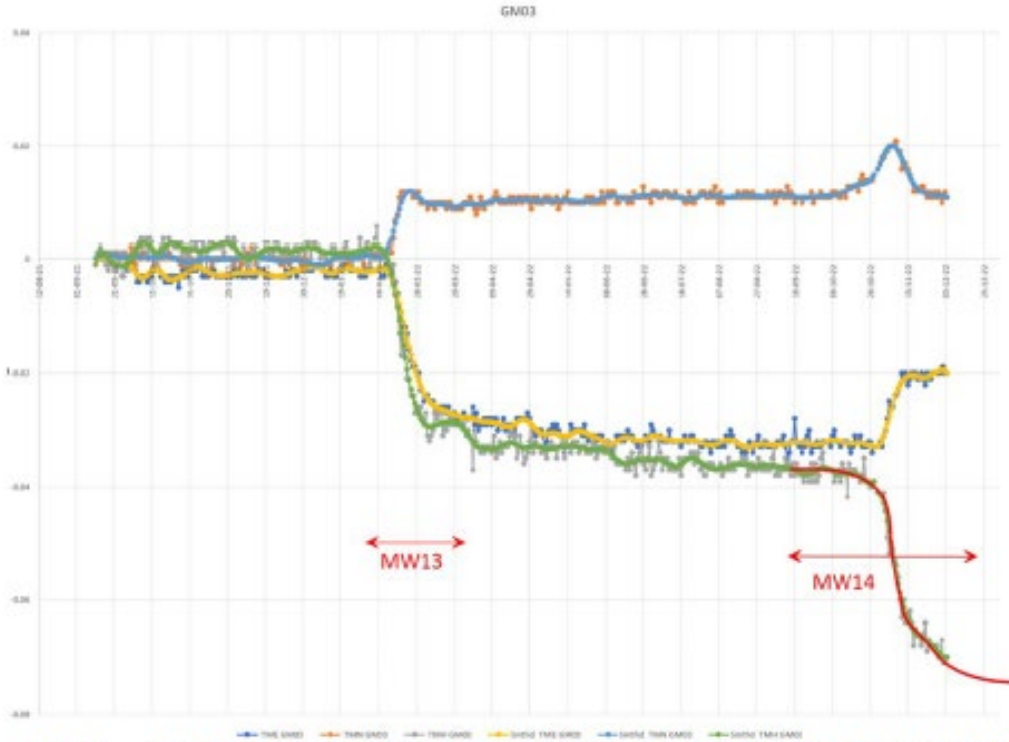



Fig. 2.16 Observed subsidence at GNSS station GM03 over MWs 13 to 14 on a daily basis (MSEC)

- **Based on the available subsidence monitoring:**
  - the maximum observed subsidence level after MW13 was ~38mm, which is in line with model predictions (30mm, +/-20mm) and like the levels measured when MW02 was extracted.
  - MSEC (2023) predicts the final subsidence over MWs13 to 14 (at station GM03) will be ~75 mm, which is in line with model predictions (70mm, +/-20mm).
- **MSEC (2023) concluded that the subsidence levels over the remainder of the miniwall panels will be close to those levels of subsidence predicted by SCT with the FLAC modelling.**

# Comparison of subsidence monitoring results for MW13 & MW14 against predictions

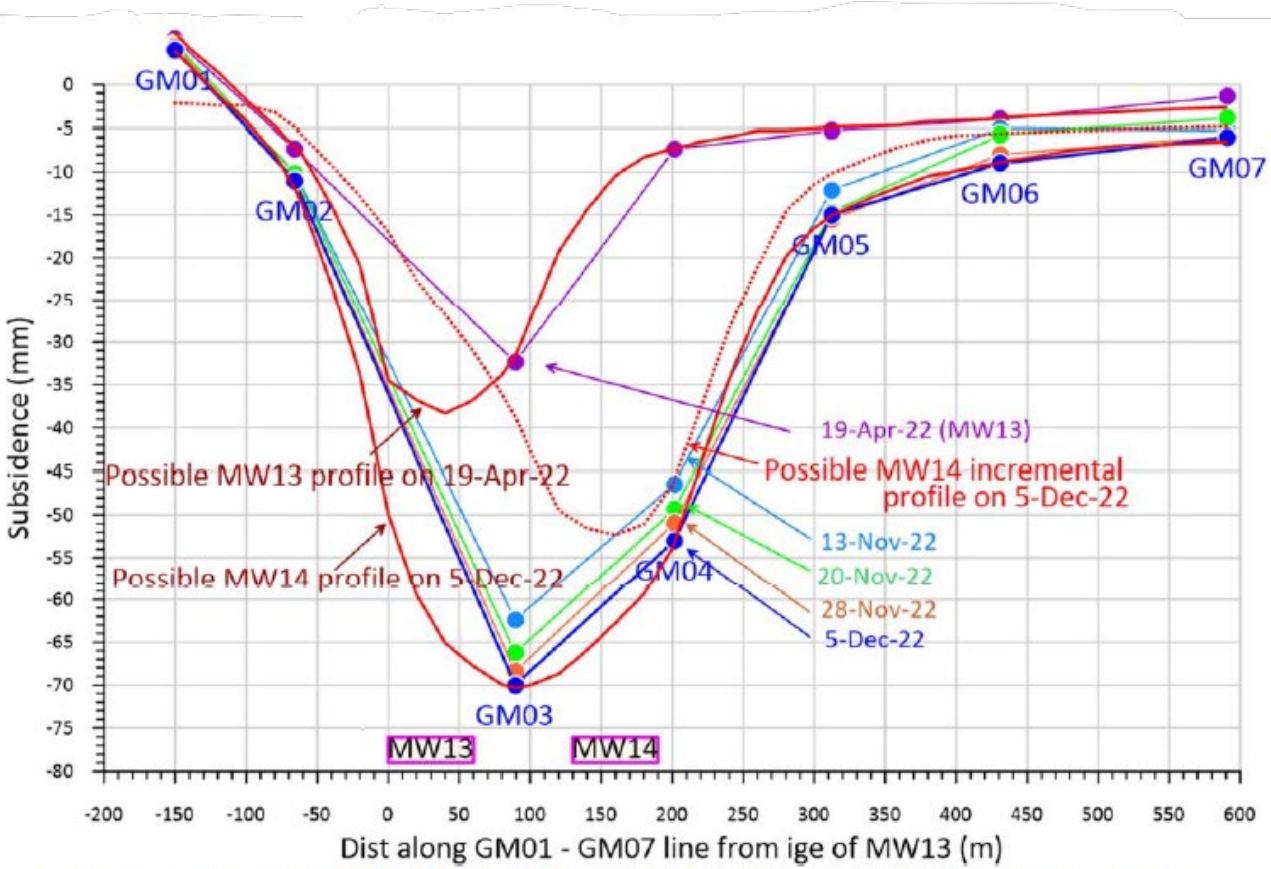
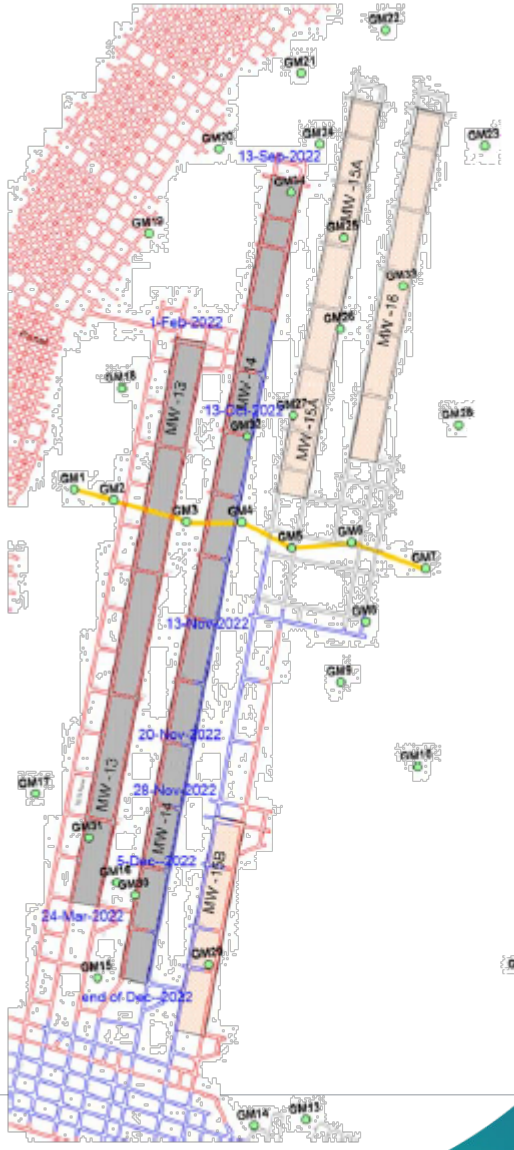



**Fig. 2.13** **Recent observed subsidence profiles across MWs 13 and 14 at stations GM01 to GM07 (MSEC)**



# Subsidence Modelling (SCT) – MW17-19

- **Modelling assessment aimed to provide a pillar width design to control subsidence to 125mm**
- **Based on SCT modelling it is predicted the mine design (56m voids / 50m pillars) will limit subsidence to less than 125mm**
- **Subsidence magnitude estimates (after miniwall extraction):**
  - *MW17: -27mm*
  - *MW18: -63mm*
  - *MW19: -118mm*
- **Modelled DoC was consertively 280m, the majority of mining where three panels are side by side occurs at depths of 260m or less, therefore the subsidence magnitudes are considered a conservative maximum estimate**

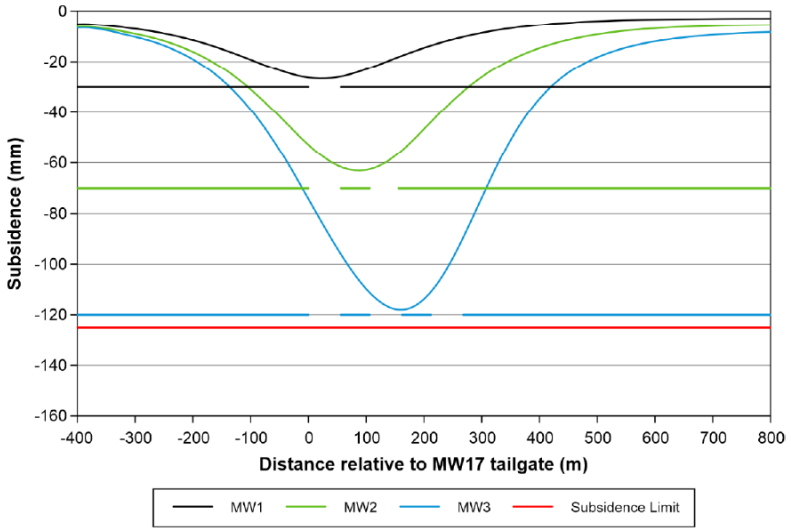



**Figure 3: Modelled surface subsidence following MW17-19 extraction in the SE Genowlan Mining Area – (+/-) 20mm subsidence tolerance/natural variability should be applied to these results.**

# Predicted Subsidence Contours

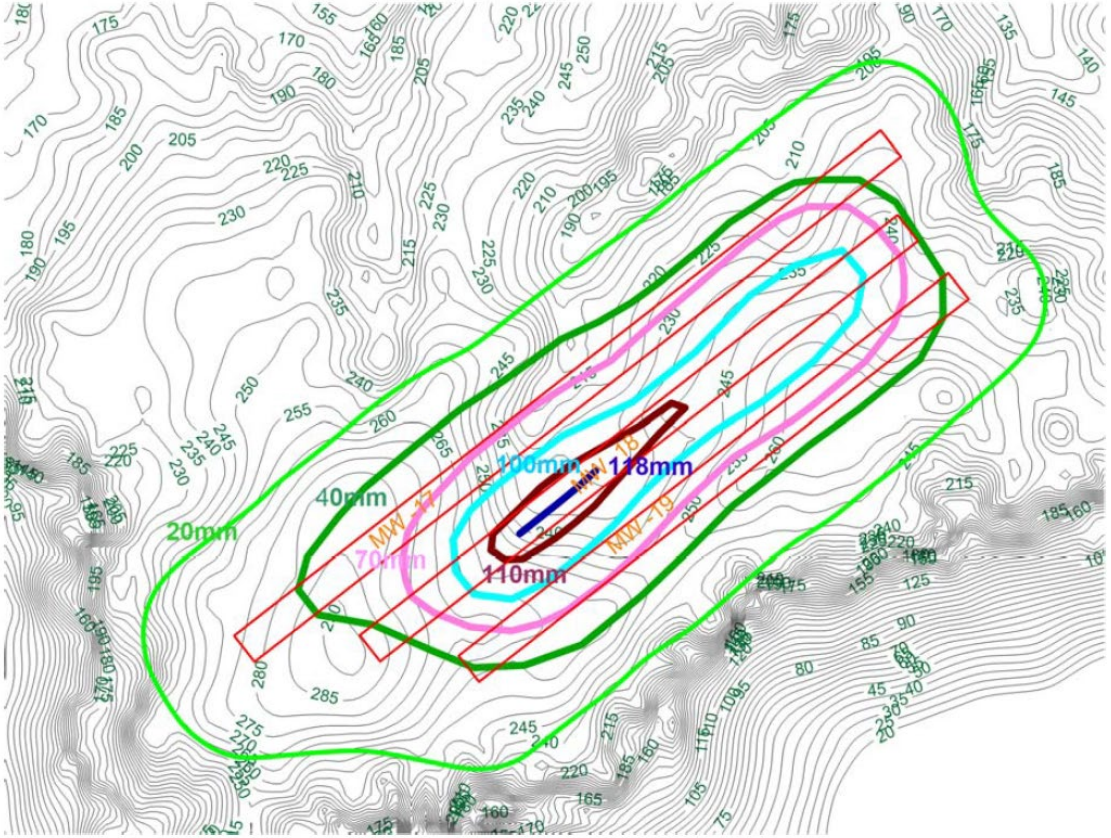
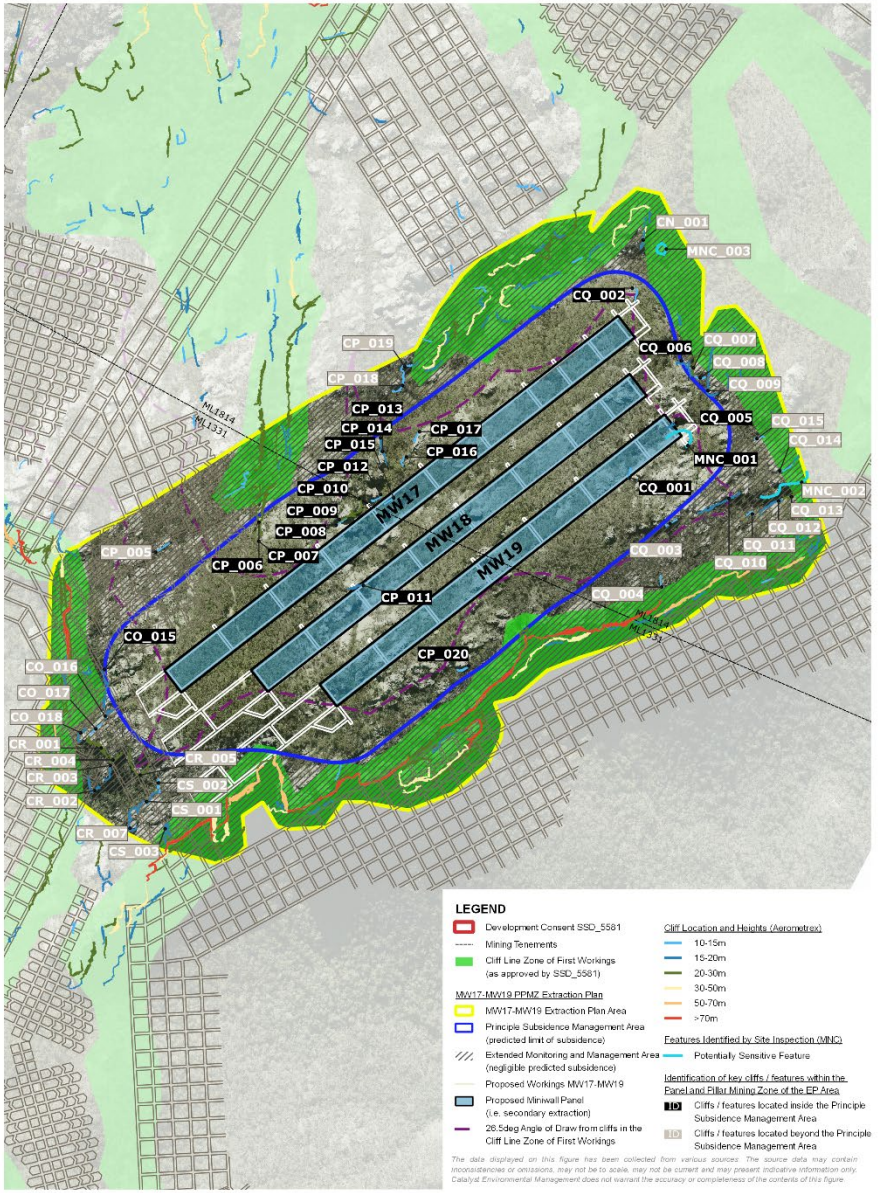



**Fig. 3.9** **Predicted subsidence contour levels (using 26.5° AoD) overlain over DoC contours and panel boundaries for MWs 17 to 19 (MSEC after SCT, 2022)**

# Cliff Impact Assessment

- **Identified cliffs have been assessed by MSEC, including subsidence predictions for each cliff within the principal subsidence management area**
- **The maximum predicted subsidence at the identified cliff sites over or near MWs 17 to 19 is less than 110 mm,**
- **The report concludes that there should be little chance of exceedance of the conditions of approval for the cliffs that have been identified over the proposed MWs 17 to 19**




**Key Cliffs / Features Located within the Panel and Pillar Mining Zone**

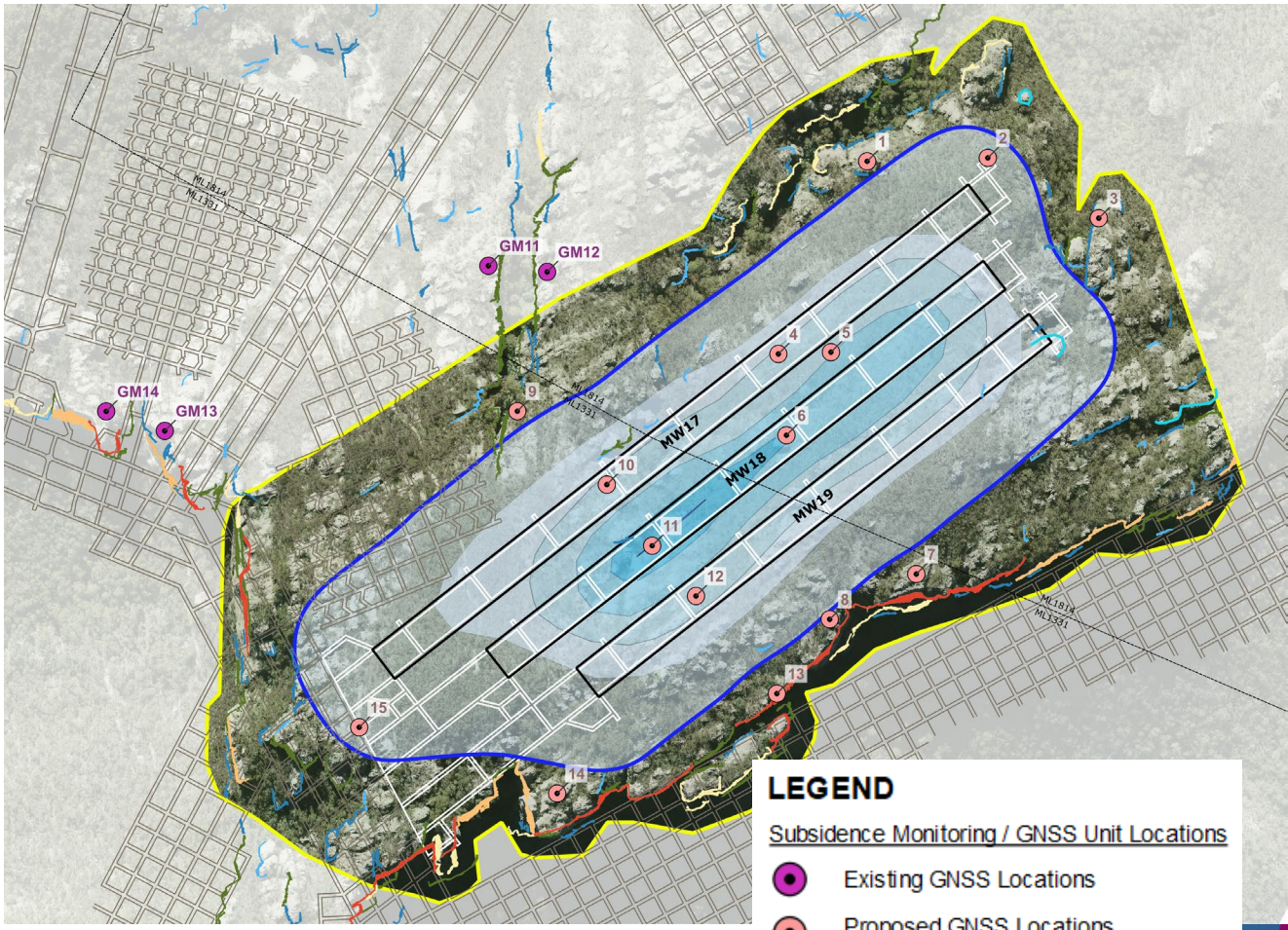
MW17-MW19 PPMZ Extraction Plan

# Subsidence Monitoring

- **Based on subsidence monitoring program approved for MW13-16, including:**
  - Underground Mining Control
  - Monitoring ground movement (GNSS monitoring units – **Slide 30**)
    - Total of fifteen (15) GNSS units proposed
    - Record X, Y, Z spatial position readings to <+/-5mm accuracy
    - Continuous and near real time data, with notifications to key site personnel in accordance with trigger thresholds
    - May be co-located with photo control target to improve photogrammetry
  - Remote monitoring of the surface
    - Stereo Vertical Photogrammetry
    - 3D Oblique Photogrammetry
    - Undertaken approximately six-month intervals, 5 baseline surveys compete
  - Trigger-based Targeted Surface Inspections (where required)
  - Environmental Monitoring Programs, incl:
    - Surface water
    - Groundwater
    - Biodiversity
    - Aquatic Ecology and Stream Health

# Proposed Subsidence Monitoring / GNSS Unit Locations

- GNSS units labelled 4, 5 and 6 are ideally located for subsidence modelling validation
- GNSS units labelled 9 to 13 provide a pseudo subsidence line through the area of predicted maximum subsidence
- GNSS units labelled 10 and 11 also provide redundancy and record natural variability for points 4 and 6.
- The remaining proposed units are measuring potentially sensitive features, or at cliffs in the cliff line zone for potential movements beyond predictions.



# Draft Submission for Consultation

- **Extraction Plan and Appendices:**
  - Extraction Plan Main Report
  - Land Management Plan
  - Biodiversity Management Plan
  - Public Safety Management Plan
  - Subsidence Monitoring Program
  - Master Trigger Action Response Plan
  - Graphical Plans for MW17-19 (Plan 2 and Plan 5)
  - *Note, the Airly Water Management Plan is being submitted to the department separately, but has been reviewed in consideration of this proposed Extraction Plan*
- **Technical Reports:**
  - Pillar Width Numerical Modelling Assessment (SCT, 2022)
  - Subsidence Predictions and Impact Assessment Report (MSEC, 2023)
  - Baseline Biodiversity Assessment (RPS, 2023)
  - Baseline Historic Heritage Assessment (RPS, 2022a)
  - Baseline Aboriginal Cultural Heritage Assessment (RPS, 2022b)

# Timelines and Next Steps

- **Draft submission meeting with IEP and DPE Monday 13th February to discuss Extraction Plans and any IEP feedback**

- **Draft documents provided for consultation week commencing 13 February (ASAP)**

- **Next steps:**
  - Final edits following consultation and EP submitted
    - four weeks provided for consultation and feed back to be received (**mid March**)
  - DPE assessment of EP
    - Acknowledged 90 day assessment period as per DPE guidelines (**mid July**)
    - Earlier approval sought if feasible due to commencement of development of MW17 in June/July, considering continued conservative approach (and pending IEP feedback and conclusions)
  - Approval to be sought from NPWS for installation of GNSS monitoring units (**ASAP**).
  - Commence development (**June/July**).

CENTENNIAL

## Appendix 1 E: BCS Response to Draft Management Plans (dated 27/3/23)

Department of Planning and Environment

Our ref:DOC23/244136

Sam Price
Environmental and Community Superintendent
Centennial Coal Company Limited, Airly
Sam.Price@centennialcoal.com.au

Dear Sam

**Mt Airly Panel and Pillar Zone Extraction Plan – Miniwalls 17-19**

Thank you for your e-mail dated 23 February 2023 to the Biodiversity, Conservation and Science Directorate (BCS) of the Department of Planning and Environment (DPE) inviting comments on the Panel and Pillar Zone Extraction Plan for Miniwalls 17-19 (the extraction plan).

Several sub-management plans were submitted for BCS consultation, this includes:

- the subsidence monitoring program
- the public safety management plan
- the land management plan; and
- the biodiversity management plan

Whilst reviewing the sub-management plans above BCS attempted to contact Centennial Coal, via telephone, to raise and discuss some of the matters detailed in this response. This included requesting consultation with the National Parks and Wildlife Service, and to request the copies of other reports associated with the extraction plan to provide necessary detail. Unfortunately contact with Centennial could not be made during the consultation period.

BCS's detailed comments and recommendations are provided in **Attachment A**. If you have any questions about this advice, please do not hesitate to contact Ben Ellis, A/ Principal Project Manager, via ben.ellis@environment.nsw.gov.au or (02) 8275 1838.

Yours sincerely

**Liz Mazzer**
**A/ Senior Team Leader**
**Biodiversity, Conservation and Science Directorate**

27 March 2023

Attachment A – BCS's comments and recommendations

CC – Lisa Menke, National Parks Area Manager

CC - NSW Planning – Energy and Resource Assessments Team

# BCS's comments and recommendations

# Mt Airly Panel and Pillar Zone Extraction Plan – Miniwalls 17-19

## 1 The extraction plan and mine design should be revised according to a precautionary approach so that subsidence thresholds do not have the potential to be exceeded

A 125mm subsidence threshold is defined in the EIS for the Airly Coal Mine and referenced within the project's approved development consent (Schedule 3 Condition 2).

Throughout the sub-management plans it is stated that the approvals for Panel and Pillar Mining are based on predicted surface subsidence levels of up to 100-125mm and that the extraction plan has adopted a conservative mine design to control subsidence to levels predicted in the EIS. However, the predicted incremental subsidence resulting from mining is stated to be 118mm with a subsidence tolerance of 20mm. This has the potential to create maximum vertical subsidence levels of up to 138mm (See Figure 1 below).

**Table 3.1: Maximum Incremental Subsidence Predictions (SCT, 2022)**

| Miniwall Panel Width | Maximum Predicted Subsidence (mm)[a] |
|---|---|
| One Miniwall | -27 |
| Two Miniwalls | -63 |
| Three Miniwalls | -118 |

*a) SCT (2022) note that a subsidence tolerance/natural variability of +/-20mm should be applied to the modelled subsidence*

**Figure 1 Incremental vertical subsidence, noting subsidence tolerances of +/-20mm**

In its determination report of 15 December 2016, the Planning Assessment Commission (PAC) recognized the significance of the Mugii Murum-ban State Conservation Area (MMBSCA), stating that:

*"The Airly Mine is situated in an area of spectacular geodiversity with majestic cliffs and rock formations that are considered highly significant and delight the local community and visitors alike. The potential subsidence effects of mining must be very carefully examined in order to ensure that potential subsidence impacts do not lead to a deterioration in these natural values*".

BCS agrees with this statement, and as such, does not support the approval of a mine design which has the potential to result in non-compliant subsidence levels.

Given the proposed mine design has the potential to result in subsidence level exceedance, it is recommended that the current mine design is revised. Consideration should be given to alternative designs which may be more representative of a precautionary approach and have a higher likelihood of ensuring subsidence remains within 125mm.

In requesting BCS consultation, the extraction plan main report was not provided for review. As such, our understanding of the potential surface expression of subsidence is limited to the summary information in the sub-management plans. Providing the extraction plan main report would assist in BCS to fully understand the method and context behind the subsidence modelling undertaken.

Recommendation

1.1 Revise the proposed mine design to a layout which has a higher likelihood of remaining within the 125 mm subsidence threshold

## 2 The key outcomes of all risk assessments should be revised to consider the exceedance of the 125mm subsidence threshold

BCS notes that the key outcomes of all sub-management plans have been predicated on the expectation that the proposed mine design will result in subsidence levels under the 125 mm threshold.

As stated above, the summary of subsidence modelling indicates that exceedance of the 125 mm subsidence threshold is possible under the current extraction plan design. As such, BCS has concerns that the risk assessments and associated management plans underestimate the significance of the potential impact which may occur on the natural values of the MMBSCA.

The outcomes and determinations for all associated risk assessments and management plans, which are predicated on the 125mm threshold not being exceeded, should be reviewed to determine if further avoidance, mitigation, and monitoring will be necessary.

Recommendation

2.1 Review, and where required, revise the outcomes and determinations of all risk assessments and management plans which are predicated on the 125mm threshold not being exceeded.

## 3 The area manager for Mugii Murum-ban State Conservation Area should be consulted

During the consultation period, it was brought to BCS attention that the National Parks and Wildlife Service Area Manager has not been consulted by Centennial Coal. As the extraction plan area is within the MMBSCA, BCS consider it essential that the National Parks and Wildlife Service is provided the full extraction plan and all sub-management plans to review, with sufficient time to provide comment on these documents.

Recommendation

3.1 Consult with the National Parks and Wildlife Service Area Manager, providing them the full extraction plan and sub-management plans to review

## 4 The Trigger Action Response Plan for the project should be provided

During this request for consultation BCS were not provided the main extraction plan for review.

The sub-management plans provided to BCS for consultation provide reference to the project's master Trigger Action Response Plan (TARP), however they do not contain details on the adaptive management strategy proposed for natural values within the MMBSCA.

As BCS understands, the main extraction plan contains the master TARP for the entire project, inclusive of factors detailed within sub management plans. Review of the master TARP will be necessary for BCS to understand if the triggers for intervention and corrective actions proposed by Centennial Coal are appropriate.

Recommendation

4.1 Provide the extraction plan main report, including the master TARP, for BCS review

## Appendix 1 F: NSW RR Response to Draft Management Plans (dated 14/3/23)

**Resources Regulator**
Department of Regional NSW

14th March 2023

Sarah Kimm
Centennial Coal
Sarah.kimm@centennialcoal.com.au

Via: Major Projects Portal

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Dear Sarah,

I refer to the Airly Coal 2 Extraction Plan MW17-MW19 sub management plan submitted to the Resources Regulator on 3rd March 2023 (SSD-5581-PA-67).

The Resources Regulator acknowledges receipt of the documentation, however, provide no comments on draft submissions at this stage.

Please contact our department on 1300 814 609 if you wish to organise an engagement session with the relevant team.

*CONTACT*

Should you require any further information or clarification, please contact the Regulator on

1300 814 609 (Press Option 2 Press Option 5) or email nswresourcesregulator@service-now.com.

Yours sincerely,

**Matthew Newton**

Principal Inspector – Environment and Rehabilitation Operations

Resources Regulator

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## Appendix 1 G: DPE - Water Response to Draft Management Plans (dated 31/3/23)

**Department of Planning and Environment**

Our ref: OUT23/4966

Jacqueline Cooke
Centennial Coal

Email: Jacqueline.Cooke@centennialcoal.com.au

31 March 2023

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Subject: Airly Coal Mine Expansion – Extraction Plan MW17-19 & Water Management Plan

Dear Jacqueline Cooke

I refer to your request dated 23 February 2023 providing the Department of Planning and Environment (DPE) Water an opportunity to comment on the above matter.

The Department of Planning and Environment- Water (DPE Water) has reviewed the Airly Mine Extraction Plan for MW17-19, and the included Water Management Plan. We require the proponent to address recommendations prior to submitting the plan for approval which relate to groundwater monitoring and modelling, and water licensing. Recommendations to be addressed in future revisions of the plan are also provided which relate to data presentation and interpretation.

Please see attachment A for further detail.

Should you have any further queries in relation to this submission please do not hesitate to contact DPE Water Assessments at water.assessments@dpie.nsw.gov.au,

Yours sincerely,

Liz Rogers
Manager, Assessments, Knowledge Division
**Department of Planning and Environment: Water**

# Attachment A

# Detailed advice regarding the Airly Coal Mine Expansion - Water Management Plan

## 1.0 Water take and licensing

### Recommendation Prior to Submitting for Approval

#### 1.1 Recommendation

That Centennial Coal quantifies the maximum groundwater take consistent with the definition in the NSW Aquifer Interference Policy (AIP). Sufficient entitlement must be held in a water access licence to account for the water take in each water source prior to the take occurring.

#### Explanation

The Water Management Plan (WMP) outlines that groundwater inflows have been estimated *'from transfers between the surface and underground workings, which are metered (i.e., groundwater inflows = transfer from underground workings to surface – transfer from surface to underground workings)'*. This is not consistent with the definition of groundwater inflows in the AIP which states that the removal of water from a water source is the water leaving the aquifer and entering the void.

## 2.0 Water Management, Monitoring and Modelling

### Recommendations Prior to Submitting for Approval

#### 2.1 Recommendation

That Centennial Coal provide the 2021 groundwater model supported by an external Independent Review to assess the suitability of the groundwater trigger levels and monitoring regime.

#### Explanation

The WMP states that the hydrogeological model, developed as part of the Airly Mine Extension Project, was updated to reflect the 2021 mine plan and schedule. This updated hydrogeological model has been used to produce revised drawdown predictions, upon which groundwater trigger levels and the future usability of current monitoring sites has been assessed.

However, the updated hydrogeological model and the external independent review has not been made available to DPE Water to assess the suitability of the WMP and its monitoring provisions against the updated groundwater level drawdown projections.

#### 2.2 Recommendation

That Centennial Coal provides an explanation for the difference between modelled and observed groundwater inflows shown in Figure 3.3 of the WMP.

#### Explanation

A comparison between modelled and observed groundwater inflows was shown in Figure 3.3 of the WMP. It shows that minimal observed groundwater inflows have occurred since January 2012 and are much lower than the modelled groundwater inflows. No explanation has been provided nor referenced to explain this discrepancy.

### 2.3 Recommendation

That Centennial Coal revise the site water balance predictions to include data from all previous years of operation, not just the wet year of 2022.

### Explanation

A summary of the site water balance results (Table 3.3 of the WMP, Table 1 in the appendix of this memo appendix) for future conditions is based on the annual site water balance for 2022. DPE Water does not agree that using the site water balance for one year of operation is appropriate to determine a probable site water balance for future conditions. Future water balances should be predicted using multiple years of data.

### 2.4 Recommendation

That Centennial Coal include monitoring of surface water discharge at "the Grotto" monitoring site.

### Explanation

Section 4.2.2 of the WMP states that *'There is no flow monitoring of the Grotto currently undertaken'* (pg 44). This contradicts the requirements of Schedule 4, Condition 13(c)(ii) of the Development consent SSD 5581 that continuous flow monitoring should occur at the Grotto. No justification has been provided as to why monitoring has not occurred at this site. The monitoring site 'Genowlan Creek 2' is located downstream of the Grotto, hence is not considered to meet this monitoring requirement.

### 2.5 Recommendation

That Centennial Coal provide more detail on which groundwater monitoring sites will be lost due to mine work progression and which monitoring sites will become dry if the updated 2021 groundwater model level drawdown predictions occur.

### Explanation

It has been noted in the WMP that groundwater monitoring sites screened within the Lithgow Seam will be lost as mine working progress. It has also been noted that some groundwater monitoring sites are expected to become dry if the updated groundwater level drawdown predictions, produced by the 2021 groundwater model, occur. It has not been explained how these monitoring sites will be replaced (if applicable) and when the monitoring site replacement will occur so that sufficient time is provided to produce site-specific trigger levels before the other monitoring sites are lost.

### 2.6 Recommendation

That Centennial Coal define what period of data is used to develop trigger levels for surface water flows. It is not clear if this is based on the first two years of data only, or the entire monitoring record.

### Explanation

The WMP outlines that water quality trigger values within the Gap Creek and Genowlan Greek catchments is *'...assessed against triggers developed with reference to historical monitoring data.'* Clarification is needed as to what period 'historical monitoring data' refers to (that is, the whole monitoring period versus a particular monitoring period window) before DPE Water can comment on the suitability of these surface water quality trigger values.

### 2.7 Recommendation

That Centennial Coal revises the trigger values for groundwater quality so that it incorporates at least the first two years of baseline monitoring.

### Explanation

The WMP outlines that groundwater quality trigger values have been developed using the historical groundwater monitoring data. In particular *'Trigger values are based on an exceedance of 80th percentile of concentrations recorded in the last 24 months respectively…'*. DPE Water does not agree that this method is suitable for developing trigger values, particularly when it is evident that groundwater quality changes have occurred at some monitoring sites during the preceding 24 months (2020 to 2022). Trigger levels should incorporate at least the first two years of data and a minimum of 8 monitoring points. Monitoring data from additional years can be incorporated to update trigger levels provided it can be adequately determined that the data is within expected natural variation.

## 3.0 Water Data Presentation and Interpretation

### Recommendations Post Approval of Plan

#### 3.1 Recommendation

That Centennial Coal include a quality assurance methodology and plan for the next version of the WMP.

#### Explanation

It is not clear if QA/QC analysis has been performed on the monitoring data to confirm the suitability of the data to characterise site conditions, to develop trigger values, and for conducting statistical analysis.

#### 3.2 Recommendation

That Centennial Coal improve the graphical representation of the monitoring data for visibility and interpretability, and to allow easy reference to trigger levels.

#### Explanation

It is currently difficult to see how water level and water quality data relates to trigger levels and how the monitoring parameters are varying over time. The monitoring data time series graphs should be updated to improve how third parties interpret the data. This should include the use of contrasting colours, applying consistent x-axis time scales, ensuring the y-axis range encompasses all monitoring data values, and utilising semi-log plots when monitoring data spans over several orders of magnitude.

#### 3.3 Recommendation

That Centennial Coal expand the reported summary statistics to include the minimum and maximum values, along with the interquartile range.

#### Explanation

Summary statistics have not been adequately applied to describe the range and variation of monitoring data. The maximum and minimum values for each monitoring characteristic should be reported alongside the count and median values. Consideration should also be given to the suitability of quoting an interquartile range.

#### 3.4 Recommendation

That Centennial Coal conduct statistical trend analysis on the monitoring data to identify increasing, steady, and decreasing trends in monitoring data.

#### Explanation

Statistical trend analysis has not been used to identify and describe changes in the monitoring data. Conducting statistical trend analysis can assist in identifying changes to monitoring parameters before trigger limits are reached.

### 3.5 Recommendation

That Centennial Coal analyse and explain the identified water level and quality changes.

### Explanation

There are geochemical changes evident in the monitoring data time series graphs. No reason for the variability has been supplied, nor a reference to relevant monitoring reports. This may be available in the next Annual Report (last one publicly available was published in March 2022). This could also be available in previously published monitoring reports and should be referenced within the WMP.

## End Attachment A

## Appendix 1 H: IEP Response to Draft MW17-18 Extraction Plan (dated 28/7/23)

28 July 2023

SCT OPERATIONS PTY LTD
www.sct.gs | ABN 23 078 328 953
WOLLONGONG OFFICE
PO Box 824 Wollongong NSW 2520 Australia
Telephone: +61 2 4222 2777 Email: contactus@sct.gs
BENDIGO | BRISBANE | NEW ZEALAND | CHINA

Edwina White
Group Manager Approvals
Centennial
Level 20, 1 Market St
SYDNEY NSW 2000

**DPE4689T**

Dear Edwina

**AIRLY MINE: REVIEW OF MW17-18 PANEL & PILLAR MINING ZONE EXTRACTION PLAN**

Centennial Airly Pty Ltd (CAPL) owns and operates Airly Mine 40km northwest of Lithgow in New South Wales. CAPL is preparing an Extraction Plan (EP) detailing the geometry for two miniwall panels, MW17-18 located below the south-eastern part of Genowlan Mountain, designed to maintain surface subsidence to less than 125 mm. CAPL invited the Independent Expert Panel (IEP) for Airly Mine, Professor Ismet Canbulat (University of NSW) and Dr Ken Mills (SCT Operations Pty Ltd), to review this EP as part of the pre-submission consultation and provide feedback on subsidence and subsidence impacts expected on Genowlan Mountain and surrounding cliff formations. This letter report provides the outcomes of our review.

The IEP considers:

- the proposed geometry is likely to achieve CAPL's commitment to maximum subsidence of less than 125 mm
- subsidence monitoring is suitable to confirm the low levels of subsidence expected.
- surface impacts from this mining are expected to be imperceptible
- all cliff formations within the Cliff Line Zone are protected by an angle of draw of greater than 26.5° and by the low levels of subsidence over the mining area.

Our review of the EP documentation provided indicates that CAPL relies heavily on numerical modelling results to maintain maximum subsidence below 125 mm. Recent subsidence monitoring after the completion of MW10-12 and MW13-MW15A shows that predictions based on this numerical modelling have been accurate. On this basis, the maximum subsidence of 88 mm predicted for the proposed geometry for MW17-MW18 is considered likely to be a reliable indicator of maximum subsidence.

At these low levels of subsidence, surface impacts such as cracking, rock falls or other perceptible impacts to rock features are not expected to be evident.

## 1. Introduction

CAPL has provided the IEP with the Airly Extraction Plan (EP) for MWs 17-18 (CAPL 2023) to replace the initially proposed EP for MW17-19. CAP has provided EP (MW17-18) to the IEP for consultation in compliance with Schedule 3, Condition 7 of Airly's SSD 5581 approval conditions. These conditions require consultation with the IEP in Conditions 7(b), (d), (e), (f), (g), (h) and (i) and the Subsidence Monitoring Program, Land Management Plan (LMP) and the Public Safety Management Plan (PSMP).

CAPL (2023) includes:

- Extraction Plan Main Report (MW17-18): MW17-18 Panel & Pillar Mining Zone Extraction Plan: Revision No. MW17-19 Main Report_Rev_1.
- Land Management Plan (MW17-18 LMP): MW17-18 Panel & Pillar Mining Zone Extraction Plan: Revision No. MW17-18 LMP_Rev_1.
- Public Safety Management Plan (MW17-18 PSMP): MW17-18 Panel & Pillar Mining Zone Extraction Plan: Revision No. MW17-18 PSMP_Rev_1.
- Subsidence Monitoring Program: MW17-18 Panel and Pillar Mining Zone Extraction Plan: Revision No. MW17-18 SMP_Rev_1.

The findings of the IEP's review of these document is represented in this letter report in the following structure:

- Section 2 presents an overview of the site as context for the subsequent discussion.
- Section 3 discusses the estimation of maximum subsidence.
- Section 4 recommends the MSEC (2023) report is revised.
- Section 5 discusses other plans.

## 2. Site Overview

Figure 1 shows a plan of the proposed MW17-18 mining geometry. The IEP understands that:

- two miniwall panels are planned to create 70 m wide voids between a 70 m wide chain pillar
- the depth of overburden strata above these panels ranges from 215 m to 290 m (noting a discrepancy between Page 35 of the main report, which indicates 240-280 m and Figure 3.4, which indicates 215-290 m).
- significant cliffs within the Cliff Line Zone are protected by a horizontal distance equivalent to an angle of draw of 26.5° (half depth) from either the base of the cliff or the top of the cliff, whichever is greater.

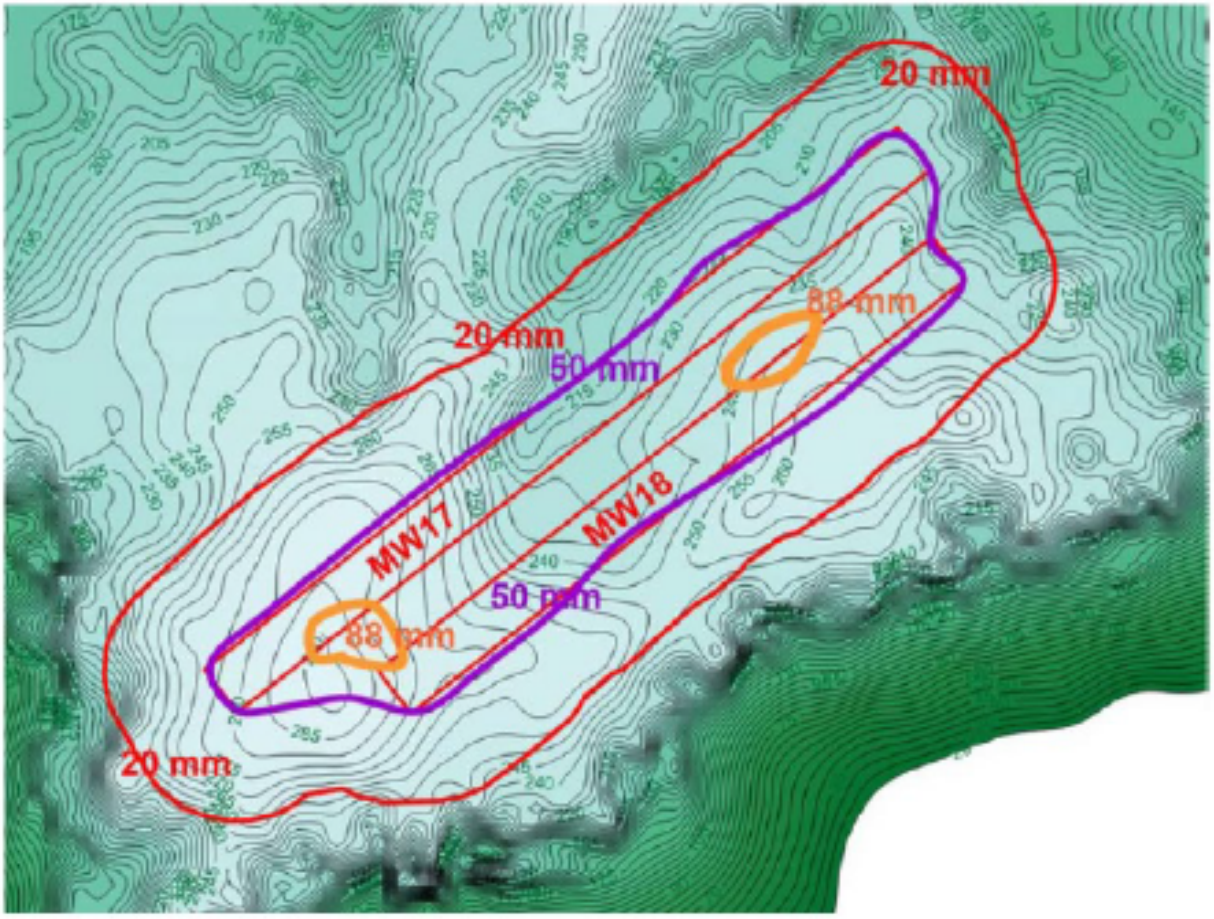


**Figure 1: Site plan showing overburden depth and predicted subsidence contours at the completion of both panels (Figure 3.4 of CAPL 2023 sourced from Figure 2.6 in MSEC 2023).**

## 3. SUBSIDENCE ESTIMATES

The management of subsidence described in the EP documents is predicated on the maximum subsidence being 88 mm, as indicated by numerical modelling (SCT 2023). A good correlation between predictions based on this numerical model and subsidence recently measured over MW10-12 and MW13-15A gives confidence that the predictions of maximum subsidence over the proposed geometry are likely to meet CAPL's commitment to maximum subsidence of less than 125 mm.

The GNSS units used to monitor subsidence on Genowlan Mountain appear to have a nominal accuracy of better than ±3 mm in vertical elevation. Maximum subsidence needs to be less than 120 mm to be confident that the 125 mm subsidence limit is not exceeded through random variation within the tolerance of the GNSS measurement system.

There is some ongoing residual subsidence evident above Mt Airly. The magnitude of this residual subsidence is expected to be in the range of 5-10% of maximum subsidence or up to about 10 mm. Therefore, the maximum subsidence at the time of mining needs to remain less than 110 mm to be confident that the 125 mm threshold is not being exceeded by residual subsidence and survey tolerance.

With the prediction in SCT (2023) of maximum subsidence of 88 ±20 mm, there is considered to be a high likelihood of final subsidence remaining less than 125 mm even after random variation associated with survey tolerance, residual subsidence and variability in the numerical modelling is taken into account. The numerical model may also account for residual subsidence, indirectly if not explicitly, so there may be some 10-12 mm of extra margin available.

The GNSS units planned above MW17 and MW18 are expected to provide a strong indication of maximum subsidence. Units located over the centre of MW17 and the centre of the chain pillar between MW17 and MW18 are the most critical. All units should be installed well before MW17 commences.

## 4. Subsidence Assessment Report

The IEP recommends updating the subsidence assessment report of MSEC (2023) to recognise that maximum subsidence measured so far over MW13-15A is 89 mm (given 15 mm of subsidence occurred before GN32 was installed) with an additional 5 mm subsidence expected from residual subsidence.

The IEP note that the total of 94 mm after residual subsidence is equal to the maximum subsidence predicted in SCT (2023).

## 5. Other Considerations

Public safety is recognised to be a low probability, high consequences event. The low levels of subsidence reduce the probability of surface impacts that may affect public safety. The IEP recommends some further consideration be given to the controls in the Public Safety Management Plan. The IEP did not review the latest version of the Adaptive Management measures, and the recommended changes may already be included.

If a TARP code orange is triggered, the IEP recommends controlling access to the public in and around the EP zone until the area is inspected. If a TARP code red is triggered, the IEP recommends barricading the area until miniwall extraction has ceased and the entire area is inspected.

If you have any queries or require further clarification of any of the issues raised, please don't hesitate to contact either of us directly.

Yours sincerely

Ken Mills
SCT Operations Pty Ltd

Ismet Canbulat
University of New South Wales

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*Disclaimer*

*Ismet Canbulat is employed as Professor, Head of School and Kenneth Finlay Chair of Rock Mechanics at The University of New South Wales (UNSW) Sydney. In accordance with policy regulations of UNSW regarding external private consulting, it is recorded that this report has been prepared by the author in his private capacity as an independent consultant, and not as an employee of UNSW. The report does not necessarily reflect the views of UNSW, and has not relied upon any resources of UNSW.*

*References*

CAPL 2003 "Extraction Plan Main Report (MW17-18): MW17-18 Panel & Pillar Mining Zone Extraction Plan – Airly Mine (SSD_5581) July 2023" with attachments. Report provided to IEP in email from Edwina White dated 18 July 2023.

MSEC 2023 "Centennial Coal: Airly Colliery – MWs17 and MW18 – Subsidence Prodictions and Impact Assessment for the Natural and Built Features over and near the proposed MWs 17 to 18 in support of the Extraction Plan Application" MSEC Report MSEC1351 Revision A dated 3 July 2023.

SCT 2023 "MW17-18 Pillar and Panel Optimisation Assessment: Increasing from 56M Panels and 50M Pillars to 70.5 Panel and 70M Pillars" SCT Letter Report AIRLY5612 dated 8 June 2023.

## Appendix 1 I: NPWS Response to Draft MW17-18 Extraction Plan (dated 31/7/23)

Our reference: DOC23/672706
Your ref: SSD–5581-PA-78

Centennial Airly
Centennial Coal Company Pty Ltd
Level 20, 1 Market Street
Sydney, NSW 2000

Via Major Projects Portal – PAE 60185206

**Re: State Significant Development 5581 (SSD)**

Thank you for the referral of the revised *Centennial Airly Extraction Plan Main Report (MW17-18) MW17-18 for the Panel & Pillar Mining Zone Airly Mine, dated July 2023* (CAEP) for the narrow longwalls (MW17 – MW18) subject to the SSD via the Department of Planning and Environment Major Projects - Portal.

The Extraction Plan as referred is subject to Schedule 3, Condition 7 of SSD Approval, for narrow longwalls affects land reserved under Part 4 of the *National Parks and Wildlife Act 1974* (NPW Act) as Mugii Murum-ban State Conservation Area (SCA). NPWS as the land manager appreciates the opportunity to provide comment.

On review of the CAEP and supporting documents, NPWS raises a number of matters with respect to direct and indirect impacts to the SCA. These matters are summarised below and described in detail as part of **Attachment 1** to this letter.

NPWS recommends

- maintaining the panel width of 61m and extraction height of 2.8m as originally approved in the 2016 SSD Approval and consistent with the EIS and not increasing panel widths by 17.5% as proposed.
- using the proposed 70m wide barrier pillar to ensure a stated conservative approach
- consider and discuss the implications of the faults mapped as crossing directly through and above the narrow longwalls (MW17&18) as proposed, and ensure the subsidence monitoring program considers the faults and applies a program of adequate monitoring and early risk detection
- increase in the number of GNSS units measuring subsidence directly above and in between the narrow longwalls.
- provision of all raw data for subsidence, groundwater piezometer and stream level/flow for Airly mine (in an excel file(s)) to NPWS and BCD on a quarterly (3 month basis).

The applicant is also advised that no unauthorised access or construction works are permitted on the SCA without authorisation by the NSW National Parks and Wildlife Service. The Service advises that it is an offence under the NPW Act to damage land reserved without appropriate approvals in place.

In the preparation of this response, NPWS have consulted with the North West Biodiversity, Conservation and Science Division and relevant technical experts. NPWS comments and recommendations are provided in Attachment 1 to this letter.

If you have any questions about this advice, please contact Lisa Menke, NPWS Manager, Mudgee Area via phone on 6370 9006 or email at *lisa.menke@environment.nsw.gov.au*.

Yours sincerely,

**DAVID CRUST**

Director, Blue Mountains Branch
**National Parks and wildlife Service**

31 July 2023

**Enclosure** : Attachment 1 – NPWS detailed response to revised Centennial Airly MW17-18 Extraction Plan

# NPWS response – Centennial Airly MW17-18 Panel and Pillar Mining Zone Extraction Plan SSD-5581

On review of the revised *Centennial Airly Extraction Plan Main Report (MW17-18) MW17-18 for the Panel & Pillar Mining Zone Airly Mine, dated July 2023* (CAEP) the National Parks and Wildlife Service (NPWS) provides the following advice.

As the CAEP works occur on/under Mugii Murum-ban State Conservation Area (SCA) which are lands reserved under the NSW *National Parks and Wildlife Act 1974* (NPW Act) NPWS agrees with the Planning Assessment Commission – *Determination Report as issued for the* Airly Mine Extension Project (SSD 5581) which recognised the significance of the SCA as one of *spectacular geodiversity with majestic cliffs and rock formations that are considered highly significant and delight the local community and visitors alike (sec.5.1 pg 3).* As part of the planning justification the Commission specified that the potential subsidence effects of mining must be very carefully examined and monitored in order to ensure those impacts do not lead to the deterioration of the natural values of the SCA. Under the Development *Consent* as issued by the *Planning Assessment Commission for the State Significant Development 5581 – Airly Mine Extension Project – 15 December 2016* (SSD Approval) the onus remained with Centennial Airly to demonstrate that narrow longwall mining (NLW) or miniwall operations accord with the set performance measures. NPWS recognise that Centennial Airly's NLW operations to date appear to have exceeded subsidence levels above those approved and supported by the:

- Environmental Impact Statement Airly Mine – Airly Mine Extension Project State Significant Development 5581, Centennial Coal Expansion Report No 137623024_061_R_Rev2_Vol 1 Ch1-12(EIS) - *Airly Coal Mine Expansion | Planning Portal - Department of Planning and Environment (nsw.gov.au)*
- Final Assessment Report – Airly Mine Extension Project (SSD 5581) , dated September 2016 (DPE 2016) - *Airly MEP_Final Assessment Report v13_CP (nsw.gov.au)*
- Report of the Independent Review Panel *on Accuracy and Reliability of Mine Subsidence Impacts on Sensitive Features Across the Airly Mine Extension Application Area, dated 1 July 2026* which forms the basis of the Planning Assessment Commission – *Determination Report for the* Airly Mine Extension Project (SSD 5581), dated 15 December 2016 justification.

CAEP originally confirmed that maximum subsidence of 680mm had occurred, more than 5 times higher than the predicted max. subsidence of 125mm as specified in the EIS. The CAEP for MW17-18 now confirms that subsidence has further increased to a max. of 727mm, almost 6 times the level approved in the EIS. The resulting adverse and irreversible impacts accompanying the exceeded subsidence is fractured cliffs, exposed rock features and cracked pagodas in the SCA.

Under the original Extraction Plan, (Strata Control Technology (SCT2022)) predicted max. vertical subsidence over the then three NLW 17 to 19 was predicted to be 118 mm with a tolerance of +/-20mm. In response NSW Environmental and Heritage Group (**BCS/NPWS 2023-DOC23/244136**) highlighted that the max. incremental subsidence from this prediction meant that max. vertical subsidence of 138mm would be set, inconsistent with the EIS. It was recommended that an alternative design be considered to achieve the precautionary approach within the parameters of the approved max. subsidence of 125mm.

## 1. Revised extraction design MW17-18

On review of the revised CAEP, NPWS queries if the revised mining geometry as discussed to achieve the modified panel void widths of 70.5m and 3.0m extraction height separated by a 70m wide barrier pillar is actually "*substantially the same*" as that approved in 2016 as it represents a 17.5% increase on the 61m panel width originally approved in 2016.

NPWS acknowledges that while some conservatism is gained by maintaining pillar widths at 70m, the design appears far less conservative in terms of the proposed panel width of 70.5m (originally

maximum panel width of 61m) combined with a revised extraction height of 3m (originally max. height of extraction of 2.8m). The model also uses a depth of cover (DOC) of 260m despite the report noting that the DOC ranges between 240m to 280m. Based on the average DOC of 260m the report determined that it would be representative however no variance, or error margin is provided to support this assertion as part of the CAEP.

The NLW modelling provided appears to be assessed outside the known range of previous empirical subsidence data held, so the model appears to have limitations which are not adequately discussed nor does the report draw conclusions around the margin of error. NPWS remains concerned that the modelling is untested, and inconsistent with provisions set under the SSD Approval, increasing void and height of extraction potentially places the significant geological landscape of the SCA at a higher subsidence risk.

**Recommendations**

NPWS recommends revising the extraction plan to:

1.1 provide justification that the mine design divergence is for the purposes of the existing consent "substantially the same" and considers significant geological formations in accordance with the provisions of condition 7 of the Development Consent as issued by the Planning Assessment Commission for the State Significant Development 5581 – Airly Mine Extension Project – 15 December 2016 (SSD Approval), include validation of performance measures prior to proceeding into areas of higher geological sensitivity, this shall be based on preceding subsidence and geological formation data.

1.2 maintain the SSD Approved panel width of 61m and panel height of 2.8m not increasing by 17.5% as proposed.

1.3 apply the proposed barrier pillar width of 70m to reduce risk of adverse damage to the SCA as part of the conservative approach

1.4 update the referencing to the revised Water Management Plan to support the extraction planning, providing a link to the current version located on the Centennial Airly website.

## 2. Subsidence prediction

The original subsidence modelling for Airly mine was undertaken by Golders (2015)[1] and reviewed by MSEC (2015) who confirmed that predicted subsidence ground movements appeared reasonable, and accurate at the time. The reports did acknowledge a remote risk associated with unusual geological formations (predominately faults) present under the cliff lines leading to a chance of abnormal subsidence occurring. Overall, the reports alluded to a low subsidence risk, with no predicted surface cracking over the steeply sloped areas or cliff lines, and no slope movements. Unfortunately, this predicted low risk of subsidence has proven inaccurate in other areas of mining operations with subsidence exceeding initial predictions inconsistent with the EIS and SSD Approval.

The Strata Control Technology (SCT2023)[2] calibrated model used to inform the CAEP applies the subsidence data collected from other NLW operations at Airly to predict subsidence associated with proposed extraction at MW17 and MW18. This model was also used to justify the proposed optimised panel geometry, see SCT 2023-Attachment E of the CAEP, without exceeding the max. subsidence limit of 125mm. This revised model predicted subsidence to an upper design limit of 95mm (+/-20mm) aligning with a stated precautionary approach. The model appears to have been derived from subsidence data held where the widest NLW panels extracted have been 61m wide. The model appears to be contrary to the provisions of Schedule 3 of the SDD Approval in meeting the established performance measures needed before moving into more significant geological areas of the SCA.

[1] *Golders (2015) Subsidence Predictions and Impact Assessment for Airly Mine.* Report No. 127621105-003-R-Rev2.

[2] SCT (2023) *Att E – Letter MW17-18 PILLAR AND PANEL OPTIMISATION ASSESSMENT: INCREASING FROM 56M PANELS AND 50M PILLARS TO 70.5 PANELS AND 70M PILLARS – as Attachment E to the CAEP*

The chosen configuration of 3m extraction height, 70.5m voids, and 70.0m wide barrier pillar within the "intact" pillar zone for a depth of cover (DOC) of 260m, is notably within the "(failure) onset" pillar zone of 280m DOC. The report also identified a DOC range from 240m to 280m mining area, but it appears only an average DOC was applied as mostly representative. The actual conservatism of this average DOC approach remains of concern. If pillar zone failure occurs, there is risk that subsidence will exceed 125mm.

The model according the SCT 2023, was derived from previous data held, with only very limited recognition that the previously detected exceedance of the 125mm subsidence limits where likely caused by fracturing of the strata above the pillars. The presence of known faults in the extraction area appear do not form part of the model, nor are they included in any of the discussions about any uncertainties held around the analysis, model outputs or assumptions made.

**Recommendations**

NPWS recommends revising the extraction plan to:

2.1 provide a justification that extrapolating of the model well outside the range of previous empirical subsidence data held for Airly is considered fit for purpose for any deviation proposed under the extraction plan subject to the SSD Approval under Schedule 3.

2.2 ensure the variability in mining height is considered as part of the non-controlled extraction due to spall, cavities, or operational variation during mining operations is included in the model

2.3 document uncertainty held around the analysis, providing for calculated error margins for the subsidence predictions based on the identify likely variation or potential deviations , indicating the level of any uncertainty held about the model outputs or assumptions.

## 3. Potential interaction with geological formations on the SCA

The Environmental and Heritage Group (BCS 2023) advised previously that fault and seam data for the Airly Mine in this locality appeared to significantly differ between technical reports, the EIS and the spatial layers provided by Centennial Airly. The discrepancies although obvious remain unsupported by any explanation in the CAEP.

Under the CAEP previous subsidence exceedance was perceived or largely assumed to be the result of shear failure above the pillars. The modelling appears not to have incorporated the likely and potential effects of geological structures (faults, lineaments etc) as an increased risk factor, nor included potential extent of subsidence error margins attached to these natural and very present faults in the extraction area. Although they represent an elevated risk the faults are not considered in any real detail under the CAEP. NPWS acknowledges that faults are identified in the Genowlan Mountain with two faults cutting straight through the centre of MW 17 & 18. The presence of faults appear to have a real, and significant effect on both the magnitude of mining-induced subsidence and the shape of the mining profiles over the mined panels. This is likely to decrease the conservative view assumed in the NLW design configuration, potentially leading to increased subsidence risk as a result of the proposed wider panels (70.5m).

**Recommendations**

NPWS recommends revising the extraction plan to:

3.1 provide confirmed fault mapping with an explanation of the known and potential increased subsidence risk as it relates to the MW17 & 18 beyond what is calculated as part of the model, providing for a risk margin.

3.2 provide a discussion on adequate and preferred subsidence monitoring configuration to measure subsidence associated with the faults through and above MW 17 & 18.

## 4. Subsidence monitoring

NPWS recognises that 16 GNSS units are proposed, with 9 (56%) in areas predicted to experience < 20mm subsidence, with only 7 (44%) directly measurements of total subsidence. This is considered

inadequate, especially since MSEC 2023[3] identified that: *Slightly higher measurements would have been recorded if there were more GNSS units located over the central zones between these MWs.* No GNSS units appear to be located in this area as part of the Monitoring Program for MW 17 and 18.

The *Determination Report for the* Airly Mine Extension Project (SSD 5581) recognised and via the SSD Approval committed the proponent to certain design specifications, data acquisition and justification prior to extraction operation in more sensitive landforms (sec.5.1 pg 3-). This required the establishment of a high confidence subsidence monitoring method established and delivered, if the CAEP is questioning the adequacy of previous data collection, NPWS requests improvements be made to the Subsidence Monitoring Program into the future.

**Recommendations**

NPWS recommends revising the Subsidence Monitoring Program, to:

4.1 recognise the fault mapped as crossing directly through and above MW 17 & 18, justifying that the subsidence monitoring network is adequate for identifying areas of vertical subsidence as part of an enhanced early warning system.

4.2 increase in the number of GNSS units measuring subsidence directly above, and between the narrow longwalls for the south-eastern part of Genowlan Mountain and concentrate more GNSS units in areas predicted to experience higher levels of subsidence.

4.3 require an early warning system, supported by clear reporting operations will potentially exceed subsidence thresholds, with a robust framework for identifying and responding to subsidence trends.

4.4 provide raw subsidence data for Mt Genowlan extraction area should be provided to NPWS quarterly (3 monthly) basis.

## 5. Water Monitoring under the water management plan

As the land manager, NPWS must maintain the health viability and resilience of the SCA waterways and aquifers. The CAEP appears to give only rudimentary consideration of matters attached to the Extraction Plan – Water Management Plan.

In particular, the only functional piezometers monitoring Narrabeen Sandstone aquifers near the new extraction area appear to be ARP06 and ARP15SP. The CAEP has provided limited information on the piezometers, their functionality or adequacy of existing monitoring systems in this location.

**Recommendations**

NPWS recommends revising the extraction plan to:

5.1 include as part of the Extraction Plan a review of the adequacy and functionality of the piezometers and the monitoring configuration under the Extraction Plan, as only piezometers ARP06 and ARP15SP in the Narrabeen Sandstone aquifers appear operational and relevant

5.2 revise the water management plan, to include reporting on, and provision of the groundwater piezometer and stream level/flow data collected for the Airly Mine (in an excel spreadsheet file(s) format) to NPWS on a quarterly (3 month basis) to support its land management role.

[3] MSEC (2023) *Centennial Coal: Airly Colliery – MWs17 and MW18 Subsidence Predictions and Impact Assessments for the Natural and Built Features over and near the proposed MWs 17 to 18 in support of the Extraction Plan Application, dated 3 July – as Attachment F to the CAEP.*

## Appendix 1 J: BCS Response to Draft MW17-18 Extraction Plan (dated 31/7/23)

Our ref: DOC23/673678
Your ref: PAE-60185207

Sam Price
Environmental and Community Superintendent
Centennial Coal Company Limited, Mount Airly
Sam.Price@centennialcoal.com.au

Dear Sam

**Mount Airly Panel and Pillar Zone Extraction Plan – MW 17-18**

Thank you for your e-mail dated 14 July 2023 to the Biodiversity, Conservation and Science Directorate (BCS) of the Department of Planning and Environment (DPE) inviting advice on the revised Airly Panel and Pillar Zone Extraction Plan for Miniwalls 17-18 (the extraction plan). As we understand, Centennial Coal Company Ltd (Centennial Coal) has revised the extraction plan to incorporate feedback from various government agencies and have removed a complete extraction panel (hence the name change from MW17-19 to MW17-18).

It is important to note that in our previous response to the extraction plan (dated 27 March 2023), BCS was not provided within the entire extraction plan report to review, instead we only received selected sub-management plans. In this most recent revision and response to agency submissions, BCS have now received the entire extraction plan for review. As such, our comments on this revision of the extraction plan have been prepared according to the new information provided by Centennial Coal.

In response to BCS comments, Centennial Coal have modified the pillar and panel design to reduce the maximum predicted subsidence. We note that this design:

- Proposes wider panels than that in the approved Environmental Impact Statement (EIS) for Mount Airly (dated 2016); and
- Proposes an increased height of extraction.

The revised mining geometry includes two narrow longwall panels, MW17 and MW18, with panel void widths of 70.5m, extraction height of 3.0m and a 70m wide barrier pillar. This proposed new panel width represents a 17.5% increase on the 61m panel width approved in the EIS. While the increase in extraction height from 2.8m to 3m represents a 7% increase. Although some conservatism may have been gained by removal of a longwall and maintaining pillar widths at 70m, we consider the revised proposal is far less conservative in terms of the proposed panel width and height of extraction.

Since all prior subsidence experience at Mount Airly mine has occurred with a maximum panel width of 61m and maximum height of extraction of 2.8m, it is evident that the modelling for the extraction underneath the south-eastern part of Genowlan Mountain is extrapolating outside the range of previous empirical subsidence experience at Airly Mine. As such, there is the potential that the approved subsidence threshold of 125mm could potentially be exceeded due to the proposed increase in panel width and height of extraction. This puts cliffs, pagodas and rock features inside Mugii Murrumban State Conservation Area at risk.

Further, we note that a large mapped geological fault is bisecting MW 17 -18 (See Attachment B - Figure 1). The Subsidence Prediction and Impact Assessment (MSEC 2023) identifies similar faults to have contributed to the increased levels of subsidence over Mount Airly.

Lastly, the extraction plan main report proposes 16 Global navigation satellite system (GNSS) units for monitoring subsidence above MW 17-18. Of these, 9 are located away from proposed longwalls in areas predicted to experience 20mm or less of subsidence, leaving only 7 located in areas which will measure the total subsidence above proposed mining areas.

BCS's recommendations are provided in **Attachment A** and detailed comments are provided in **Attachment B**.

If you have any questions about this advice, please do not hesitate to contact Ben Ellis, A/Principal Project Manager, via ben.ellis@environment.nsw.gov.au or (02) 8275 1838.

Yours sincerely

**Sarah Carr**
**Director North West**
**Biodiversity, Conservation and Science Directorate**

31 July 2023

Attachment A – BCS's Recommendations

Attachment B - Extract of Airly extraction plan main report

**Attachment A**

# BCS's recommendations

# Mount Airly Panel and Pillar Zone Extraction Plan – MW 17-18

## Recommendations

1.1. Centennial Coal maintain the panel width approved in the EIS and not increase it by 17.5% as proposed.

1.2. Centennial Coal maintain the extraction height of 2.8m and not increase it to 3m as proposed.

1.3. A detailed subsidence monitoring program be conducted around the fault mapped as bisecting MW17-18.

1.4. Install at least additional 9 GNSS units directly above and in-between MW 17-18, with specific focus in the areas with 280m depth of cover.

1.5. No secondary extraction to take place until there is an adequate number of GNSS units installed to establish an appropriate baseline.

**Attachment B**

## Extract of Airly Extraction Plan Main Report

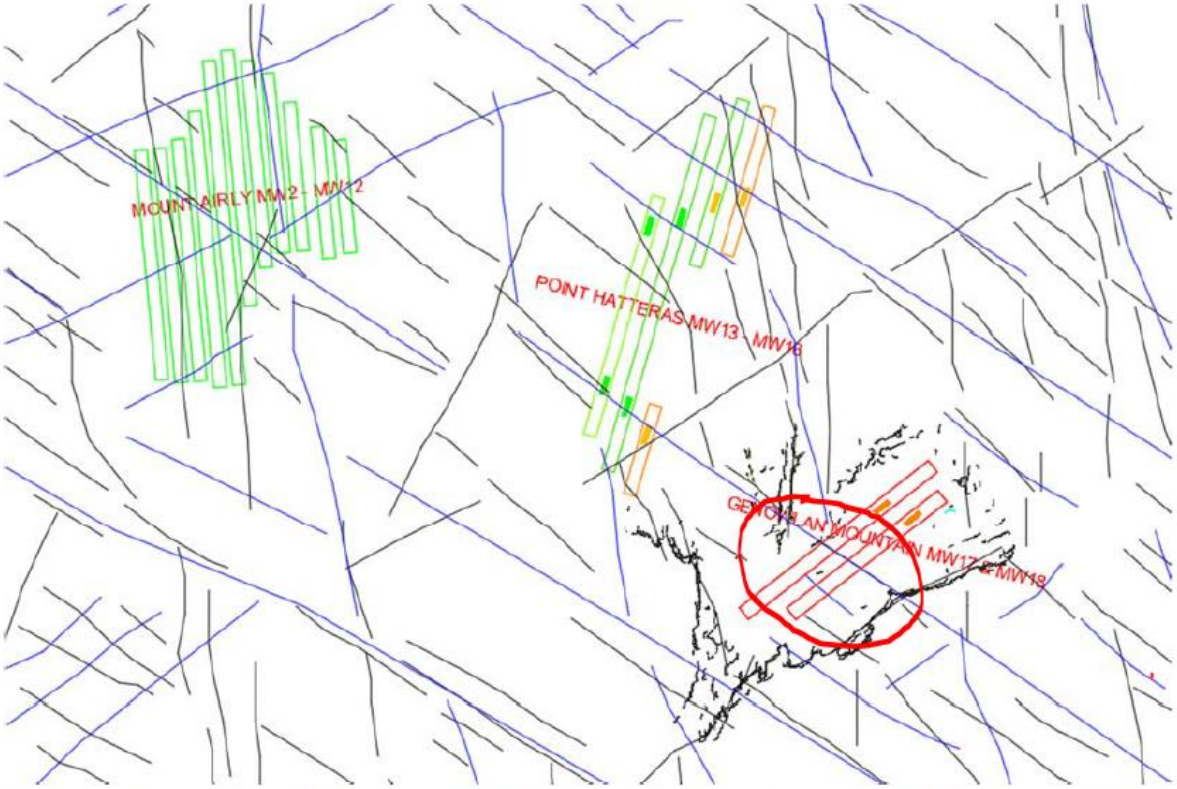


Fig. 2.7 Identified geological structures at Airly before panel extraction, i.e. in EIS with current mined panel boundaries (Source: CA, 2022)

**Figure 1 Extract of Airly extraction plan main report showing large fault bisecting proposed MW 17-18 (Circled in Red)**

## Appendix 1 K: DPE - Water Response to Draft MW17-18 Extraction Plan (dated 10/8/23)

Department of Planning and Environment

Our ref: OUT23/12634

Ms Veronica Howat
Centennial Coal
Email: dpiepostapproval@centennialcoal.com.au

10 August 2023

Subject: Airly Coal Mine Expansion (SSD-7142) – MW17-18 Extraction Plan

Dear Ms Howat

I refer to your submission dated 14 July 2023 providing the Department of Planning and Environment (DPE) Water an opportunity to comment on the Airly Coal Mine Expansion MW17-18 Extraction Plan.

The MW17-18 Extraction Plan includes a link to a Water Management Plan dated September 2018. This is not a current document and does not address DPE Water's comments on the MW17-19 Extraction Plan.

DPE Water recommends that an updated Water Management Plan be provided in support of the MW17-18 Extraction Plan to enable our review of the proposed monitoring, management and mitigation for the Extraction Plan impacts. The updated plan should:

- address the comments made by DPE Water in OUT23/4966 dated 31 March 2023 on the MW17-19 Extraction Plan and Water Management Plan.
- outlin the studies undertaken to assess the impacts on natural springs and seeps predicted to occur due the extraction proposed for MW17 and MW18.

Should you have any further questions in relation to this submission please do not hesitate to contact DPE Water Assessments at water.assessments@dpie.nsw.gov.au,

Yours sincerely,

Rose-Anne Hawkeswood
A/Manager, Assessments, Knowledge Division
**Department of Planning and Environment: Water**

## Appendix 1 L: DPE - Water Response to revised MW17-18 Extraction Plan (dated 28/9/23)

# Department of Planning and Environment

Our ref: OUT23/15855

Gabrielle Allan

Email: gabrielle.allan@dpie.nsw.gov.au

28/09/2023

Subject: **Airly Coal Water Management Plan (PPMZ MW17-18 Extraction Plan)**

Dear Gabrielle,

I refer to your request for advice sent on 29 August 2023 to the Department of Planning and Environment (DPE) Water about the above matter.

The Department of Planning and Environment- Water has reviewed the latest Water Management Plan and has provided recommendations to ensure appropriate water management in **Attachment A**.

Should you have any further queries in relation to this submission please do not hesitate to contact DPE Water Assessments at water.assessments@dpie.nsw.gov.au

Yours sincerely,

Daniel Harris

A/Manager, Assessments, Knowledge Division
**Department of Planning and Environment: Water**

## Attachment A

# Detailed advice to proponent regarding the Airly Coal Water Management Plan (PPMZ MW17-18 Extraction Plan)

## 1.0 Water take and licensing

### 1.1 Recommendation – Prior to approval

The proponent must calculate the maximum groundwater take in a manner consistent with the NSW Aquifer Interference Policy (AIP).

### Explanation

The water management plan states that groundwater inflows were estimated:

> *'from transfers between the surface and underground workings, which are metered (i.e., groundwater inflows = transfer from underground workings to surface – transfer from surface to underground workings).'*

This is not consistent with the definition of groundwater inflows in the AIP. The AIP defines the removal of water from a water source as the water leaving the aquifer and entering the void. DPE Water acknowledges that further information has been provided including estimated volumes and currently held entitlement. However, it is unclear if these are estimated based on the definition under the AIP or if they have been calculated by subtracting transfers in from the volume being pumped from the void.

### 1.2 Recommendation – Prior to approval

The proponent must ensure sufficient entitlement is held in a water access license to account for water take in each water source prior to the take occurring.

### Explanation

The development consent (Schedule 4) states the applicant must ensure that there is sufficient water for all stages of the development. If necessary, the proponent must adjust the scale of operations on site to match its available water supply.

## 2.0 Groundwater

### 2.1 Recommendation – Post approval

The proponent should submit a recalibrated and updated groundwater model. This model should include the latest data and be supported by an external independent review when the water management plan (WMP) is next updated in 2024.

### Explanation

Recommendation 2.1 in DPE Water's previous advice on the WMP (March 2023) required the proponent to provide the 2021 groundwater model supported by an external independent review to assess the suitability of the groundwater trigger levels and monitoring regime. Schedule 4, condition 13(c)(iii) of the development consent requires a program to review and validate the groundwater model for the development, including independent expert review.

### 2.2 Recommendation – Post approval

The proponent should include all quality assurance procedures and methodology documents listed in Section 4.5 of the WMP as an appendix in the next version of the WMP.

### Explanation

Updating and staging of strategies, plans or programs is a requirement under Schedule 6.4 of the development consent. This ensures plans and programs are updated on a regular basis, and that they incorporate any recommended measures to improve the environmental performance of the development.

Recommendation 3.1 in DPE Water's previous advice on the WMP (March 2023) required the proponent to include a quality assurance methodology and plan for the next version of the WMP.

Section 4.5 - Quality Assurance (QA) in the latest version of the WMP includes a series of QA procedures implemented to maintain data quality. However, none of the QA documents or methodologies were provided in the WMP.

### 2.3 Recommendation – Post approval

The proponent must update the WMP to include:

- the updated site water balance
- the most up-to-date monitoring data for groundwater inflows and in situ coal moisture.

### Explanation

Revising strategies, plans and programs is a requirement under Schedule 6.3 of the development consent. The groundwater model is due to be updated in 2024 which will initiate an update to the site water balance and the WMP.

## End Attachment A

## Appendix 1 M: NPWS Response to revised MW17-18 Extraction Plan (dated 28/9/23)

Our reference: DOC23/823898
Your ref: SSD–5581

Gabrielle Allan
Energy and Resource Assessments
Department of Planning and Environment

By email: *gabrielle.allan@dpie.nsw.gov.au*

Dear Gabrielle

**Re: State Significant Development 5581 (SSD) – Extraction Plan Airly Mine**

Thank you for the referral of the revised *Centennial Extraction Plan Main Report MW17-18 Panel & Pillar Mining Zone Extraction Plan, dated August 2023* (CEP) for the narrow longwalls (MW17 – MW18) subject to the State Significant Development 5581 (SSD-5581) Airly Mine Expansion Project via the Department of Planning and Environment Major Projects Portal.

The National Parks and Wildlife Service (NPWS) appreciates the opportunity to provide advice on the CEP prepared under Schedule 3, Condition 7 of the SSD Approval, as Centennial Airly's mining operations directly affect land reserved as Mugii Murum-ban State Conservation Area (SCA) under the *National Parks and Wildlife Act 1974* (NPW Act).

On review of the CEP, supporting documents and the outcomes of our agency's consultation with Centennial as outlined in Appendix D of the CEP, NPWS raises the following matters attached to Centennial's proposed changes to its extraction operations in the Genowlan Mountain Area of the SCA. These matters are summarised below and described in detail as part of Attachment 1 to this letter.

NPWS recommends;

- maintaining the panel width of 61m and extraction height of 2.8m as originally approved under the 2016 SSD Approval consistent with the EIS and not increase it by 17.5% as proposed whilst applying the 70m pillar width as part of conservative approach to mining in this locality.
- assessing the implications attached to the known and adequately described faults/lineaments crossing directly through and above the narrow longwalls (MW17&18).
- ensuring the monitoring system is adequate and systems are well placed to support early risk detection, this includes increasing or augmenting the placement of the GNSS units measuring subsidence directly above and in between the narrow longwalls, adequately including sensitive or key areas.
- conditioning the provision of all raw data to NPWS for subsidence, groundwater, and stream level/flow monitoring for the Airly Mine as it has a direct bearing on the management of the SCA, on a quarterly (3-month basis) as an excel file.

- convening a technical meeting with NPWS, BCD and the Airly Mine Independent Expert Panel to address current and outstanding subsidence issues and risks attached to the CEP and the narrow long walls MW17 – MW18.

NPWS in preparing this response, has consulted with the Northwest Biodiversity, Conservation and Science Division of Department of Planning and Environment and an independent technical expert.

If you have any questions about this advice, please contact Lisa Menke, NPWS Manager, Mudgee Area via phone on 6370 9006 or email at lisa.menke@environment.nsw.gov.au.

Yours sincerely,

**SHAUN ELWOOD**

a/Director, Blue Mountains Branch
**National Parks and wildlife Service**

28 September 2023

**Enclosure**: Attachment 1 – NPWS detailed response to revised Centennial Airly MW17-18 Extraction Plan

# NSW National Parks and Wildlife Service detailed response

On review of the revised *Centennial Extraction Plan Main Report MW17-18 Panel & Pillar Mining Zone Extraction Plan, dated August 2023* (CEP) the National Parks and Wildlife Service (NPWS) provides the following reasoning and recommendations.

As the CEP applies to land reserved as Mugii Murum-ban State Conservation Area (SCA) under the NSW *National Parks and Wildlife Act 1974* (NPW Act), we continue to support the Planning Assessment Commission Determination Report[1] (Commission Report) and the focused recognition of the SCA values as the '*spectacular geodiversity'* present in the Genowlan Mountain Area. NPWS remains committed to the SCA protection and supports the report's specified requirements that the potential subsidence effects of mining must be very carefully examined and monitored to ensure impacts do not lead to the deterioration of the SCA's natural values. NPWS acknowledged that the approval as issued by the *Planning Assessment Commission for the State Significant Development 5581 Airly Mine Extension Project, dated 15 December 2016* (SSD 5581 Approval) reflected this and the onus remains with Centennial to strictly demonstrate that any narrow longwall (NLW) mining accords with the set performance measures.

Centennial NLW operations have previously exceeded subsidence (at MW02, MW03 and MW04) levels under the SSD 5581 Approval. The CEP and Appendix F MSEC 2023[2] confirmed subsidence of 680mm had occurred, but on final assessment this had further increased with exceedance of 727mm, almost 6 times the level approved in the EIS. It was concluded that this was due to fracturing of strata above the chain pillars, not related to actual pillar instability or failure. Based on this, mine geometry was revised using a calibrated model which recommended formation of wider chain pillars between panels to reduce the risk of subsidence. The exceedance however resulted in adverse and irreversible impacts including fractured cliffs and rock features as well as cracked pagodas. NPWS preference is to limit the risk of this occurring again and supports the most conservative approach to mining operations which potentially affect the SCA in the line with the Commission Report and SSD 5581 Approval.

Previous iterations of the CEP proposed a maximum vertical subsidence over three NLW 17 to 19 as 118 mm with a tolerance of +/- 20mm. In response NSW Environment and Heritage Group (BCS/NPWS 2023-DOC23/244136) highlighted that this would result in a maximum incremental vertical subsidence limit of 138mm, which was inconsistent with the EIS. It was recommended that an alternative design be considered to achieve the precautionary approach within the approved maximum vertical subsidence limit of 125mm.

## 1. Extraction design for the narrow long walls MW17-18

On review of the revised CEP, NPWS queries the application of the revised mining geometry to achieve the modified panel void widths of 70.5m and 3.0m extraction height separated by a 70m wide barrier pillar as it will result in a 17.5% increase above what is currently approved.

NPWS acknowledges that while some conservatism is gained by creating pillar widths of 70m (and NPWS remains supportive of the 70m barrier pillar as this is likely to reduce risk of strata fracturing above the chain pillars), however the change in panel width to 70.5m (approved panel width of 61m) combined with a revised extraction height of 3m (originally maximum height of extraction of 2.8m) remains of concern. The model in order to dictate extraction design uses an average depth of cover (DOC) of 260m despite the report noting that the DOC in this locality actually ranges between 240m to 291m. If the model is based on the average DOC, no variance, or error margin is provided to support this assertion of a conservative approach.

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[1] *Planning Assessment Commission Determination Report, Airly Mine Extension Project (SSD 5581) dated 15 December 2016*

[2] *MSEC (2023) Centennial Coal: Airly Colliery – MWs17 and MW18 Subsidence Predictions and Impact Assessments for the Natural and Built Features over and near the proposed MWs 17 to 18 in support of the Extraction Plan Application, dated 3 July – as Attachment F to the CEP*

The NLW modelling provided appears to be outside the known range of previous empirical subsidence data held by Centennial, which is acknowledged in the consultation submissions as Appendix D of the CEP. NPWS is aware that the model and drawn conclusions are likely to have limitations, and the scope is not clearly explained against the risk of the new design. NPWS remains concerned that increasing void width and height of extraction is likely to place the significant geological landscape of the SCA at a higher subsidence risk.

**Recommendations**

NPWS recommends revising the extraction plan to:

1.1 maintain the panel width of 61m and extraction height of 2.8m as originally stated under the SSD Approval consistent with the EIS and not increase extraction by 17.5% as proposed.

1.2 retain the pillar widths of 70 m, to reduce the risk of subsidence.

1.3 confirm how the model has adequately considered risk around strata fracturing and failure above the pillars as it relates to the proposed increased void widths (length and height) of the narrow long walls.

1.4 condition the requirement to avoid any surface expression of subsidence, surface cracking of all cliff lines, pagodas (irrespective of their classification), drainage of watercourses or damage to other natural features and ecosystems on the SCA as part of the mines' adherence to the stated conservative approach.

## 2. Subsidence prediction

The original subsidence modelling for Airly mine was undertaken by Golders (2015)[3] and reviewed by MSEC (2015) and confirmed that predicted subsidence ground movements appeared reasonable, and accurate at the time. The reports did acknowledge a remote risk associated with unusual geological formations (predominately faults) present under the cliff lines leading to a chance of abnormal subsidence occurring. Overall, the above reports alluded to a low subsidence risk, with no predicted surface cracking over the steeply sloped areas or cliff lines, and no slope movements. Unfortunately, this prediction was proven inaccurate with subsidence exceeding the SSD 5581 Approval. The CEP, recognised with limited presented information on the subsidence exceedance, that it was attributed to likely fracturing of the strata above the pillars.

In summary the EIS stated that vertical subsidence be limited to less than 100 mm +/- 25, with the maximum not exceeding 125 mm. This initial prediction of <100mm was based on the 2.8 m seam extraction from 61 m wide narrow long wall panels and 29.5 m wide chain pillars, with tilts less than 2.5 mm/m and strains less than 2 mm/m.

NPWS acknowledges the predicted subsidence effects as revised for the CEP by Strata Control Technology (SCT2023)[4] were initially calibrated against the measured subsidence data for MWs 02 to 07 but now incorporates subsidence results for the narrow longwalls MWs 11 to 12 and MWs 13 to 15A. This predictive model originally applied proposed optimised panel geometry with a subsidence upper design limit of 95mm (+/-20mm). The updated design and modelling now according to Centennial, which is specific to the available resource, requires a variation to the panel void widths increasing from 61 m to 70.5 m with an increased extraction height of 3m from 2.8m, calculated with the 70m pillar will now result in a *predicted vertical subsidence as 88 mm (+/-20mm)*. NPWS notes that this is based on an average DOC of 260m, however the DOC remains substantially greater than 260m and even >280m as confirmed in Appendix F.

**Recommendations**

NPWS recommends revising the extraction plan to:

[3] Golders (2015) *Subsidence Predictions and Impact Assessment for Airly Mine* - Report No. 127621105-003-R-Rev2

[4] *SCT (2023) Att E – Letter MW17-18 PILLAR AND PANEL OPTIMISATION ASSESSMENT: INCREASING FROM 56M PANELS AND 50M PILLARS TO 70.5 PANELS AND 70M PILLARS – as Attachment E to the CAEP*

2.1 confirm the depth of cover (DOC) values applied to the model used, risk and calibre of potential impact attributed to the actual narrow long walls range from 240m to 291m with 25% of the wall will have a DOC above 260m.

2.2 validate the modelling used specifically around the depth of cover values applied, and application of average values and the inherent risks, ensure complete application of subsidence and geological formation data to justify the conservative approach.

2.3 provide a justification that extrapolation of the model well outside the range of previous empirical subsidence data held for Airly Mine is fit for purpose and accords with the SSD 5581 Approval.

2.4 ensure the variability attached to present geological anomalies are adequately considered as part of the predictive modelled scenarios, and risk is discussed in the justification attached to the applied error margins, discuss uncertainty held about the predictive model outputs and assumptions.

2.5 convene a technical meeting in addition to the consultation undertaken in Appendix D with NPWS, BCD and the Airly Mine Independent Expert Panel to go through and discuss the outstanding subsidence issues and risk concerns raised around subsidence in this locality.

## 3. Interaction with geological formations on the SCA

The Environment and Heritage Group advised previously that fault and seam data for the Airly Mine in this locality appeared to significantly differ between technical reports, the EIS and the spatial layers provided by Centennial. The discrepancies although obvious remain unsupported by any explanation in the CEP. Although Centennial states that CEP design protects major external cliffs that surround the south-eastern area of Genowlan Mountain by applying a 26.5-degree angle of draw of cliffs within the Cliff Line Zone of First Workings thus predicting low levels of subsidence risk for these geological features, which appears to be major cliffs and escarpments in this locality.

NPWS supports protection of major cliffs, however all geological features on the SCA including internal geological forms are afforded a degree of protection subject to the SCA's reservation status under the NPW Act. So, all geological forms that lie in close proximity to, and over the narrow long walls (MWs 17 & 18) are important and NPWS supports the reduction of risk to the greatest extent practicable. The retention of pillar widths to 70 m is supported, to reduce risk of strata fracturing and subsidence limiting the potential for surface cracking on the SCA.

Centennial highlighted that the predictive modelling incorporated the likelihood of these geological anomalies (e.g., faults, lineaments, dykes, voids, or other geological structures, cross bedded strata, thin and brittle near surface strata layers and pre-existing natural joints etc) in deriving the outcomes presented and design of the CEP. Centennial also noted that risk factors were included in the application of the 20mm error margin. NPWS remains concerned that the extent of subsidence error attached to these natural and very present anomalies especially the faults/ lineaments in the extraction area have been underestimated.

The two main faults represent an elevated risk and are not considered in any great detail in the CEP, as their alignment cuts straight through the centre of MW 17 & 18. NPWS is concerned that the true extent of potential risk, as well as the magnitude of impact based on the application of the proposed wider panels (70.5m) is not adequately described. Appendix F acknowledged that faults appear to have contributed to the increased levels of subsidence over Mount Airly, and that far more faults were found after mining operations commence in a locality. This is not clearly articulated in the CEP, nor are they included in any of the discussions about any uncertainties held around the analysis, model outputs or the assumptions made.

### Recommendations

NPWS recommends revising the extraction plan to:

3.1 provide adequate and confirmed fault mapping, discuss fault classification, and provide confirmation of their extent. Confirm if the faults extend from resource layer (coal seam) to the surface in this locality. Specify the known and potential increased subsidence risk or

implications as it relates to the MW17 & 18, identify, or indicate the level of any uncertainty held about the model outputs or assumptions relative to the faults

3.2 confirm and state the adequacy in monitoring strategy proposed for subsidence induced damage for the area directly over, and between the narrow long walls considering the known, or suspected faults as applicable.

## 4. Subsidence and water monitoring

NPWS recognises that 16 Global Navigation Satellite System (GNSS) Monitoring Stations are proposed, with 9 (56%) in areas predicted to experience < 20mm subsidence, with only 7 (44%) directly measuring actual subsidence areas which will influence mine operations. NPWS advises that it remains concerned especially since MSEC 2023 recognised that slightly higher measurements associated with previous subsidence monitoring and subsidence detection would have been recorded if more GNSS units were located over the central zones between the NLW. It would appear that GNSS units forming part of the Subsidence Monitoring Program set for MW 17 and 18 are not entirely in key locations.

The Determination Report and SSD Approval commit Centennial to certain design specifications, data acquisition and justification prior to extraction operation in more sensitive landforms (sec.5.1 page 3). This requires Centennial to establish, with a high degree of confidence, that previous subsidence monitoring can adequately predict risk, if the CEP is questioning this adequacy to date, NPWS requests improvements be made to the Subsidence Monitoring Program into the future.

NPWS as the land manager, must ensure the health, viability, and resilience of the SCA including protection of the natural and cultural values attributed to the land, including waterways. NPWS highlights that The Grotto is located in proximity to the Extraction Plan Area, as an important ephemeral, standing water source for Genowlan Creek. This area has not been adequately characterised as part of the CEP and monitoring of this sensitive site is suggested as risks attached to subsidence and loss of alluvial cover exist.

### Recommendations

NPWS recommends revising the Monitoring Program, to:

4.1 assign predicted subsidence based on the <100mm +/- 25mm as covered by the EIS as the performance criteria, with reference to 125 mm as the maximum vertical subsidence being the upper limit not the benchmark, as part of the standard in the CEP.

4.2 provide reasoning for the subsidence monitoring configuration, inclusive of targeting large fault monitoring through and above MW 17 & 18, to justify that the subsidence monitoring is adequate for identifying subsidence as part of an enhanced early warning system.

4.3 increase the number of GNSS units (as per Table 1/ Figures 1 and 2 below) measuring subsidence directly above, and between the narrow longwalls for the south-eastern part of Genowlan Mountain with an even concentration of GNSS units in areas predicted to experience likely, or higher risks to balance the reporting.

4.4 confirm the targeted visual assessment is adequate to detect surface subsidence expression on the SCA, remaining adequate for all geological forms at risk on the SCA and the monitoring at six-month intervals is sufficient for the early detection. Confirm if shortened monitoring intervals will be applied if increased subsidence activity is detected.

4.5 ensure the early warning system, includes direct notification to NPWS, if the subsidence risk increases substantially or thresholds are approached where surface expression is likely.

4.6 require a clear statement that “no impact” is permitted to The Grotto, its formation, function and water resource inclusive of standing pools, providing for adequate monitoring of this to support the justification that no impact has occurred as a performance measure.

4.7 provide NPWS with access to raw subsidence, groundwater and stream level/flow data collected for the Airly Mine (in an excel spreadsheet file(s) format) on a quarterly (3 monthly) to support its land management functions.

**Table 1: Recommended additional GNSS Units**

| Identifier | Approximate location | Reasoning |
|---|---|---|
| **GNSS_A** | -33.1184°S 150.0564°E | This location is directly above MW17 with a depth of cover of approximately 280m. The location is close to the track to Mt Genowlan and so should be readily accessible - See Figures 1 & 2. |
| **GNSS_B** | -33.1192°S 150.0564°E | This location is between MW17 & MW18 with a depth of cover of approximately 290m. The location is close to the track and close to Mt Genowlan Trig Station and so should be readily accessible - See Figures 1 & 2. |
| **GNSS_C** | 33.1188°S 150.0581°E | This location is directly above MW18 with a depth of cover of approximately 270m. The location is close to the end of the Mt Genowlan track (as shown in Figure 1) and so should be accessible. Appropriate Rock outcrops are readily visible using Google Earth - See Figures 1 & 2. |

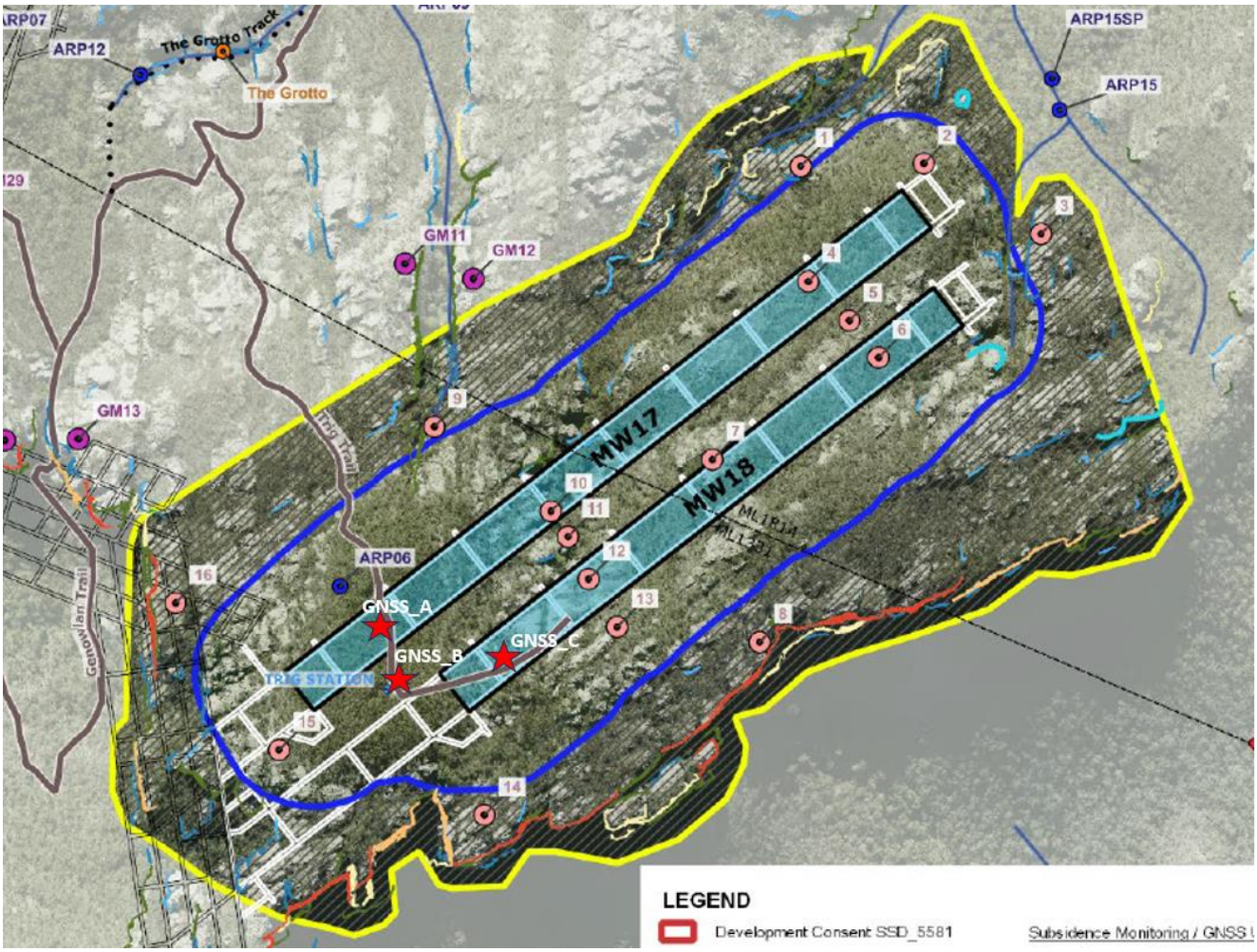


**Figure 1. Suggested additional GNSS monitoring locations (stars) so that subsidence is monitored over the higher depths of cover.**

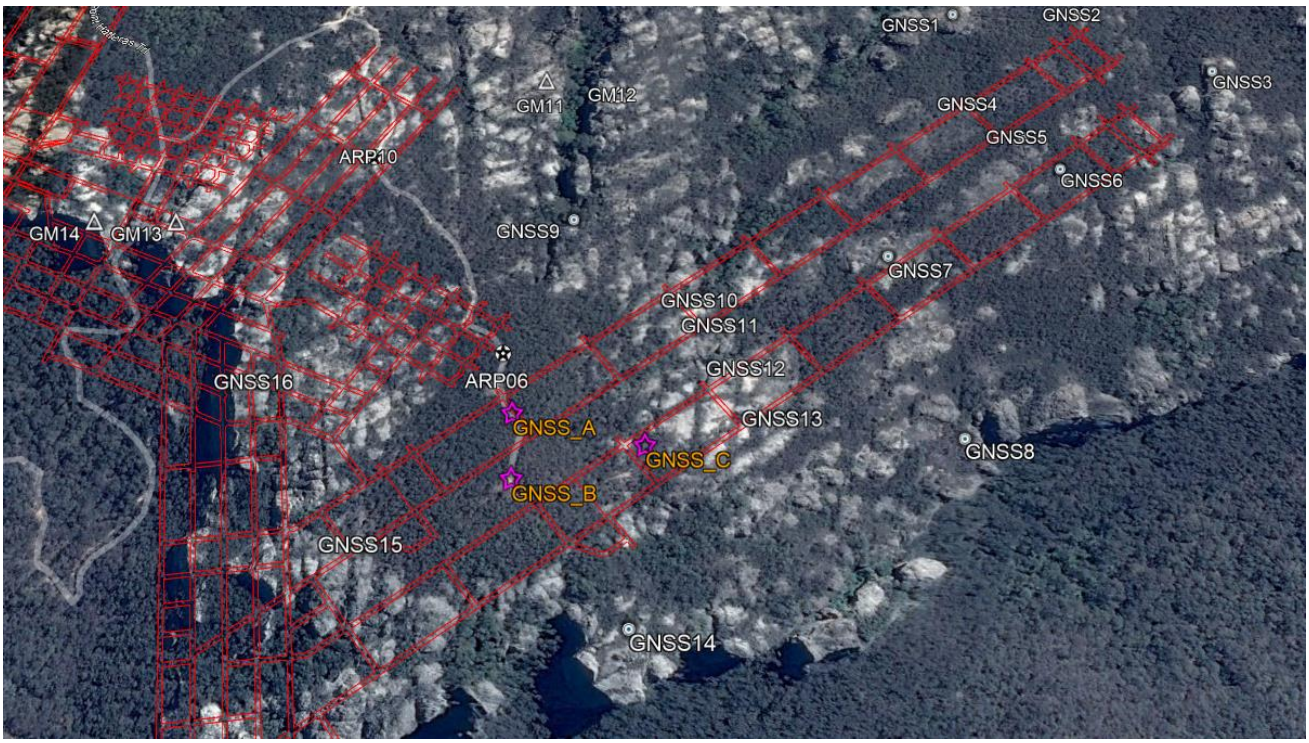


**Figure 2. Google image showing narrow longwalls and suggested additional GNSS monitoring locations (stars) so that subsidence is monitored over the higher depths of cover.**

## Appendix 1 N: BCS Response to revised MW17-18 Extraction Plan (dated 5/10/23)

Our ref: DOC23/875989
Your ref: SSD-5581

Gabrielle Allan
Team Leader
DPE Planning

gabrielle.allan@dpie.nsw.gov.au.

Dear Gabrielle

**Airly Coal 2 – Miniwall 17-18 extraction plan**

Thank you for your request dated 29 August 2023 to the Biodiversity, Conservation and Science Directorate (BCS) of the Department of Planning and Environment (the Department) inviting comments on the extraction plan for Airly miniwalls 17-18 (the extraction plan).

BCS has consulted with the National Parks and Wildlife Service (NPWS) and fully supports all 18 recommendations presented in the NPWS response dated 28 September 2023 (Attachment A). We are supportive of the proponent's proposal to increase pillar width to 70m as a more conservative approach to mining within Mt Airly, given the recent exceedance of conditioned subsidence thresholds.

BCS considers that the extraction plan should:

- Maintain the panel width of 61m and extraction height of 2.8m, in accordance with the project's EIS and conditioned under development approval SSD_5581 in 2016. We recommend that the panel dimensions should not be increased by 17.5%.
- Assess the implications of interactions between the miniwalls and the faults/lineaments crossing directly through and above the miniwalls.
- Ensure the monitoring system is adequate and systems are well placed to support early risk detection.

In addition, BCS recommends that the Department:

- Condition the provision of all raw data to NPWS for subsidence, groundwater, and stream level/flow monitoring for the Airly Mine as it has a direct bearing on the management of the SCA, on a quarterly (3-month basis) as an excel file.
- Convene a technical meeting with NPWS, BCS, and the Airly Mine Independent Expert Panel to address current and outstanding subsidence issues and risks attached to the CEP and the narrow long walls MW17 – MW18.

If you have any questions about this advice, please do not hesitate to contact Liz Mazzer, Senior Conservation Planning Officer, via liz.mazzer@environment.nsw.gov.au or (02) 6883 5325.

Yours sincerely

**Debbie Love**
**A/Director, North West**
**Biodiversity, Conservation and Science Directorate**

5 October 2023

Attachment A: NPWS response to State Significant Development 5581 (SSD) – Extraction Plan Airly Mine - 28 September 2023 (DOC23/823898)

## Appendix 1 O: Presentations provided during technical meeting on 19 October 2023

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# Airly Mine MW17-18 Panel & Pillar Mining Zone Extraction Plan

Post-submission consultation with IEP, DPE, NPWS and BCS

19 October 2023

OUR WAY IN ENERGY

# Presentation Overview

- **In July 2023, Centennial Airly supplied a draft MW17-18 Extraction Plan to relevant agencies and stakeholders for review. The Airly Mine Independent Expert Panel (IEP) considers:**
  - The proposed geometry is likely to achieve Centennial Airly's commitment to maximum subsidence of less than 125mm
  - Subsidence monitoring is suitable to confirm the low levels of subsidence expected
  - Surface impacts from this mining are expected to be imperceptible
  - All cliff formations within the Cliff Line Zone are protected by an angle of draw of greater than 26.5° and by the low levels of subsidence over the mining area
- **In August 2023, Centennial Airly supplied a revised MW17-18 Extraction Plan, updated to address comments following external consultation, including comments received from NPWS and BCS on 31 July 2023**
- **Further advice and recommendations on the revised MW17-18 Extraction Plan were provided by NPWS (28 September 2023) and BCS (5 October 2023)**
- **The objective is to convene a technical meeting and provide additional detail following submission of the MW17-18 Extraction Plan to address any outstanding subsidence issues and risk concerns**
  *(NPWS Recommendation 2.5 & BCS Recommendation 5)*

# Summary of matters raised by NPWS / BCS

# #1: Extraction design for the narrow long walls MW17-18

| Recommendation/s | Centennial Response |
|---|---|
| **NPWS Recommendation 1.1 & BCS Recommendation 1 -** maintain the panel width of 61m and extraction height of 2.8m as originally stated under the SSD Approval consistent with the EIS and not increase extraction by 17.5% as proposed<br>**NPWS Recommendation 1.2 -** retain the pillar widths of 70 m, to reduce the risk of subsidence | The understanding in relation to the mine design has developed significantly since commencement of mining in the Panel and Pillar zone, and is informed by a calibrated model for predictive purposes which has been updated with the best available information – ***slides 10-16***<br>The layout has been designed to limit the maximum predicted subsidence to a chosen upper design limit of 95mm (+/-20mm) aligning with a precautionary approach<br>The project approval (SSD_5581) does not contain restrictions on the mine design<br>The proposed concept for mining presented in the Airly Mine EIS was to limit void widths and leave sufficiently large remaining pillars to restrict mine induced subsidence to not exceed 125mm and assessed miniwall void widths ranging from 51m to 71m.<br>Schedule 3, Condition 7 – Extraction Plan (e) and (g) talk about the process for allowable divergence from the IPRP report "design parameters". Noting that, the "design parameters" also include Proposed pillar widths which have increased by more than 200% from the Airly Mine EIS (i.e. from 29.5m to 70m) – ***slide 13*** |
| **NPWS Recommendation 1.3 -** confirm how the model has adequately considered risk around strata fracturing and failure above the pillars as it relates to the proposed increased void widths (length and height) of the narrow long walls | Back analysis of previous Airly numerical models and the use of empirical abutment load methodology was applied to refine the pillar size requirements for both a 70.5m miniwall void width and various extraction heights (2.8m and 3.0m), larger miniwall void width 80m and 3.2m extraction height were also modelled for subsidence sensitivity – ***slides 12-14*** |
| **NPWS Recommendation 1.4 -** condition the requirement to avoid any surface expression of subsidence, surface cracking of all cliff lines, pagodas (irrespective of their classification), drainage of watercourses or damage to other natural features and ecosystems on the SCA as part of the mines' adherence to the stated conservative approach[object File] | The performance measures for subsidence for the Airly Mine are outlined in Condition 2 in Schedule 3 of Development Consent SSD_5581 and presented in Table 5.1 of the Extraction Plan Main Report for MW17-18 – ***slide 19***<br>The Extraction Plan assessed that the potential impacts from miniwall extraction are similar to those based on the EIS Layout and are unlikely to exceed the performance measures of SSD_5581<br>The Extraction Plan includes appropriate Trigger Action Response Plans in the unlikely event of an exceedance of a subsidence impact performance measure |

# #2: Subsidence prediction

| Recommendation/s | Centennial Response |
|---|---|
| **NPWS Recommendation 2.1 -** confirm the depth of cover (DOC) values applied to the model used, risk and calibre of potential impact attributed to the actual narrow long walls range from 240m to 291m with 25% of the wall will have a DOC above 260m<br>**NPWS Recommendation 2.2 -** validate the modelling used specifically around the depth of cover values applied, and application of average values and the inherent risks, ensure complete application of subsidence and geological formation data to justify the conservative approach | Areas of 280m depth of cover in the Extraction Plan Area are limited, generally single panel (MW17) with only a very small bit (less than 2%) of MW18 (and subsidence will be less due to end effects)<br>SCT have assessed the average pillar load for varying pillar widths for 280m and 260m DOC, and the caving and subsidence model had a depth of 260m which was determined to be representative for most of the barrier pillar<br>Predicted subsidence contour lines have been located by MSEC based on the SCT modelling profiles, depending on the changing depth of cover where miniwall panels are to be extracted – ***slide 15***<br>The layout has been designed to limit the maximum predicted subsidence to a chosen upper design limit of 95mm (+/-20mm) aligning with a precautionary approach – ***slide 16*** |
| **NPWS Recommendation 2.3 -** provide a justification that extrapolation of the model well outside the range of previous empirical subsidence data held for Airly Mine is fit for purpose and accords with the SSD 5581 Approval | The empirical abutment load methodology including empirical load calculations is an accepted industry standard that incorporates panel geometries outside of Airly historical workings |
| **NPWS Recommendation 2.4 -** ensure the variability attached to present geological anomalies are adequately considered as part of the predictive modelled scenarios, and risk is discussed in the justification attached to the applied error margins, discuss uncertainty held about the predictive model outputs and assumptions | The models run by SCT are completed with a range in joint and bedding properties of the overburden to improve the model output of the magnitude and shape of the observed subsidence profile. Joint and bedding cohesion, friction angle, frequency and length, are varied in a parametric assessment. Variations in stress and depth of weathering were also modelled to assess their impact on subsidence<br>*The modelled scenarios are further detailed in SCT report AIRLY5265 (for MW13-16)* |
| **NPWS Recommendation 2.5 & BCS Recommendation 5 -** convene a technical meeting in addition to the consultation undertaken in Appendix D with NPWS, BCD and the Airly Mine Independent Expert Panel to go through and discuss the outstanding subsidence issues and risk concerns raised around subsidence in this locality | *Meeting held 19 October 2023 –* ***this meeting*** |

# #3: Interaction with geological formations on the SCA

| Recommendation/s | Centennial Response |
|---|---|
| **NPWS Recommendation 3.1 -** provide adequate and confirmed fault mapping, discuss fault classification, and provide confirmation of their extent. Confirm if the faults extend from resource layer (coal seam) to the surface in this locality. Specify the known and potential increased subsidence risk or implications as it relates to the MW17 & 18, identify, or indicate the level of any uncertainty held about the model outputs or assumptions relative to the faults<br>**BCS Recommendation 2** - Assess the implications of interactions between the miniwalls and the faults/lineaments crossing directly through and above the miniwalls. | Identified geological structures underground are provided in Fig. 2.8 of *Attachment F – Technical Report: Subsidence Predictions and Impact Assessment Report (MSEC, 2023)* – ***slide 18***<br>The effect of faults is included in the calibrations of the SCT modelling. The models were run with a range in joint and bedding properties of the overburden to improve the model output of the magnitude and shape of the observed subsidence profile. Joint and bedding cohesion, friction angle, frequency and length, are varied in a parametric assessment. Variations in stress and depth of weathering were also modelled to assess their impact on subsidence.<br>The general geology was evaluated to be similar between the south-east Genowlan mining area and the Point Hatteras and Mt Airly mining areas.<br>Features expressed by SRK aeromag have not been seen at that orientation in underground mapping. The mapping of geological features in MW13, 14 and 15 resembling the projection are more N-S trending shear zones.<br>These consistently find expression as closely spaced joints over a narrow distance with signs of strike-slip movement (slickensides) with little to no displacement. Where intersected these features only have limited impact and are adequately supported with the current (underground) support plans and TARPs.<br>A review undertaken by MSEC found that mining regularly occurs through small faults - as is being undertaken at Airly. In these cases, the observed surface subsidence profiles, over these small faults are not very different from the observed profiles over similar panels with no faults, and the observed subsidence did not vary much from the levels that were expected. |
| **NPWS Recommendation 3.2 -** confirm and state the adequacy in monitoring strategy proposed for subsidence induced damage for the area directly over, and between the narrow long walls considering the known, or suspected faults as applicable. | The subsidence monitoring configuration has been developed with input specialists and in consultation with the IEP – ***slides 21-22***<br>The IEP considers:<br>• Subsidence monitoring is suitable to confirm the low levels of subsidence expected |

# #4: Subsidence and water monitoring

| Recommendation/s | Centennial Response |
|---|---|
| **NPWS Recommendation 4.1 -** assign predicted subsidence based on the <100mm +/- 25mm as covered by the EIS as the performance criteria, with reference to 125 mm as the maximum vertical subsidence being the upper limit not the benchmark, as part of the standard in the CEP | 125 mm is the maximum vertical subsidence upper limit<br>The layout has been designed to limit the maximum predicted subsidence to a chosen **upper design limit of 95mm (+/-20mm)** aligning with a precautionary approach<br>The Master Trigger Action Response Plan for MW17-18 (Appendix 6 of the EP Main Report) is developed around the modelled subsidence predictions, with 125mm a condition red trigger value (i.e. operations exceed approved performance measure) |
| **NPWS Recommendation 4.2 -** provide reasoning for the subsidence monitoring configuration, inclusive of targeting large fault monitoring through and above MW 17 & 18, to justify that the subsidence monitoring is adequate for identifying subsidence as part of an enhanced early warning system<br>**BCS Recommendation 3** - Ensure the monitoring system is adequate and systems are well placed to support early risk detection. | The subsidence monitoring configuration has been developed with input specialists and in consultation with the IEP – ***slides 16, 21-22***<br>The IEP considers:<br>• Subsidence monitoring is suitable to confirm the low levels of subsidence expected |
| **NPWS Recommendation 4.3 -** increase the number of GNSS units (as per Table 1/ Figures 1 and 2 below) measuring subsidence directly above, and between the narrow longwalls for the south-eastern part of Genowlan Mountain with an even concentration of GNSS units in areas predicted to experience likely, or higher risks to balance the reporting. | The revised MW17-18 Extraction Plan proposed 18 GNSS monitoring stations, 6 (33%) located in the extended monitoring area and 12 (66%) directly measuring subsidence areas<br>Airly Mine has chosen to adopt the proposed recommendation by replacing the previously proposed site labelled 18, with the three recommended additional GNSS units – ***slide 22*** |
| **NPWS Recommendation 4.4 -** confirm the targeted visual assessment is adequate to detect surface subsidence expression on the SCA, remaining adequate for all geological forms at risk on the SCA and the monitoring at six-month intervals is sufficient for the early detection. Confirm if shortened monitoring intervals will be applied if increased subsidence activity is detected. | The mine design has been specifically developed in response to the sensitive surface environment to avoid significant impact. The IEP considers:<br>• Surface impacts from this mining are expected to be imperceptible<br>The primary monitoring methods for early detection (***slide 22***) include:<br>• Underground mining control to confirm that formation of underground workings is implemented as per the design specifications that determine the predicted subsidence movements and impacts; and<br>• Near real time continuous monitoring undertaken using GNSS monitoring stations at targeted areas with appropriate triggers based on predicted subsidence values |

# #4: Subsidence and water monitoring (cont.)

| Recommendation/s | Centennial Response |
|---|---|
| **NPWS Recommendation 4.5 -** ensure the early warning system, includes direct notification to NPWS, if the subsidence risk increases substantially or thresholds are approached where surface expression is likely | Actions and responses in Condition Amber in the Ground Movement and Subsidence Effects Monitoring aspect of the Master Trigger Action Response Plan for MW17-18 (Appendix 6 of the EP Main Report) requires consultation with NPWS if modelled subsidence predictions are exceeded |
| **NPWS Recommendation 4.6 -** require a clear statement that "no impact" is permitted to The Grotto, its formation, function and water resource inclusive of standing pools, providing for adequate monitoring of this to support the justification that no impact has occurred as a performance measure | The performance measures for subsidence for the Airly Mine are outlined in Condition 2 in Schedule 3 of Development Consent SSD_5581 and presented in Table 5.1 of the Extraction Plan Main Report for MW17-18<br>The Grotto is located outside the EP Area, it is not expected that the proposed MW17 to 18 extractions will have any impact on this feature – ***slide 23***<br>Monitoring for The Grotto includes:<br>• Monitoring for the presence/absence of mine-induced damage or change to features (no significant rock falls or surface cracking)<br>• Watercourse quality and flow volumes<br>• Aquatic ecology<br>• Fauna monitoring<br>• Flora composition, vegetation structure and ecological function (as defined by the Biodiversity Assessment Method)<br>• Rapid aquatic assessment (modified from the AUSRIVAS methodology) |
| **NPWS Recommendation 4.7 -** provide NPWS with access to raw subsidence, groundwater and stream level/flow data collected for the Airly Mine (in an excel spreadsheet file(s) format) on a quarterly (3 monthly) to support its land management functions<br>**BCS Recommendation 4** - Condition the provision of all raw data to NPWS for subsidence, groundwater, and stream level/flow monitoring for the Airly Mine as it has a direct bearing on the management of the SCA, on a quarterly (3-month basis) as an excel file. | Airly Mine agrees to provide the raw data to NPWS and this was included in Section 4.2.2 and Section 6.2 of the Subsidence Monitoring Program for MW17-18 (Appendix 5 of the EP Main Report) in the revised MW17-18 Extraction Plan to include this requirement |

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# Mine design and subsidence predictions

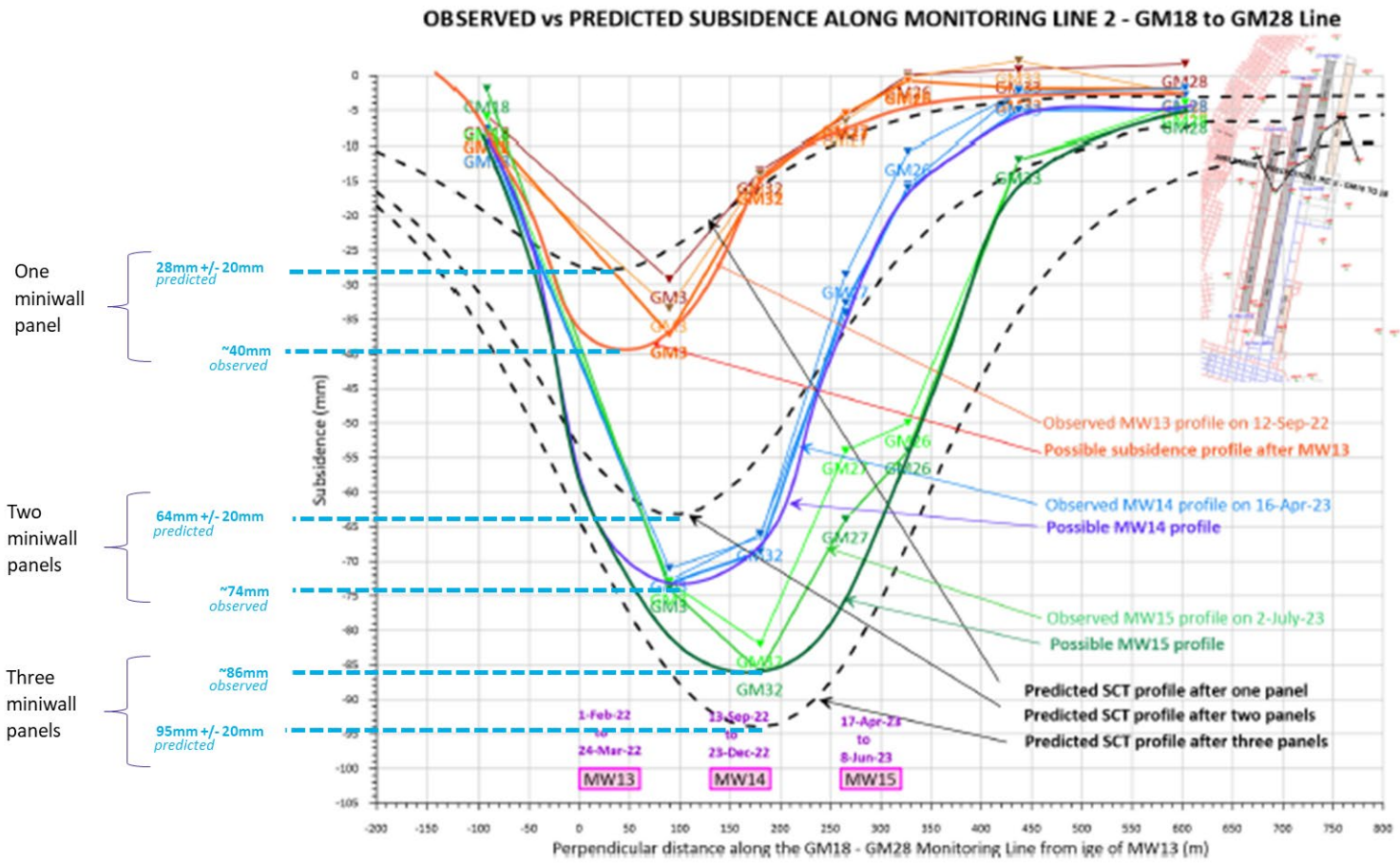
# Subsidence Modelling (SCT)

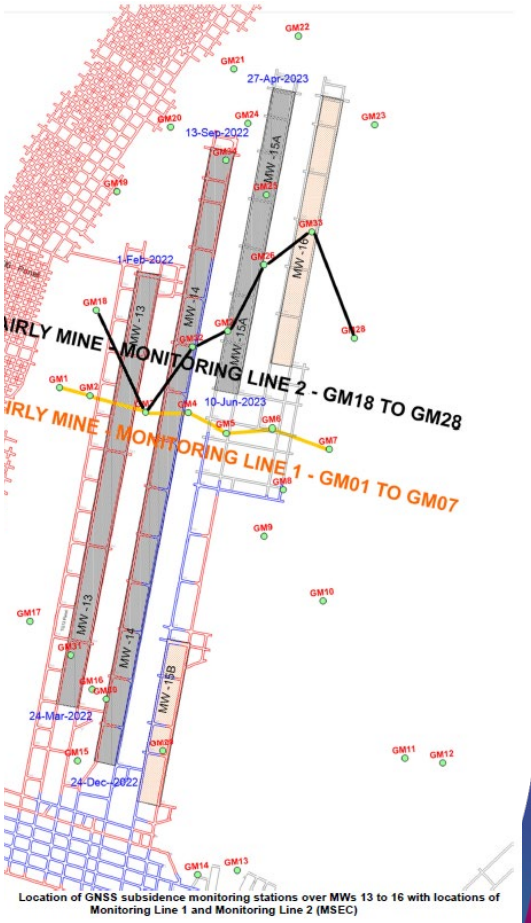
- **SCT have developed a calibrated model for predictive purposes (used previously by Airly Mine)**

- **A comparison of the measured vertical subsidence data following extraction against the SCT model predictions has been undertaken for MW11 & MW12 and MW13, MW14 and MW15A by MSEC (2023)**

- **These comparisons confirm that measured subsidence levels are within the range predicted by the SCT subsidence model and indicate the SCT modelling can be relied on with a reasonable confidence for predicting subsidence from miniwall mining at Airly Mine**

# Comparison of subsidence monitoring results for MW13, MW14 & MW15A against predictions




Location of GNSS subsidence monitoring stations over MWs 13 to 16 with locations of Monitoring Line 1 and Monitoring Line 2 (MSEC)

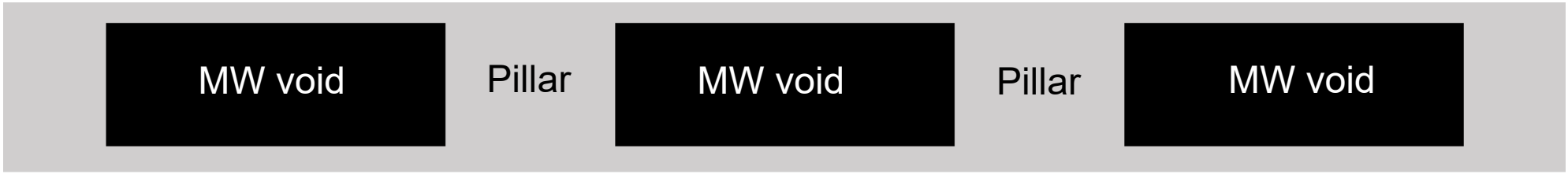
**Fig. 4.38** Observed Subsidence of GNSS units along Monitoring Line 2 plotted against time during extraction of MWs 13 to 15A versus predictions (MSEC)

# Subsidence Modelling (SCT) – MW17-18

- **Modelling assessment aimed to provide a proposed panel width and pillar width design to restrict subsidence to a chosen upper design limit of 95mm (+/-20mm)**
- **MW17-18 has been designed according to the geometry and parameters modelled by SCT (i.e. 70.5m Panel, 70m pillar, 3.0m Extraction Height)**
- **The model output shows little to no rock failure of strata above the pillars for the proposed 3.0m extraction height**
- **Subsidence magnitude estimates (after miniwall extraction):**
  - *MW17: -39mm (+/- 20mm)*
  - *MW18: -88mm (+/- 20mm)*
- **Airly Mine will monitor the incremental subsidence for each panel extracted to validate the model and to ensure the subsidence is within the progressive modelled subsidence**

# Comparison of proposed layouts

**Typical layout presented in Airly Mine EIS (61m void, 29.5m pillar, 2.8m extraction height)**

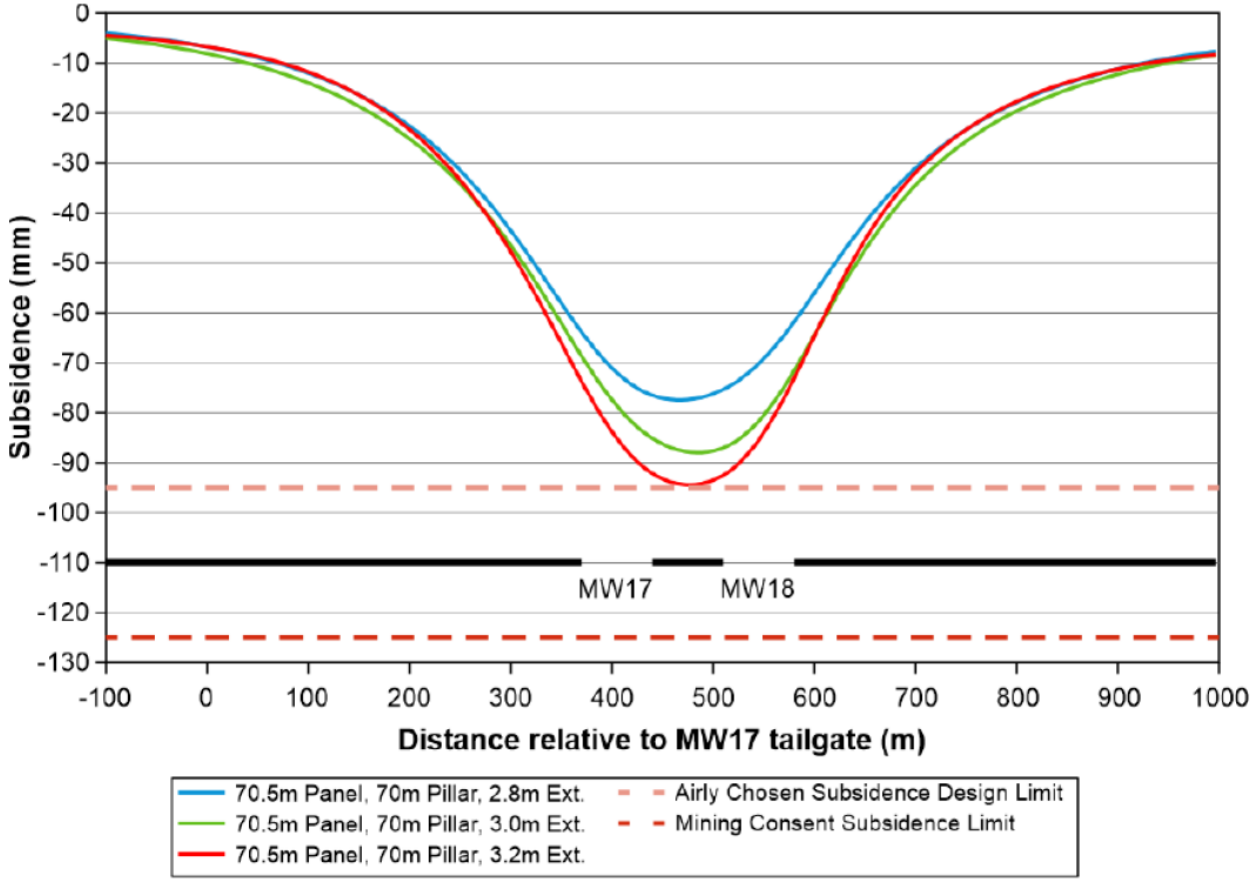



**Proposed layout in MW17-18 Extraction Plan (70.5m void, 70m pillar, 3.0m extraction height)**

# Modelled Subsidence Profiles

- Modelled subsidence profiles for the 70.5m wide panel and 70m wide pillar at each extraction height (2.8m, 3.0m and 3.2m)
- All modelled profiles are below or at the chosen upper design limit (i.e. 95mm)

**Figure 3.2: Modelled surface subsidence profiles following MW17 and MW18 extraction**

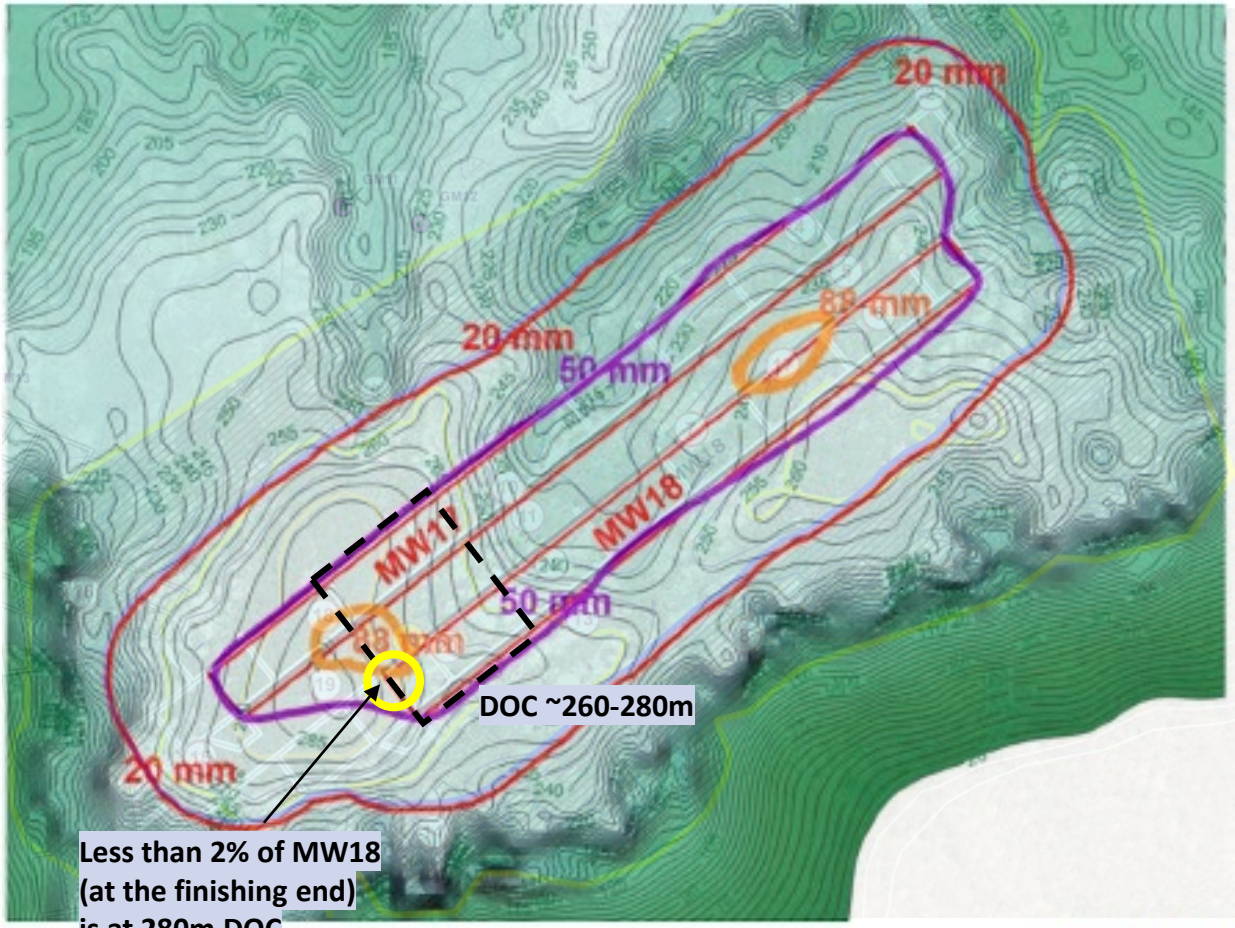



*Note: A subsidence tolerance/natural variability of +/-20mm should be applied to the modelled subsidence*

(source: SCT, 2023)

# Predicted Subsidence Contours (and DOC)

Figure 3.4: Predicted subsidence contour levels (using 26.5 degrees AoD as 20mm)




(source: MSEC, 2023)

- The cover depths over the miniwalls range from approximately 215m to 290m, with areas of higher depth of cover (i.e. greater than 280m) located to the western (finishing) end of MW17
- There is only a slight portion (~15m, or less than 2%) at the western (finishing) end of MW18 that is at 280m and the majority of the cover depths over the miniwalls less than 260m
- MSEC (2023) determined contours based on this predicted 20 mm contour line, the SCT predicted maximum subsidence values - depending on the changing DOC over the panels

# Mine design limits

- **Mine design to restrict subsidence to a chosen upper design limit of 95mm (+/-20mm) – reduced relative to previous extraction plan areas**
- **Actual modelled subsidence predictions 88mm (+/-20mm), less than upper design limit**
- **Condition Amber trigger (during extraction of MW18) is 108mm (i.e. operating outside of predictions)**
- **Multiple GNSS units along MW18 providing near real time data to validate the modelled subsidence predictions as mining in MW18 approaches higher DOC**
- **If the condition Amber level is triggered at a GNSS Monitoring unit there is allowance in the design limit for potential residual subsidence such that Airly Mine remains below the maximum vertical subsidence limit (i.e. less than 125mm)**

CENTENNIAL

# Interaction with geological formations on the SCA

OUR WAY IN ENERGY

# Mapped geological structures underground

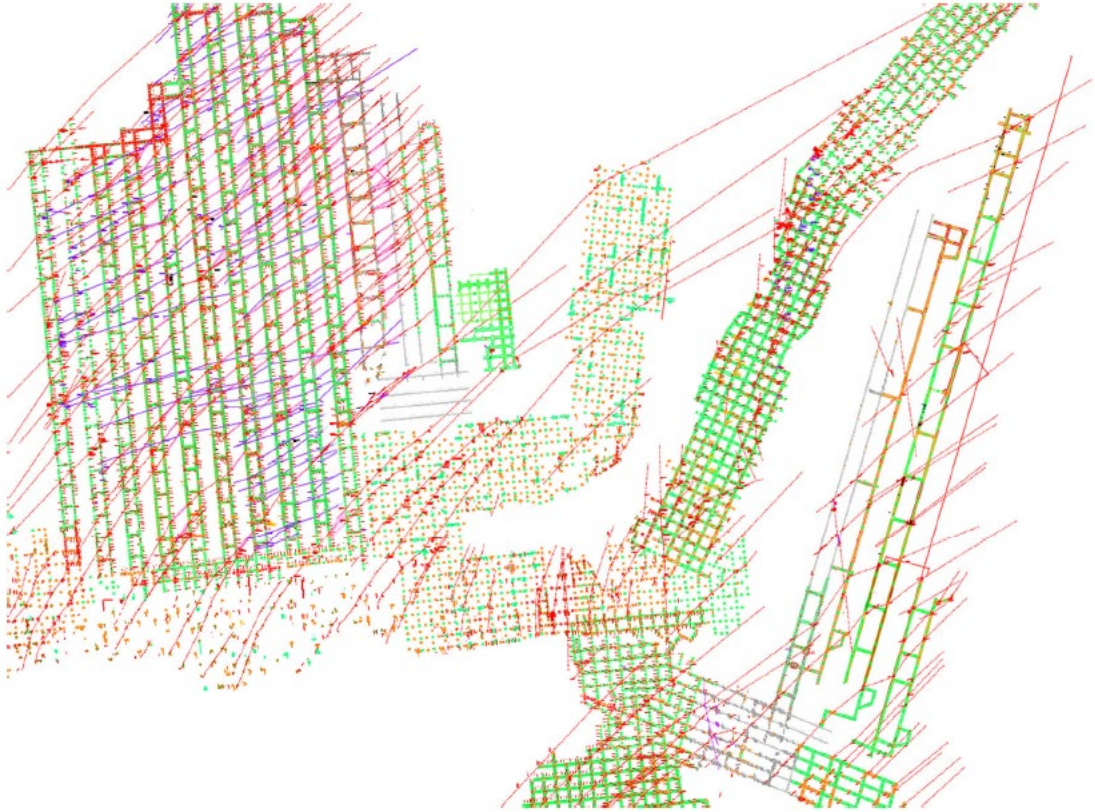


Fig. 2.8 Identified geological structures underground, i.e. at seam level at Airly (Source: CA, 2022)

# Cliff Impact Assessment

**Performance measures as specified under Condition 2 in Schedule 3 of SSD_5581**

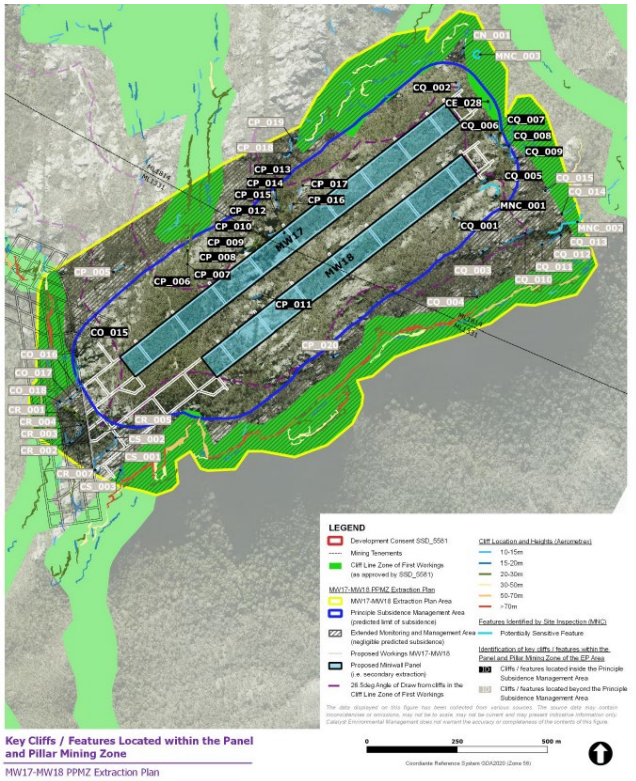
No greater subsidence impacts or environmental consequences than predicted in the EIS *(i.e. occasional rock falls, displacement or dislodgment of boulders or slabs of less than 30 m$^3$, or fracturing, that do not Impact Aboriginal heritage, EECs or public safety)*, that in total do not impact more than 2% of the total area of such cliffs.

Identified cliffs have been assessed by MSEC, including subsidence predictions for each cliff within the principal subsidence management area

The maximum predicted subsidence at the identified cliff sites over or near MWs 17 to 18 is less than 80 mm

The report concludes that there should be little chance of exceedance of the conditions of approval for the cliffs that have been identified over the proposed MWs 17 to 18

The IEP considers that all cliff formations within the Cliff Line Zone are protected by an angle of draw of greater than 26.5° and by the low levels of subsidence over the mining area



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# Subsidence and water monitoring

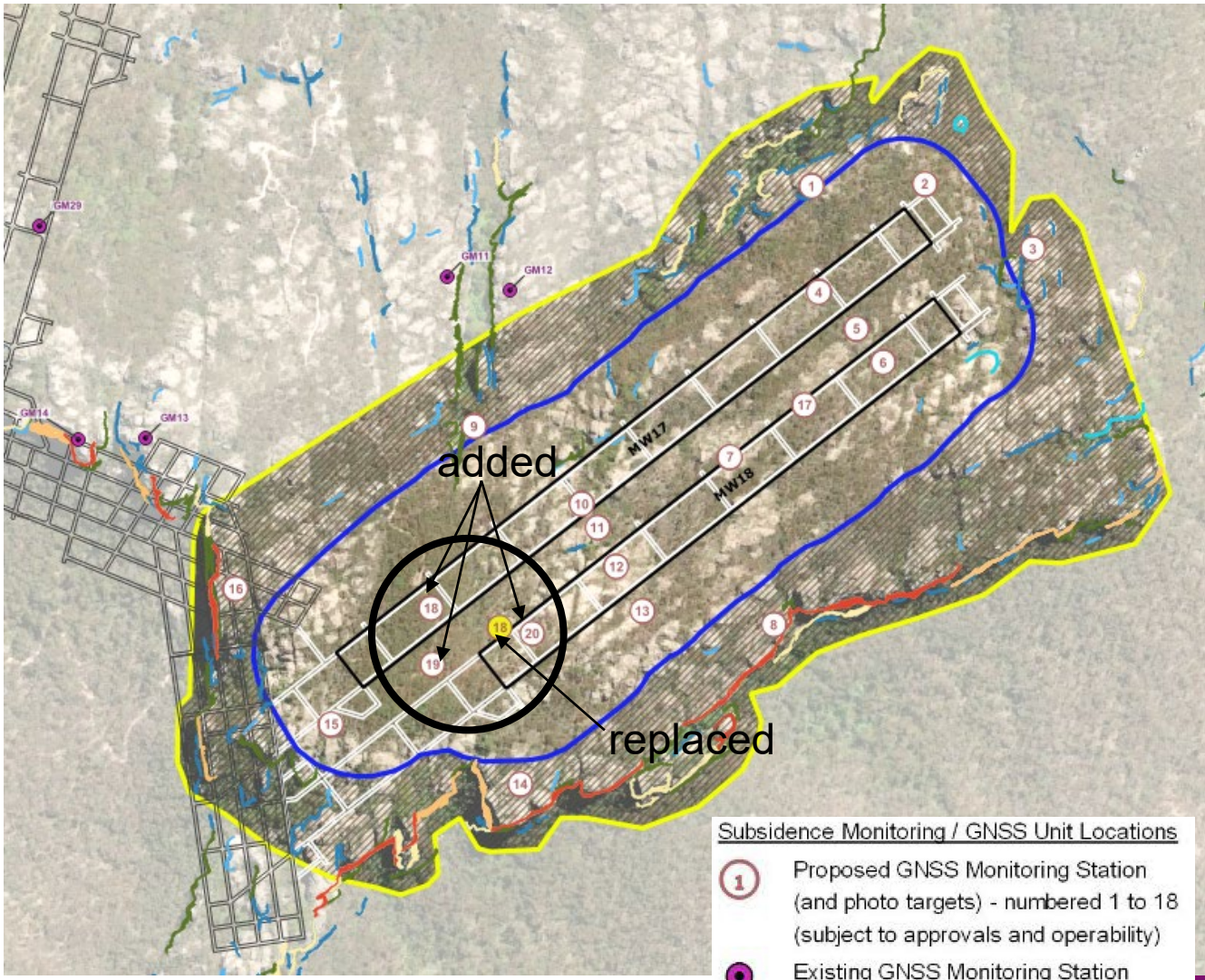
OUR WAY IN ENERGY

# Subsidence Monitoring

- **Based on subsidence monitoring program approved for MW13-16, including:**
  - Underground Mining Control
  - Monitoring ground movement (GNSS monitoring units)
    - Total of twenty (20) GNSS units proposed
    - Record X, Y, Z spatial position readings to <+/-5mm accuracy
    - Continuous and near real time data, with notifications to key site personnel in accordance with trigger thresholds
    - May be co-located with photo control target to improve remote monitoring
  - Remote monitoring of the surface
    - LiDAR
    - Undertaken approximately six-month intervals, multiple baseline surveys complete
  - Trigger-based Targeted Surface Inspections (where required)
  - Environmental Monitoring Programs, incl:
    - Surface water
    - Groundwater
    - Biodiversity
    - Aquatic Ecology and Stream Health

# Proposed Subsidence Monitoring / GNSS Unit Locations

- GNSS units labelled 4 to 6 and 10 to 12 are ideally located for subsidence modelling validation and provide contingency / record natural variability
- GNSS units labelled 9 to 13 provide a pseudo subsidence line through the miniwall panels
- GNSS units labelled 3, 5, 17, 7, 11, 19 and 15 provide a pseudo subsidence line along the miniwall panels
- GNSS units labelled 5, 17, 7 and 11 will provide data to validate the modelled subsidence predictions as mining in MW18 approaches higher DOC
- The remaining proposed units are measuring potentially sensitive features, or at cliffs in the cliff line zone for potential movements beyond predictions.




*Note, previously proposed site labelled 18 has been replaced with the three additional GNSS units recommended by NPWS*

# The Grotto

**Performance measures as specified under Condition 2 in Schedule 3 of SSD_5581**
Negligible subsidence impacts or environmental consequences.

- **The Grotto is located outside the EP Area, it is not expected that the proposed MW17 to 18 extractions will have any impact on this feature.**
- **However, there is a watercourse located in the EP Area that is connected to the Grotto, hence it was considered in this EP.**
- **Monitoring for The Grotto includes:**
  - Monitoring for the presence/absence of mine-induced damage or change to features (no significant rock falls or surface cracking)
  - Watercourse quality and flow volumes
  - Groundwater
  - Aquatic ecology
  - Fauna monitoring
  - Flora composition, vegetation structure and ecological function (as defined by the Biodiversity Assessment Method)
  - Rapid aquatic assessment (modified from the AUSRIVAS methodology)

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# NPWS / BCD meeting with IEP

Ken Mills
19 October 2023

**Geotechnical consulting, research and instrumentation for mining and civil industries.**

SCT

# Overview of Presentation

- IEP Terms of Reference
- Site Plans
- List of Questions
- Overview of subsidence processes
- Answers

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# IEP Terms of Reference

NSW GOVERNMENT Planning & Environment

## SCOPE OF WORKS

AIRLY COAL MINE INDEPENDENT EXPERT PANEL

**BACKGROUND AND OBJECTIVES**

- The Airly Mine Extension Project was approved in 2016.
- The conditions of consent require the establishment of an Independent Expert Panel to provide advice on the mine design in order to meet performance criteria for protection of key natural features.
- The Independent Expert Panel is required to be comprised of experts in mine design and numerical modelling of underground pillars.

**OUTPUTS SOUGHT**

- The members of the Independent Expert Panel are required to attend site visits at the mine, and provide written advice to the Department in relation to the approval of Extraction Plans.

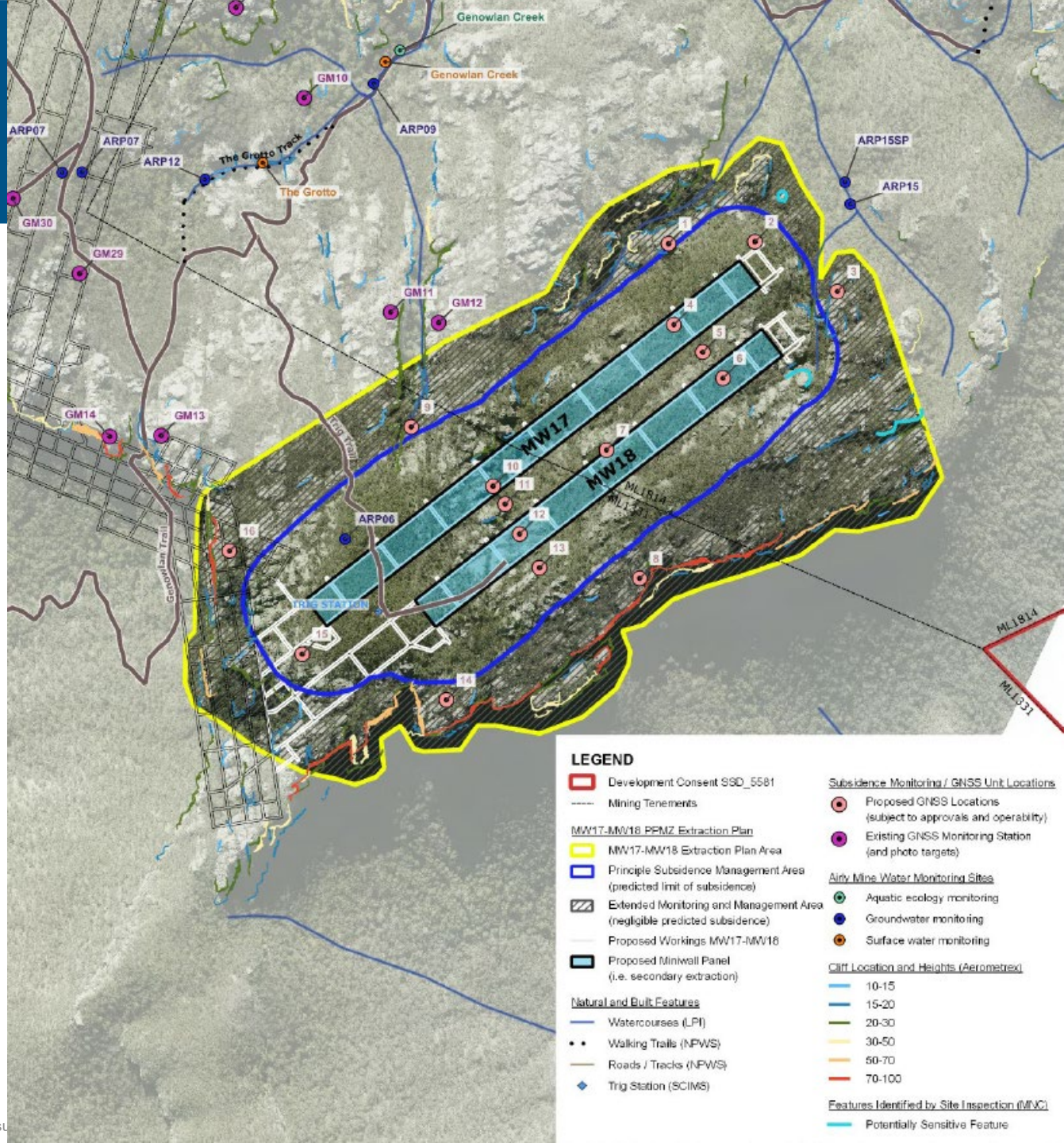
**TERMS OF REFERENCE**

- Review the Extraction Plan for the Airly Coal Mine.
- Attend sure visits and meetings at the Department.
- Provide written advice to the Department in relation to the protection of key natural features at the mine.

IEP comprises:
Dr Ken Mills (SCT)
Prof Ismet Canbulat (UNSW)

Others at SCT and UNSW have also undertaken work directly for Centennial Airly. This work has been conducted at arm's length from the IEP members.

# Site Plan

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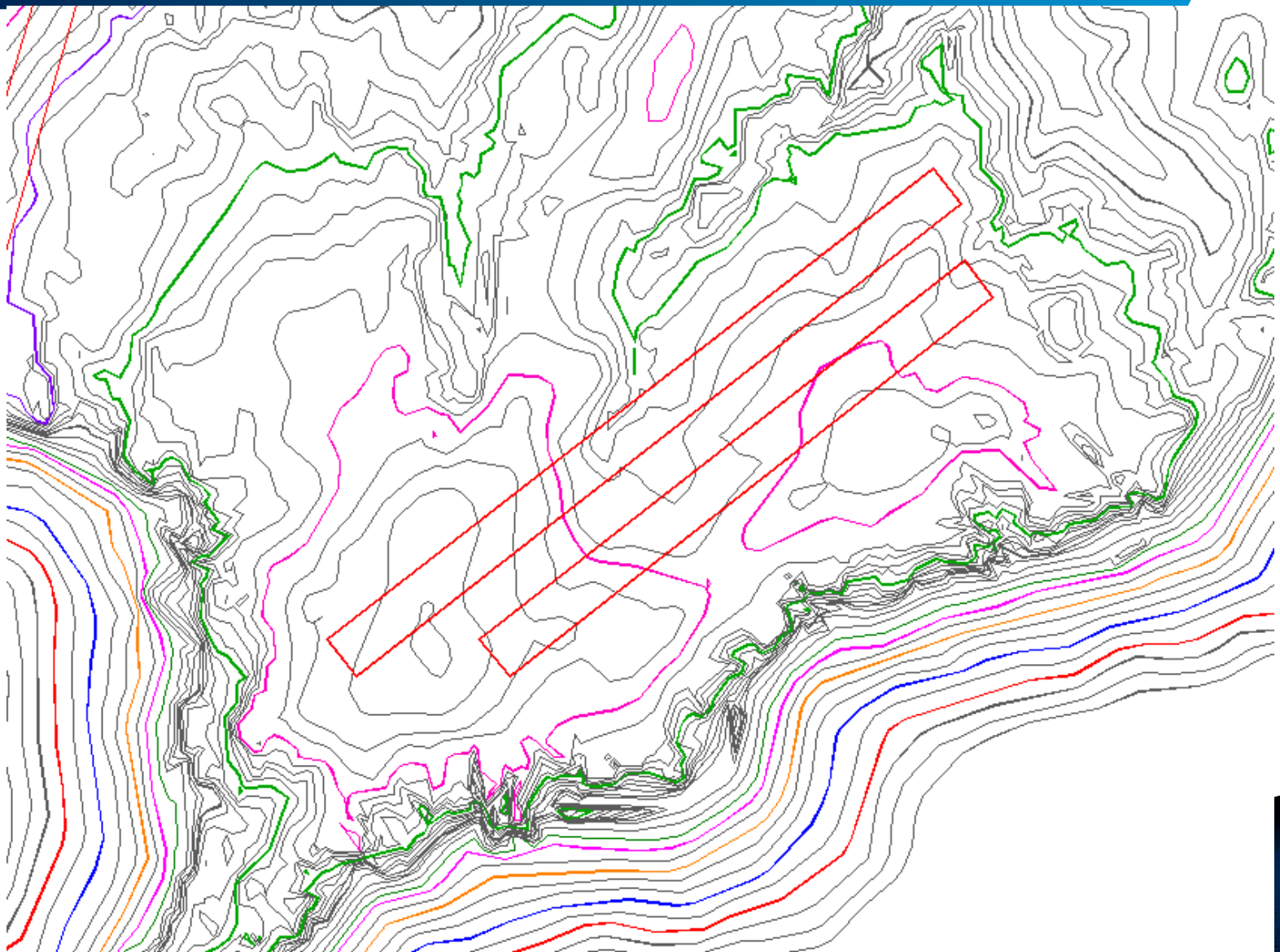
# Site Plan



# Questions

1. Can the IEP explain their view on how an increase in narrow longwall width of 17.5% and an increase in extraction height to 3m can be considered to be ‘substantially the same’ as that approved under SSD5581.

2. What does the IEP think will be the actual subsidence for the proposed narrow longwall layout with a depth of cover (DOC) of 291m (given that this Depth of Cover has not been modelled or discussed in the MW17&18 documentation)?

3. What is the level of uncertainty (error) in DOC estimates in this area?

# Questions

4. SCT (2023) stated that a 60m barrier pillar at 260m DOC is approaching 13MPa of average pillar load with the potential for the onset of failure. Figure 3 of SCT (2023) suggests that a 70m pillar and 70.5m panel at 280m DOC is already very close to 13MPa (and therefore approaching the potential for the onset of failure). What is the IEP's predictions for pillar stability exceeding 13MPa if modelled depth of cover had been increased further to 285-291m?

5. Why should NPWS/BCD not be concerned about faults and other geological structures (eg lineaments) given previous experiences in the western coalfields and the comments in MSEC (2023) in relation to faults/geological structures causing increased subsidence? [And why did the faults mapped through MW17 & 18 not receive any comment/assessment by the IEP].

6. Why should NPWS/BCD not be concerned about modelling extrapolating well outside the range of previous subsidence experience at Airly mine (which is all based on a panel width of 61m and height of extraction of 2.8m)?

# Questions

7. Has the IEP seen any empirical measurements for the MW10 pillar which was supposed to have been instrumented prior to MW10 panel extraction?

8. If yes, do these measurements support the view that increased subsidence is primarily due to fracturing and shear failure above the pillars (and is entirely unrelated to the interaction of subsidence with faults/lineaments, as suggested by MSEC (2023))?

9. Also, if yes, does the IEP think it appropriate to have none of this information discussed in the MW17&18 application (or be provided to NPWS/BCD) to enable any review/assessment of these empirical results?

# Questions

10. What is the IEP's views on the SCT (2023) caveats that:

*If the mining height cannot be controlled due to spall, cavities, or operational variation then a reduction in mining height may be required. The modelling results presented above show that the subsidence is very sensitive to the mining height. Increasing the mining height from 2.8m to 3.0m resulted in an increase in the modelled subsidence of 12mm. Previous experience at Airly Mine over MW13 and MW14 resulted in the maximum vertical subsidence exceeding the model subsidence by 12mm to 15mm. Based on this experience, there may be an increased miniwall cut height from spall or operational variation contributing to additional subsidence.*

*No modelling had previously been conducted for panel widths greater than 60m*
*A 60m barrier pillar at 260m DOC is approaching 13MPa of average pillar load with the potential for the onset of failure.*

*A 60m barrier pillar would not be recommended at 70.5 void width.?*

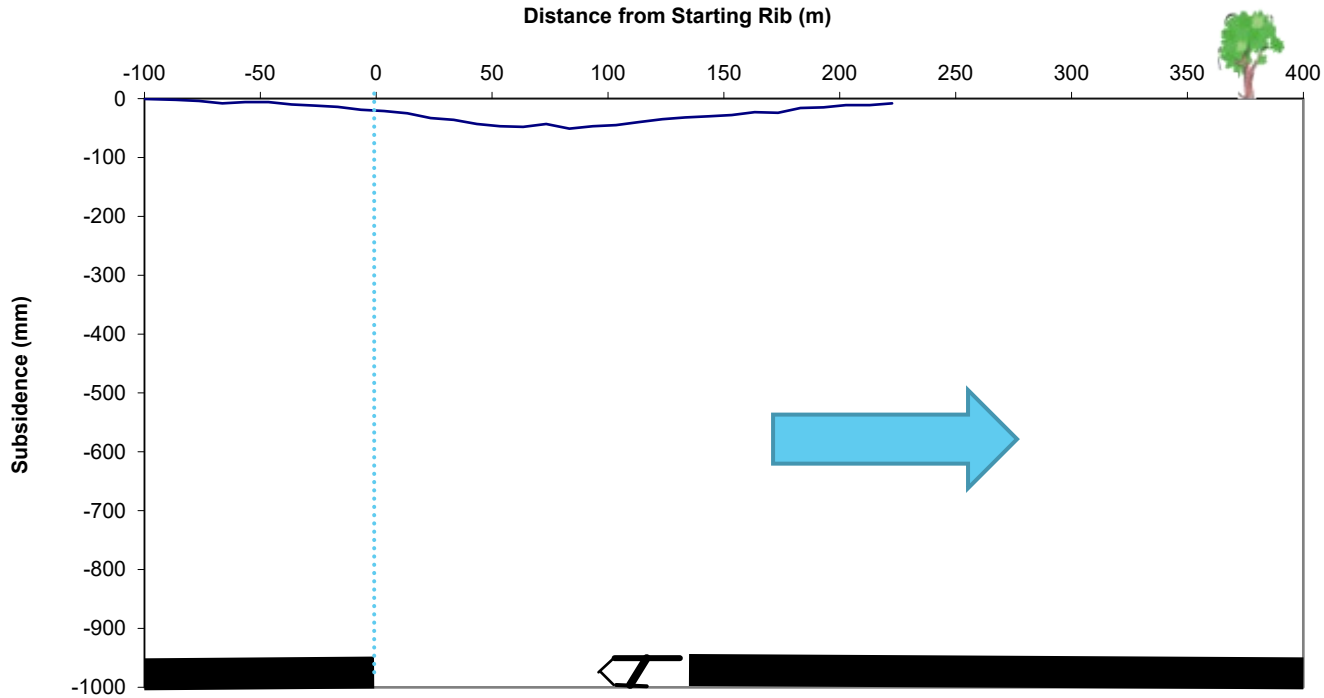
11. What is the IEP's view on the adequacy of proposed subsidence monitoring where there are no GNSS units located above the narrow longwall panels or pillar in areas with the greatest depth of covers (270m-291m)?

# Overview of Mechanics of Vertical Subsidence

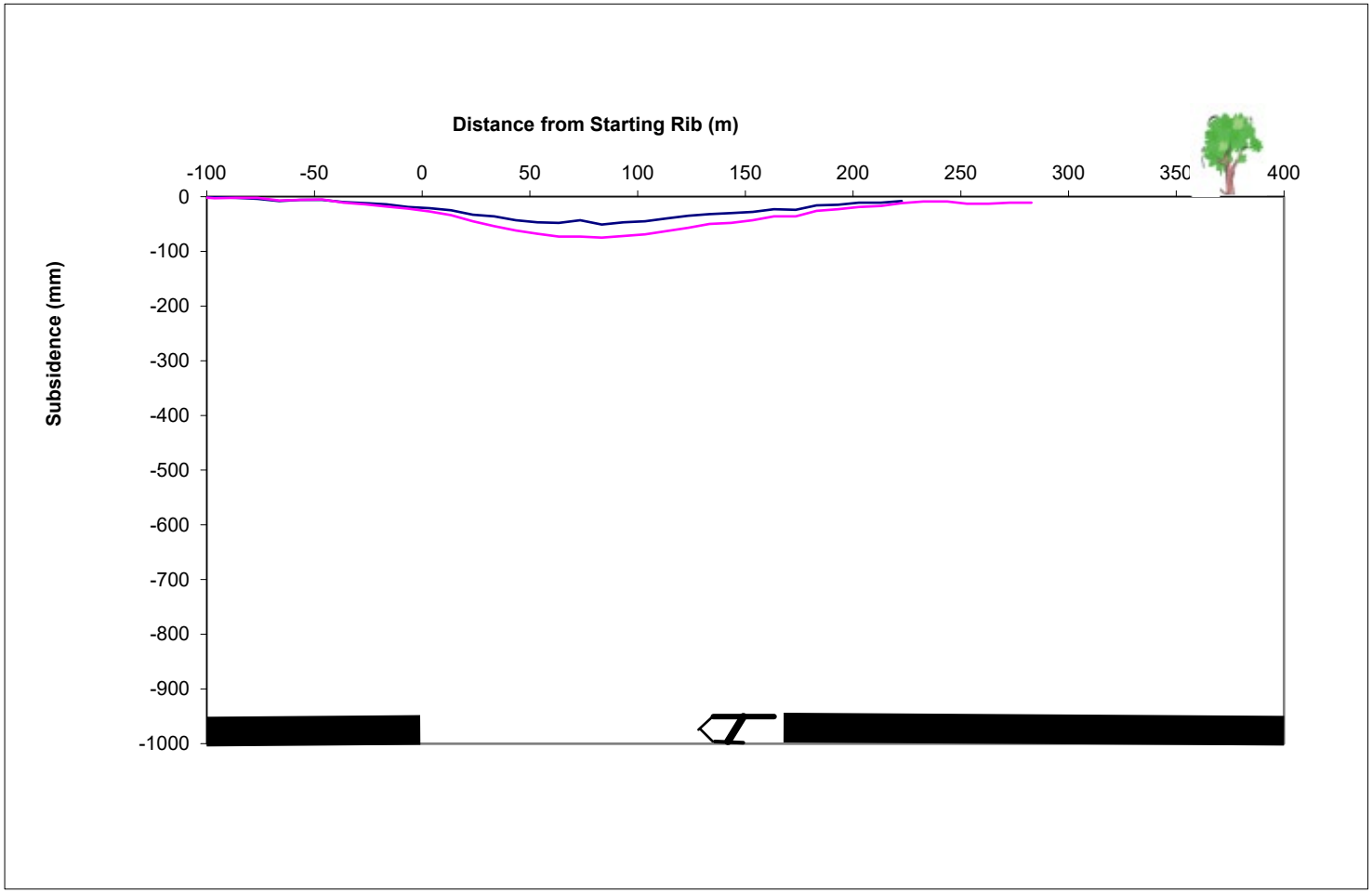
## Components of vertical subsidence:

- Sag over individual panels
- Compression of the strata between panels
- Pillar system failure

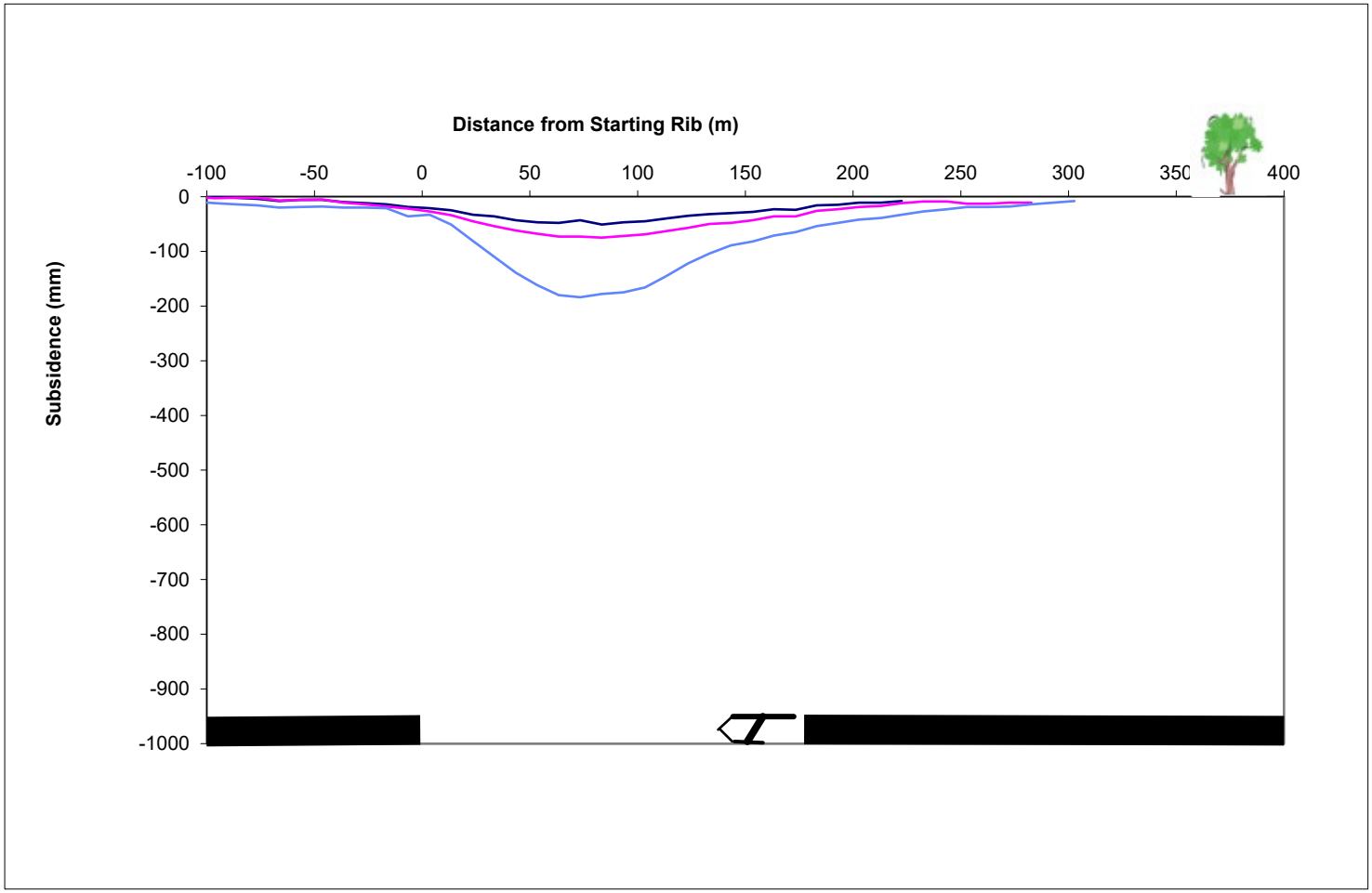
# Sag Subsidence



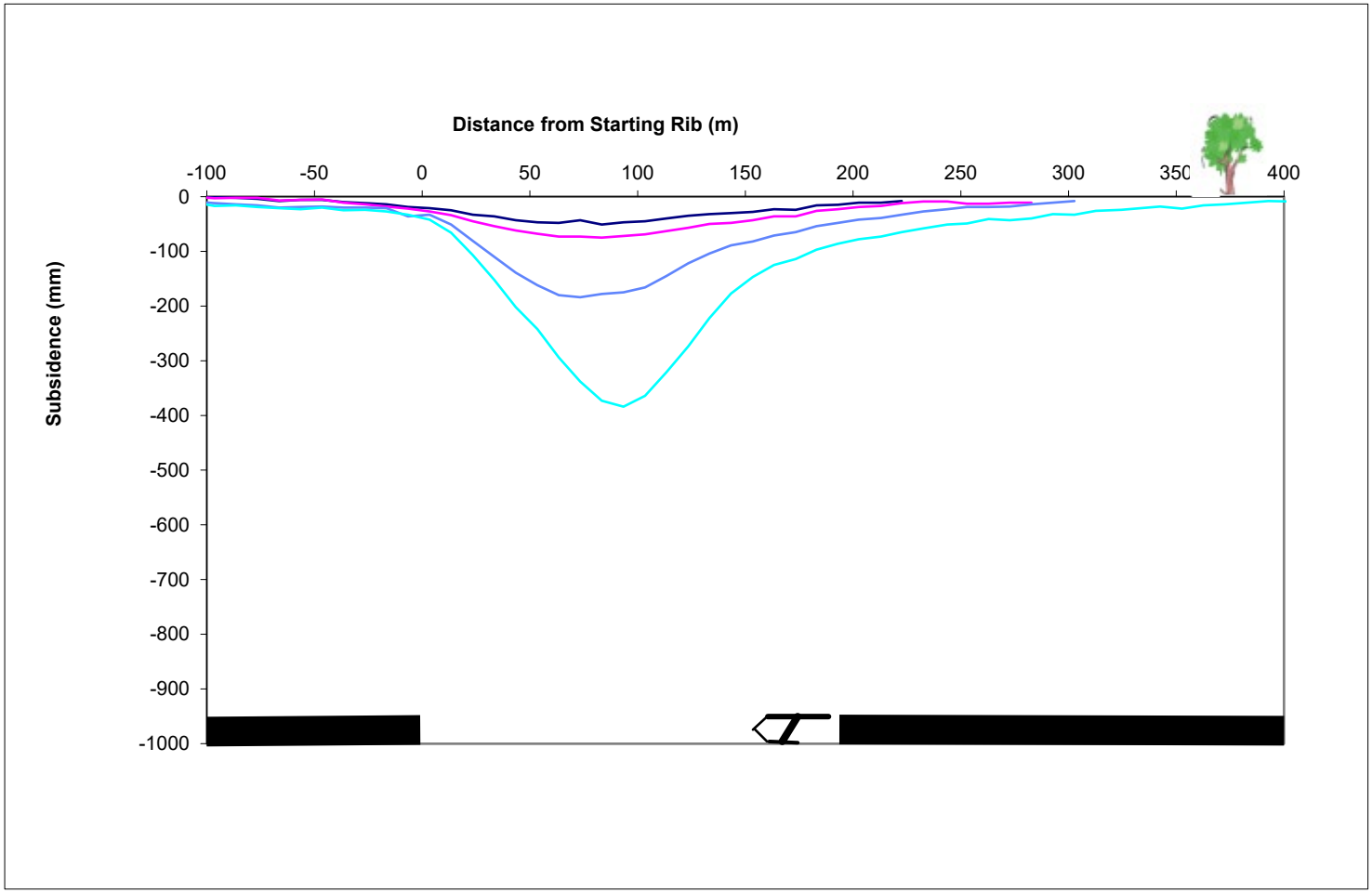
# Sag Subsidence



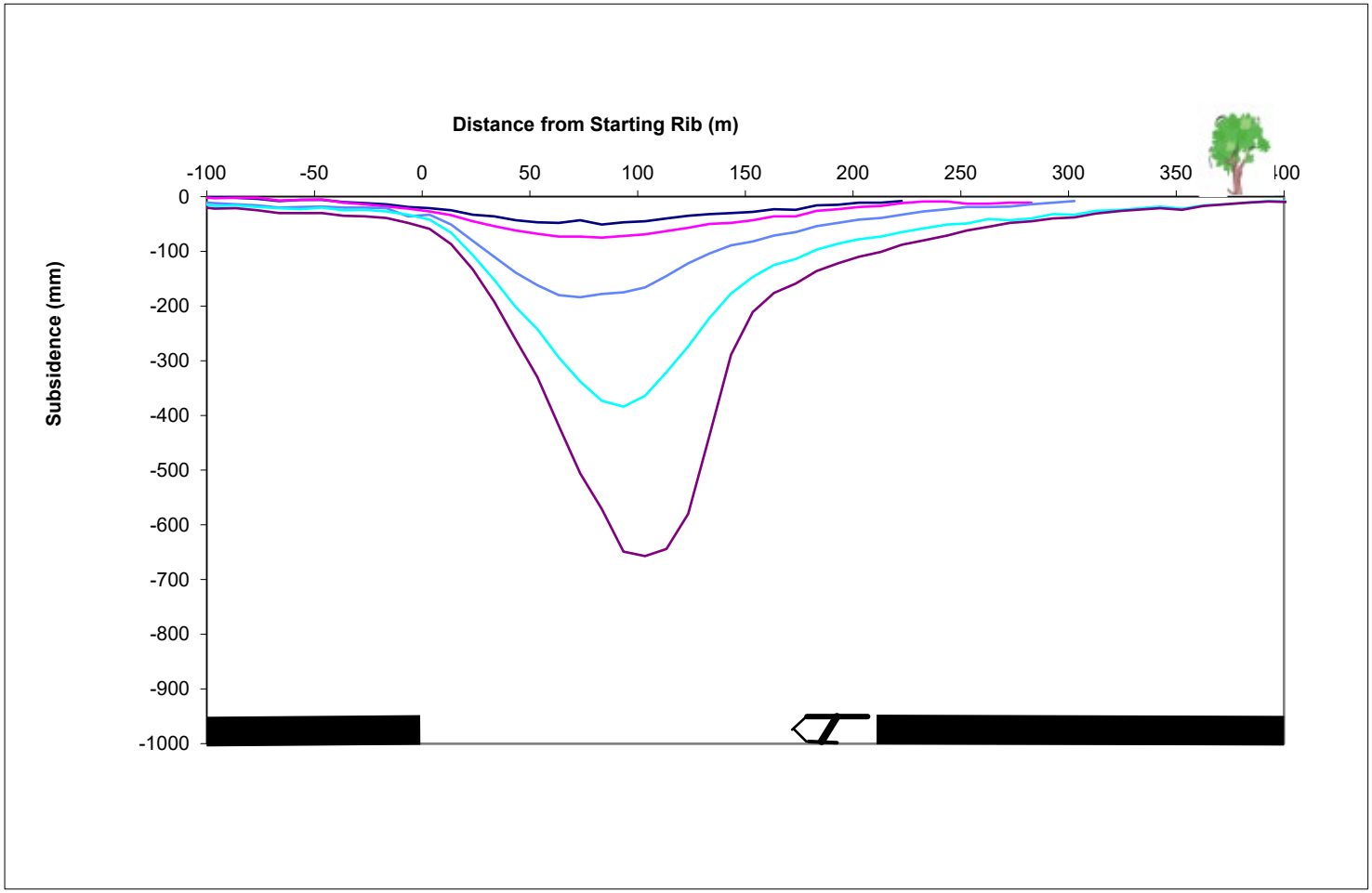
# Sag Subsidence



# Sag Subsidence



# Sag Subsidence



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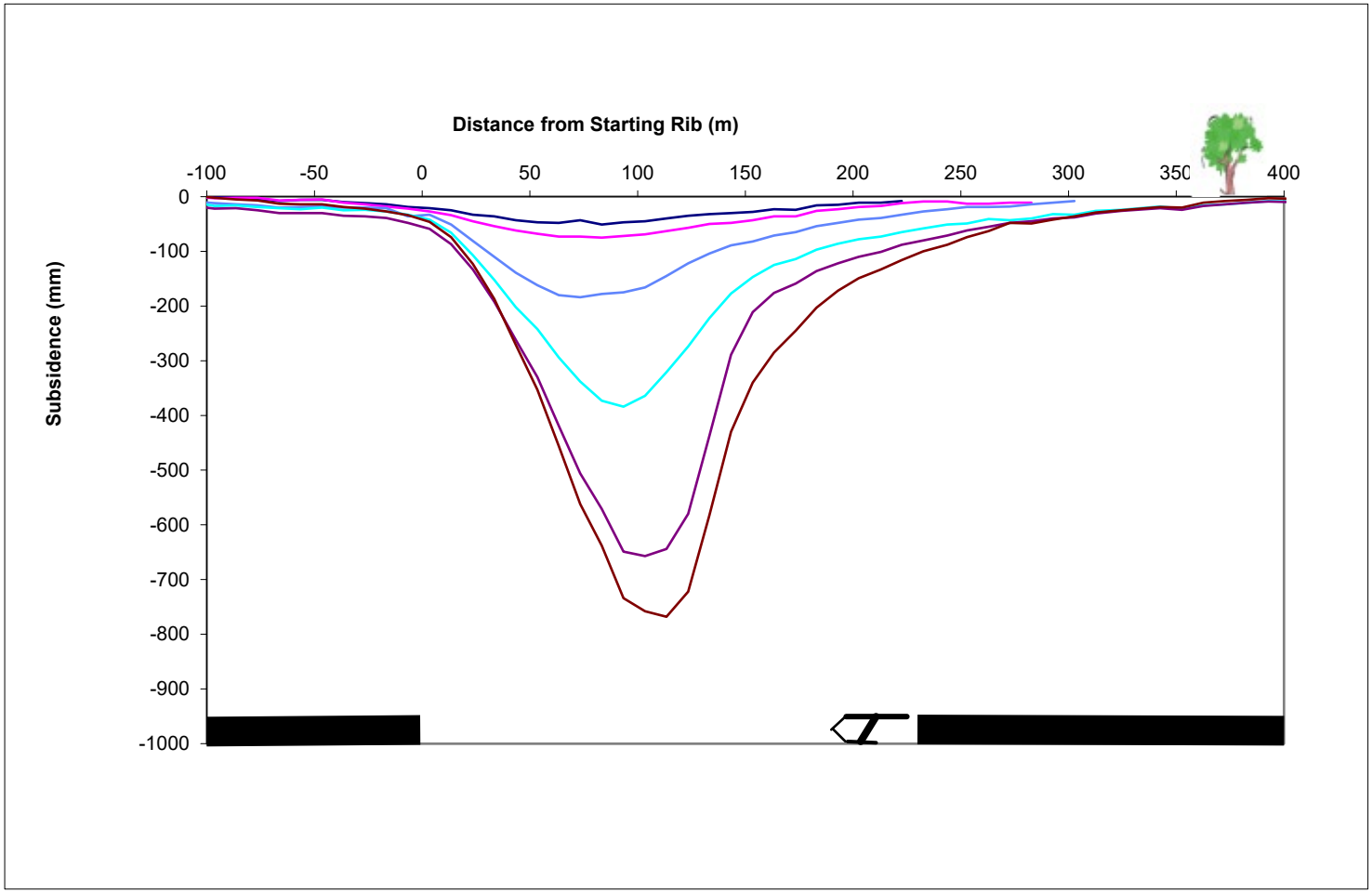
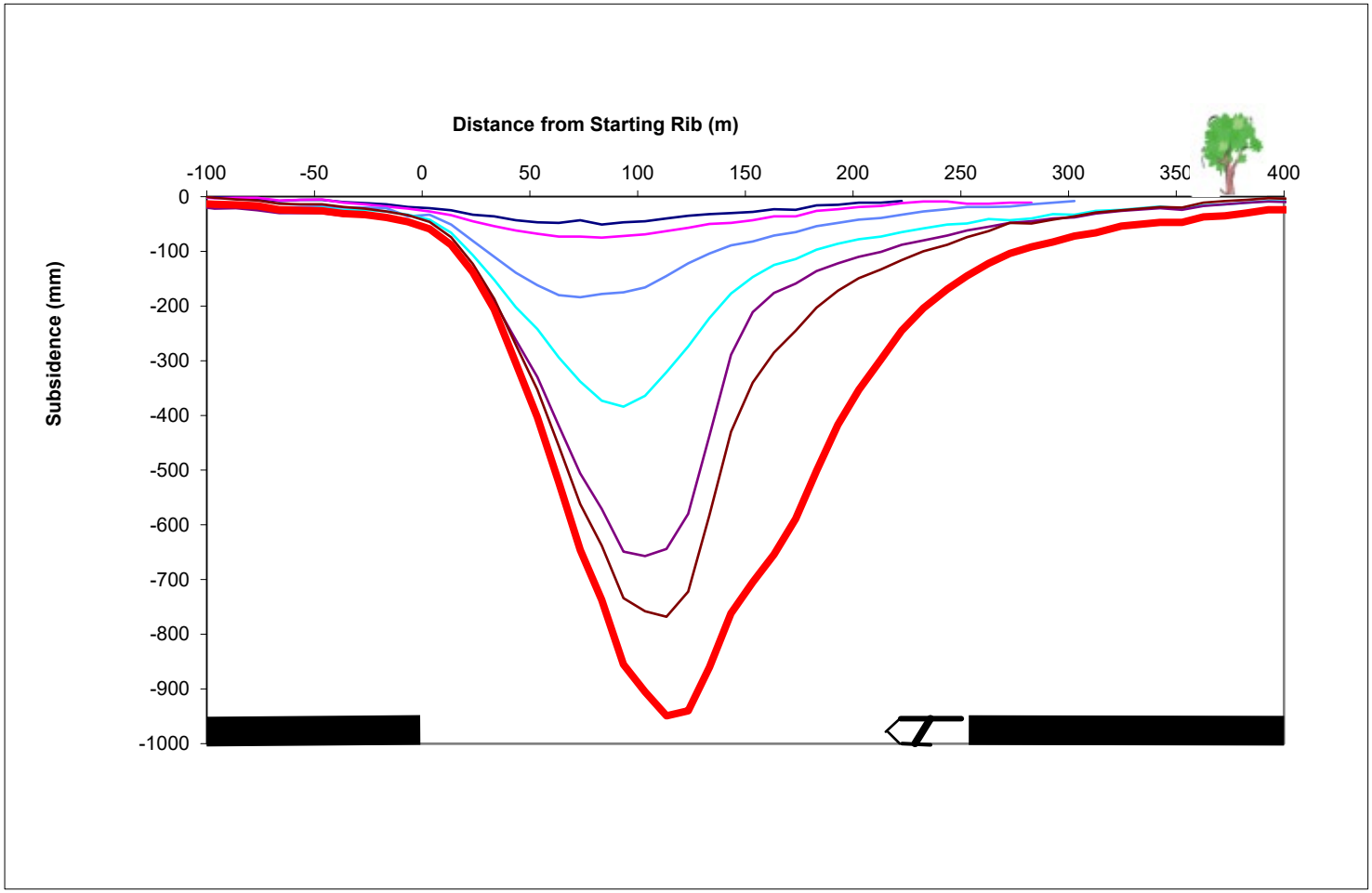
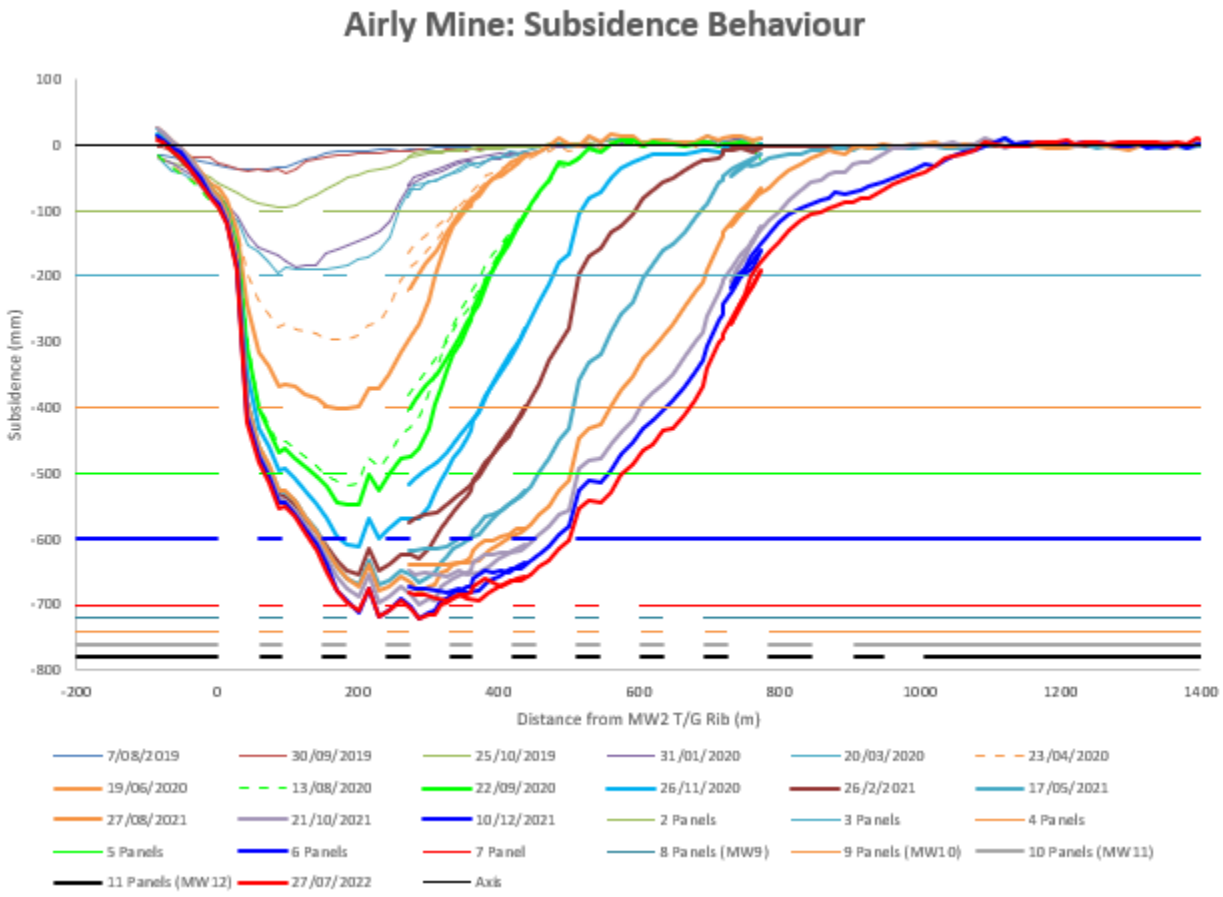


# Sag Subsidence



# Airly Experience at Mt Airly



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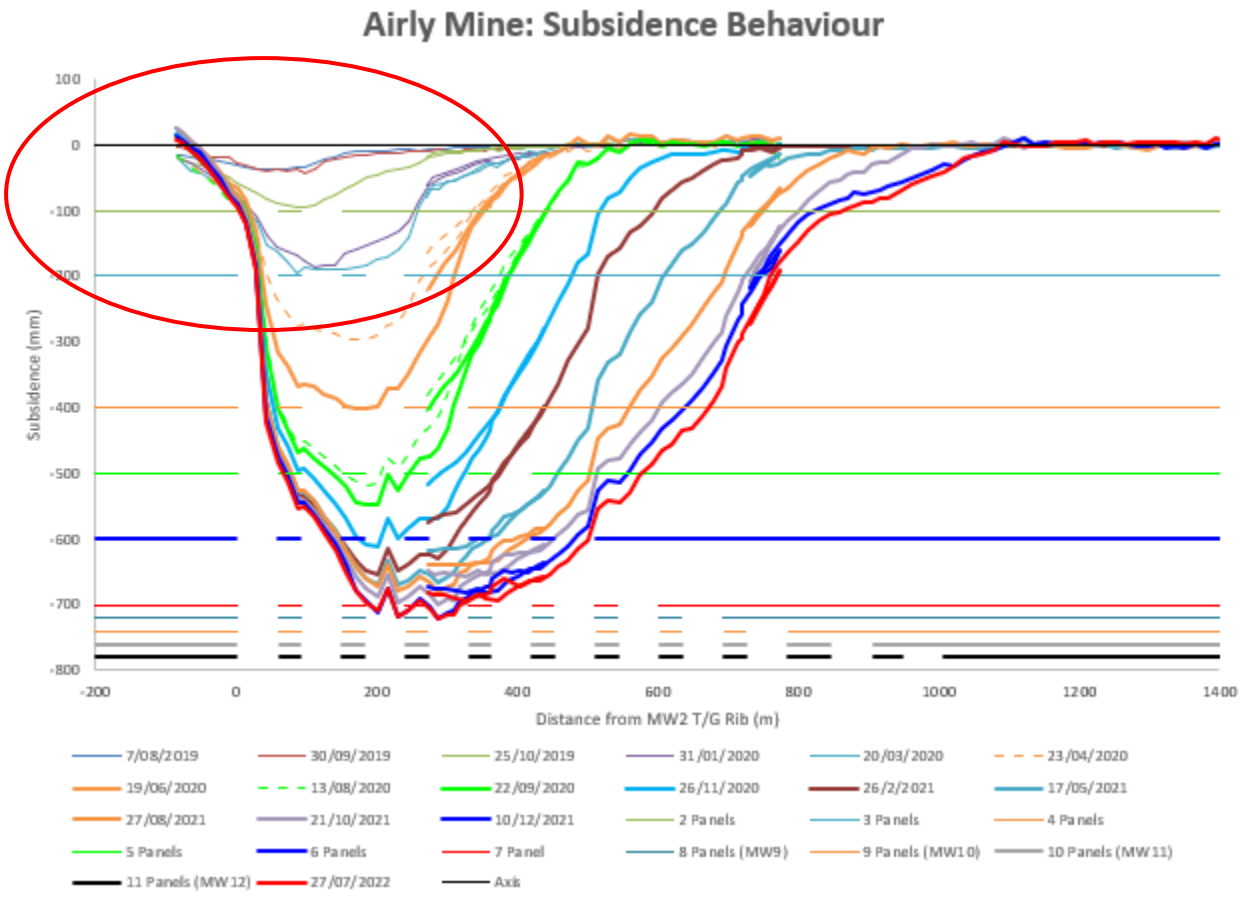

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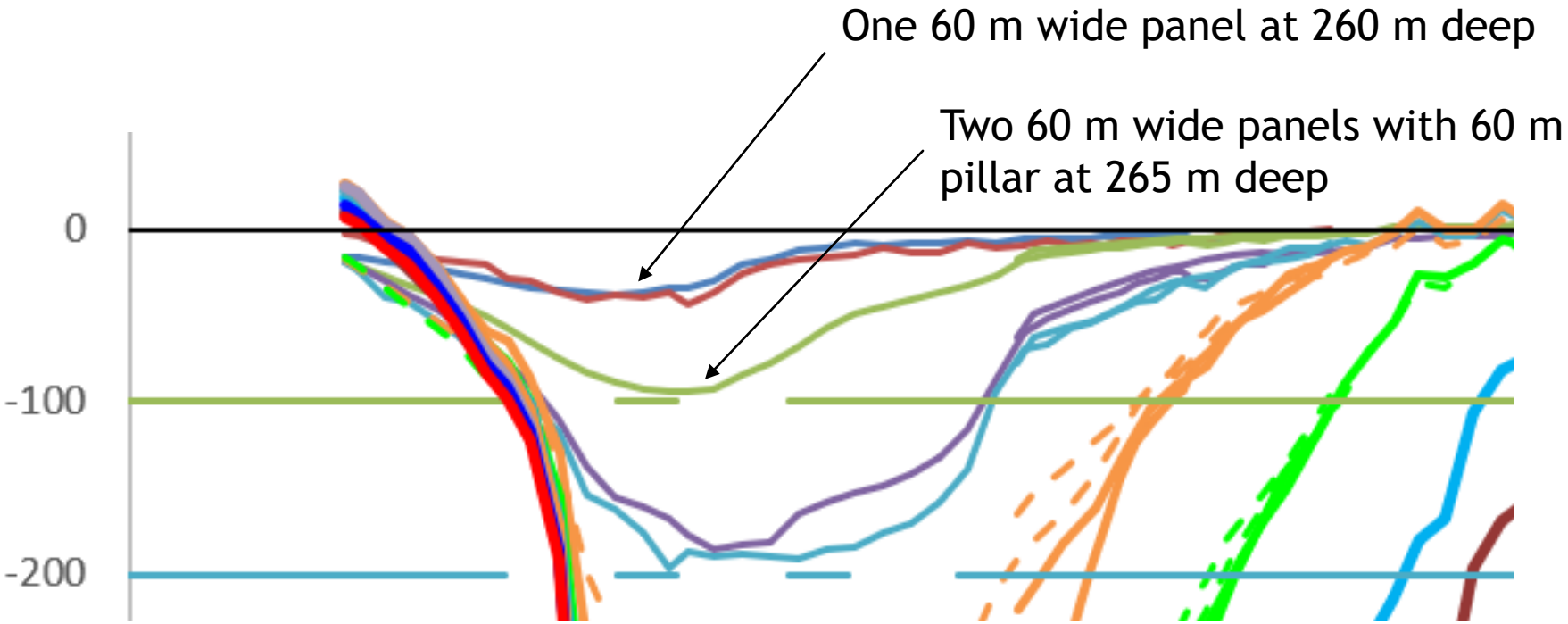

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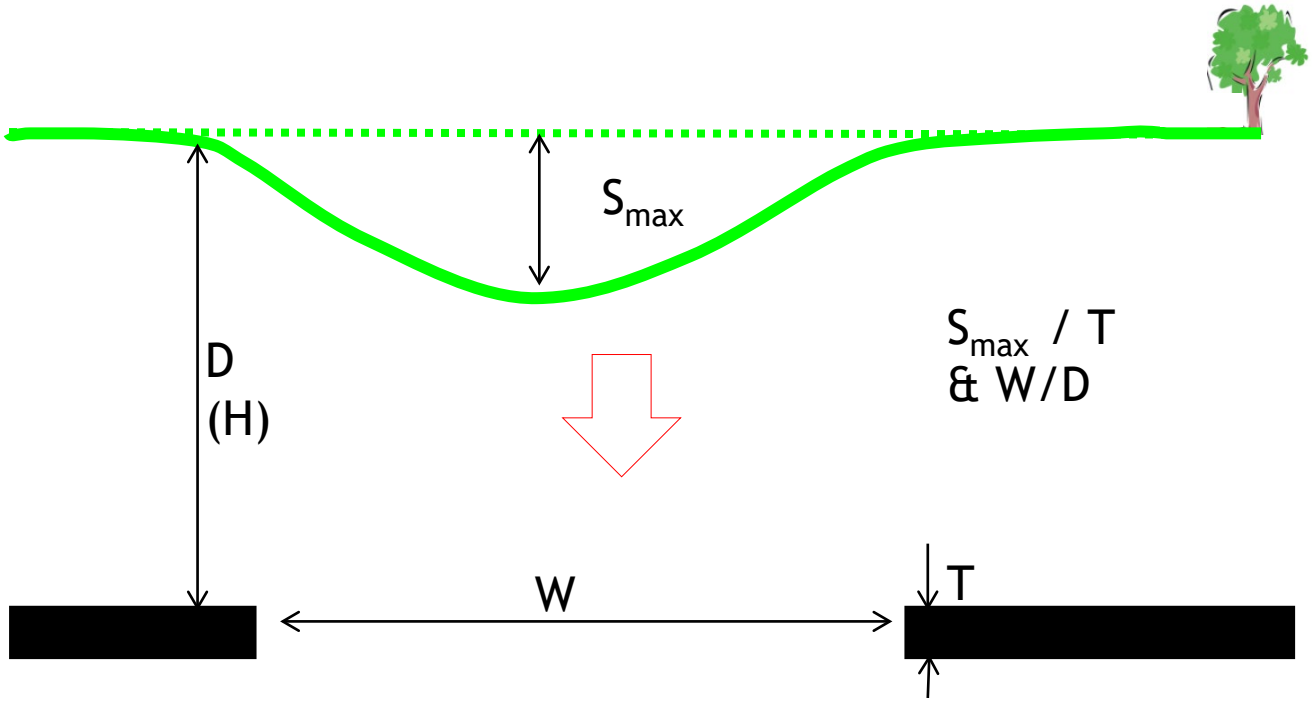
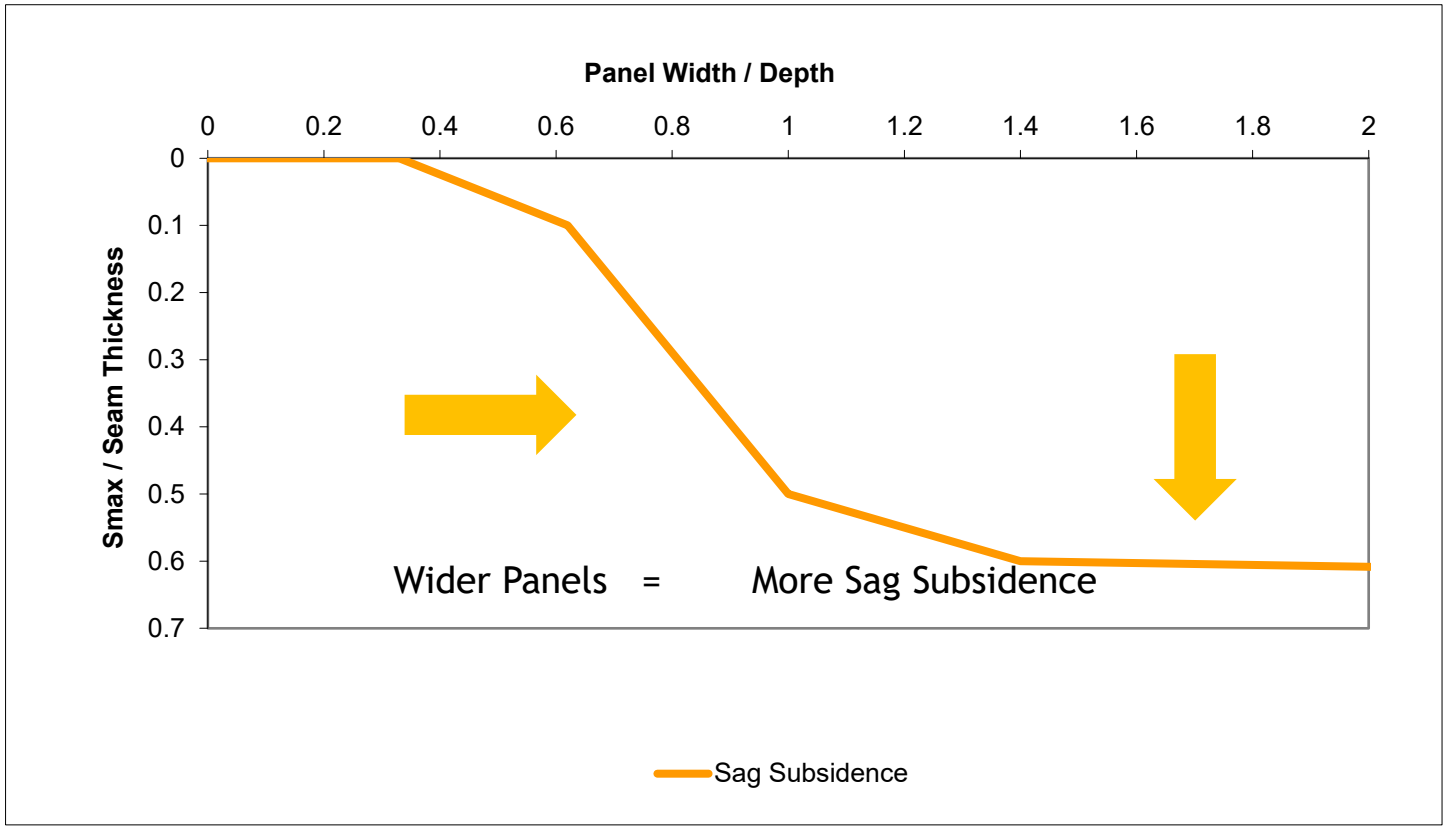


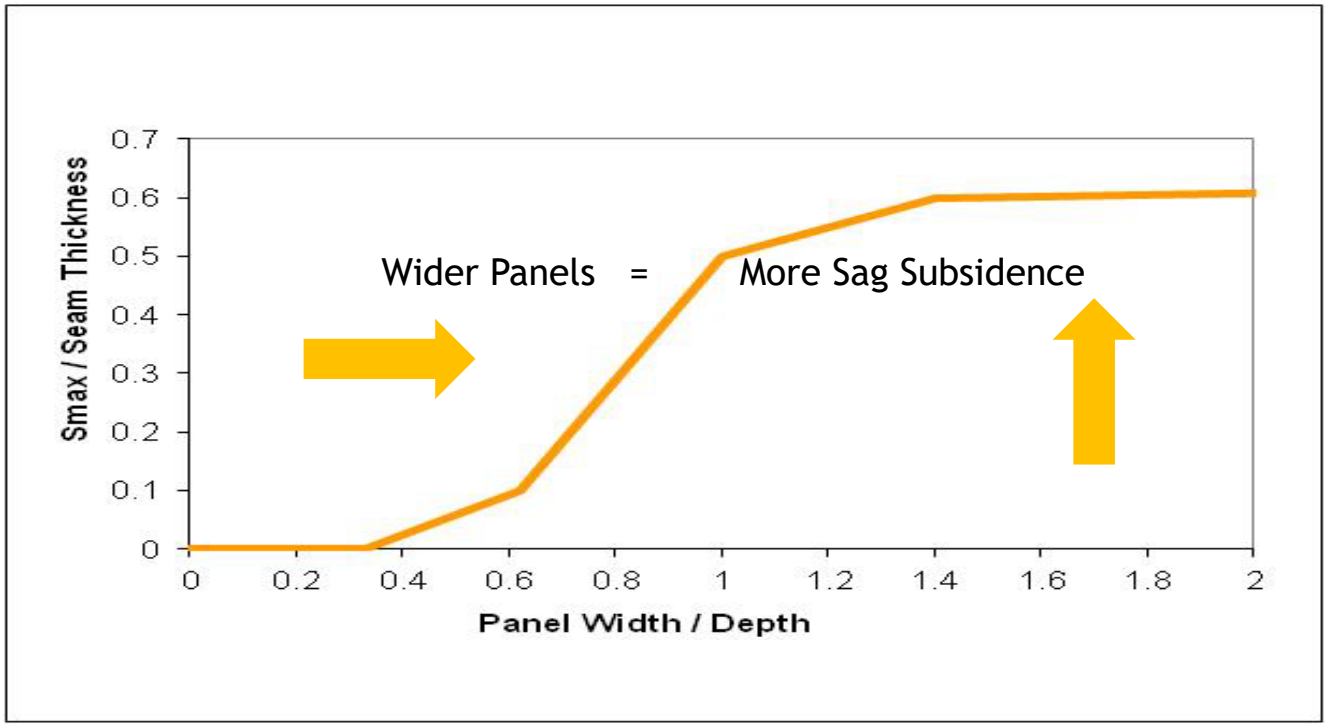

Downward Movement of Overburden Strata

# Sag Subsidence



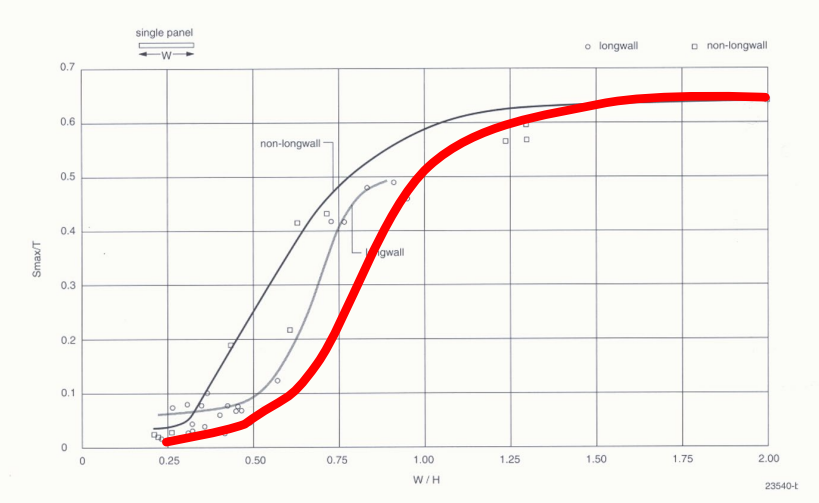

Influence of Panel Width on Sag Subsidence

# Sag Subsidence

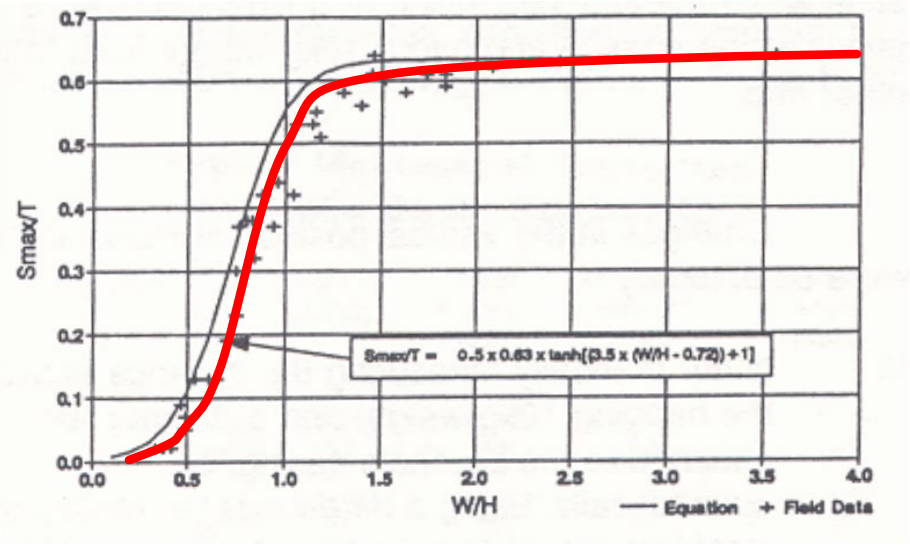



Influence of Panel Width on Sag Subsidence

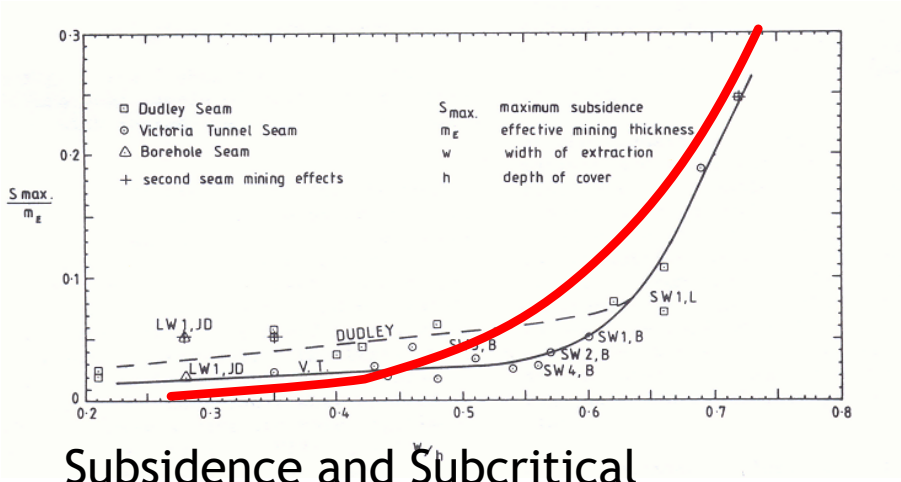
# Sag Subsidence




Relationship between W/H Ratio and Smax/T for Single Panels in the Southern Coalfield
*(after Holla and Barclay, 2000)*

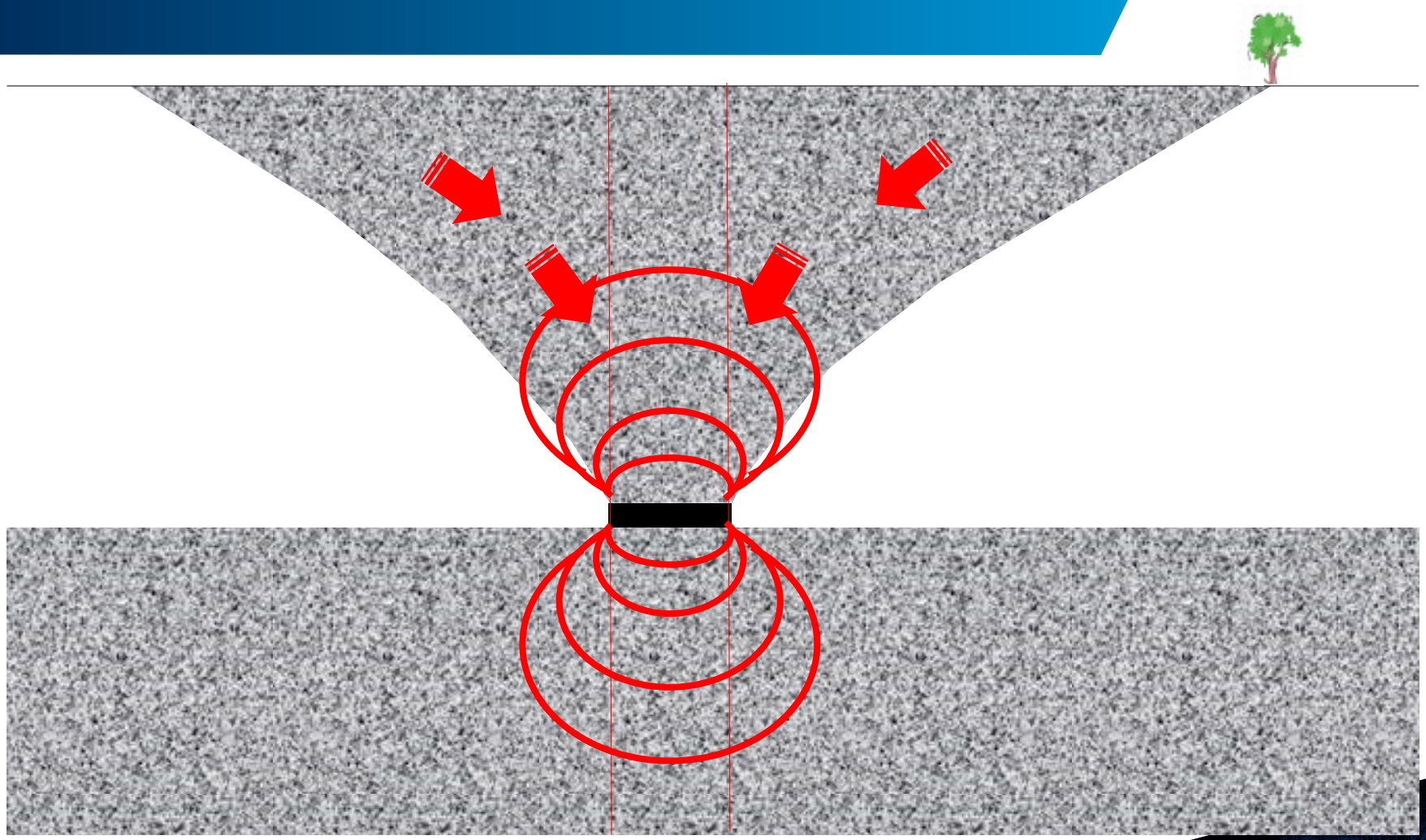


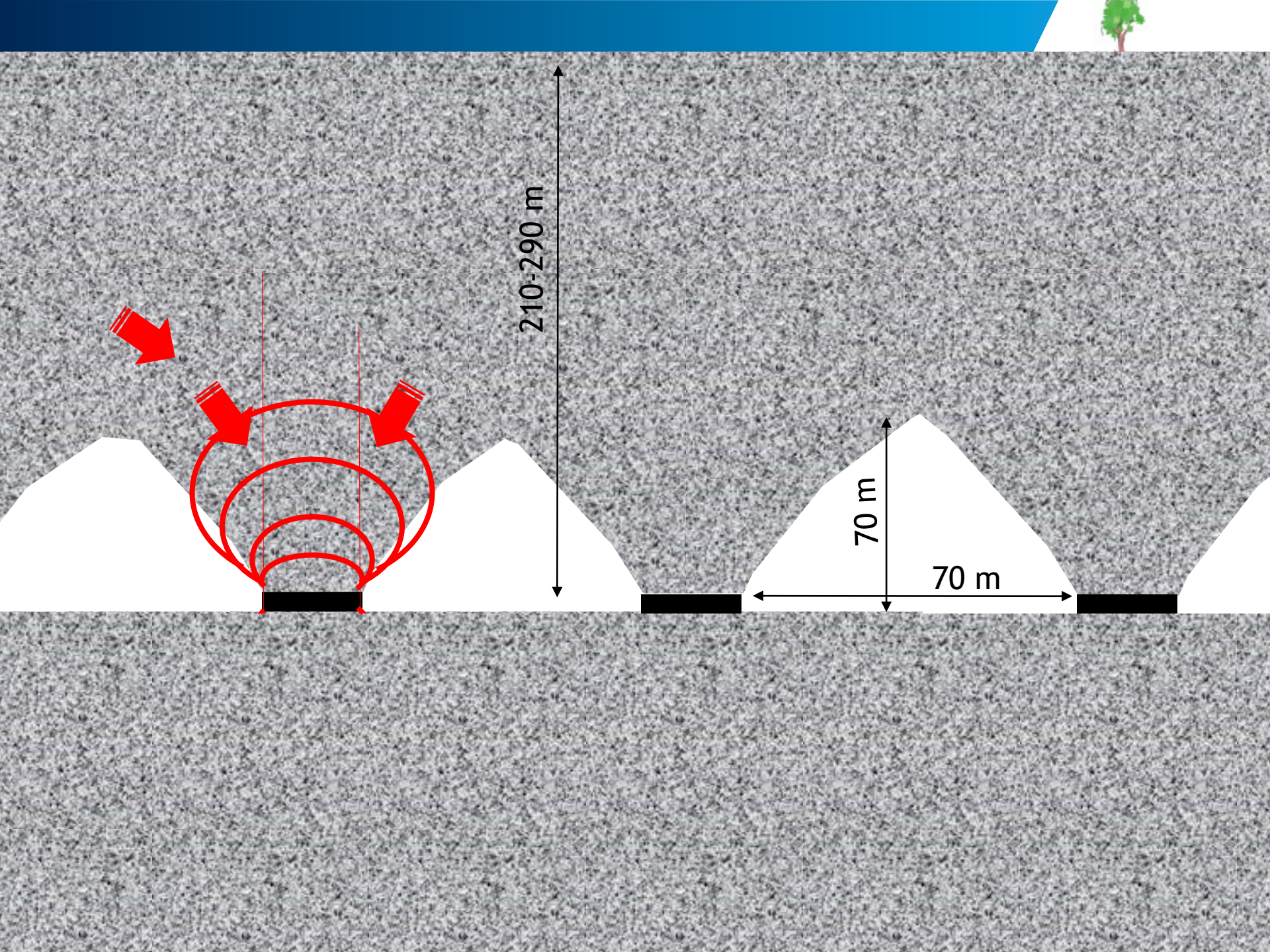

Plot of Smax/T versus W/H for the Collie Basin, WA
*(after Misich et al, 1992)*



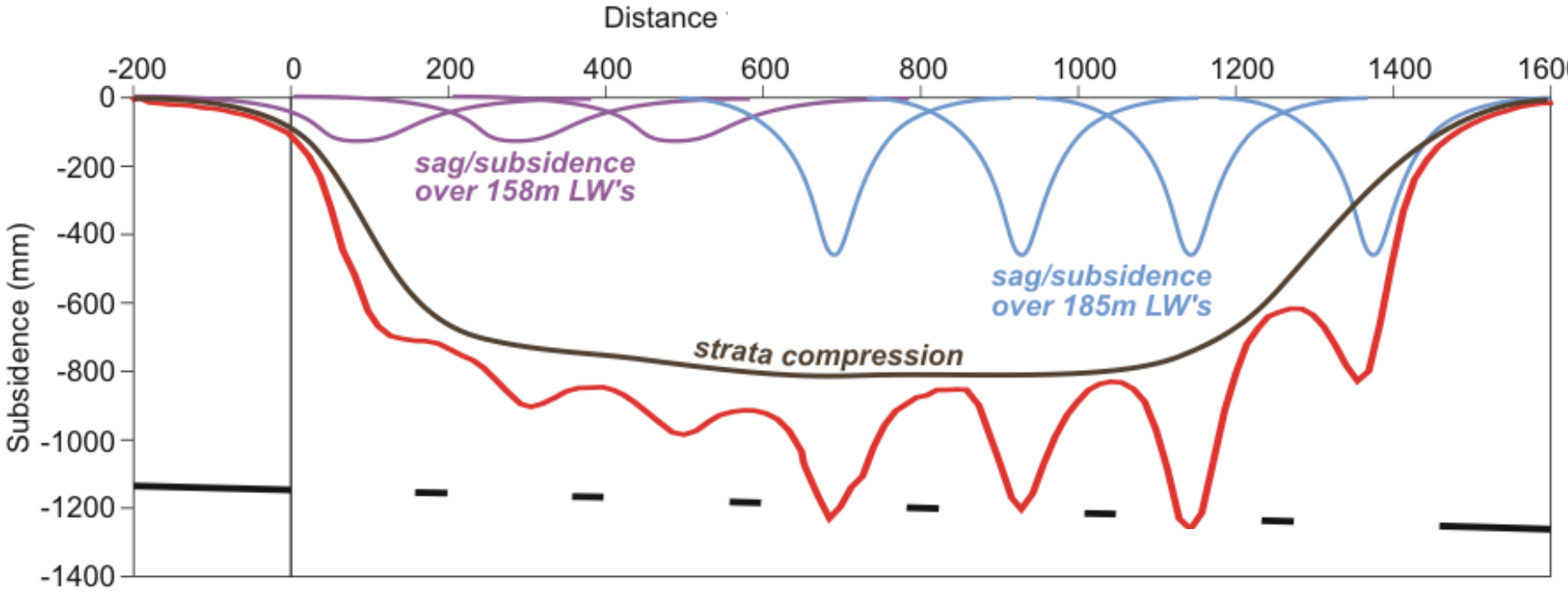

Subsidence and Subcritical Mine Geometry Newcastle
*(after Kapp, 1985)*

# Strata Compression Subsidence



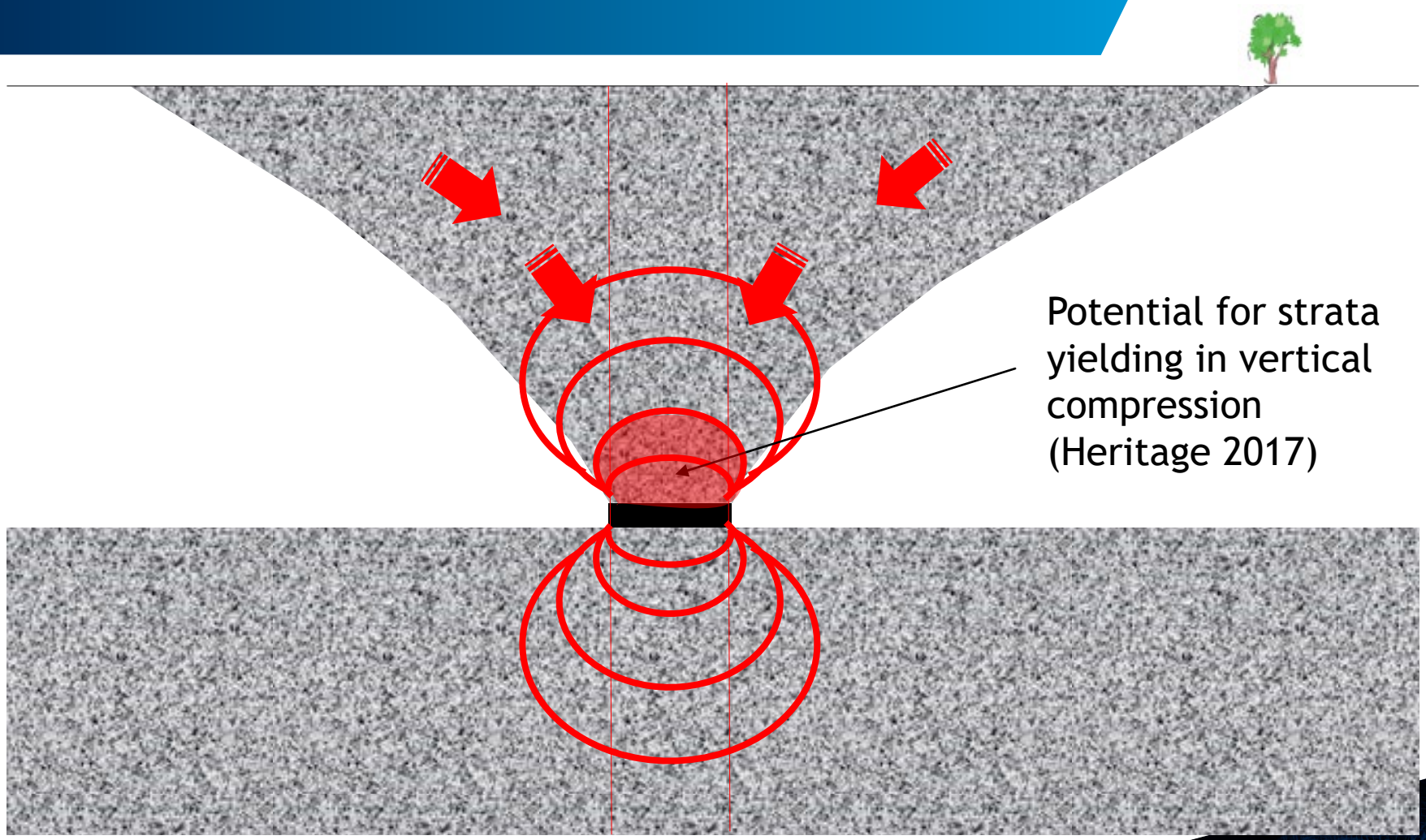

210-290 m
70 m
70 m

# Strata Compression Subsidence




Sag and Strata Compression Subsidence Combined

# Yielding of Pillar System



# Questions

1. Can the IEP explain their view on how an increase in narrow longwall width of 17.5% and an increase in extraction height to 3m can be considered to be 'substantially the same' as that approved under SSD5581.

Certainly. See explanation above. Most of the subsidence is due to pillar compression. The small increase due to sag is not significant.

2. What does the IEP think will be the actual subsidence for the proposed narrow longwall layout with a depth of cover (DOC) of 291m (given that this Depth of Cover has not been modelled or discussed in the MW17&18 documentation)?

The areas of higher overburden (280-290 m) are near the outbye end of the panels where effects of the staggered ends are expected to reduce subsidence.

3. What is the level of uncertainty (error) in DOC estimates in this area?

Not sure, but expect it to be less than ±5 m and of no consequence.

# Questions

4. SCT (2023) stated that a 60m barrier pillar at 260m DOC is approaching 13MPa of average pillar load with the potential for the onset of failure. Figure 3 of SCT (2023) suggests that a 70m pillar and 70.5m panel at 280m DOC is already very close to 13MPa (and therefore approaching the potential for the onset of failure). What is the IEP's predictions for pillar stability exceeding 13MPa if modelled depth of cover had been increased further to 285-291m?

Large pillars gain strength as they deform. Would need to discuss with SCT, but IEP does not expect pillars to become overloaded.

5. Why should NPWS/BCD not be concerned about faults and other geological structures (eg lineaments) given previous experiences in the western coalfields and the comments in MSEC (2023) in relation to faults/geological structures causing increased subsidence? [And why did the faults mapped through MW17 & 18 not receive any comment/assessment by the IEP].

The IEP don't consider faults/geological structures are likely to affect subsidence in this circumstance.

# Questions

6. Why should NPWS/BCD not be concerned about modelling extrapolating well outside the range of previous subsidence experience at Airly mine (which is all based on a panel width of 61m and height of extraction of 2.8m)?

The IEP don't believe it is well outside the range of experience at Airly. The numerical modelling provided by SCT (2023) gives insights into the mechanics of the processes and indicates small changes of no consequence.

The IEP is confident that at the low levels of subsidence that are credible for the geometry proposed that surface features and particularly the high cliffs are fully protected. Irrespective of any modelling, the IEP is confidence that the GNSS subsidence monitoring proposed will provide sufficiently accurate indications of ground movement for Centennial Airly to be able to maintain maximum subsidence less than 125 mm.

# Questions

7. Has the IEP seen any empirical measurements for the MW10 pillar which was supposed to have been instrumented prior to MW10 panel extraction? No.

8. If yes, do these measurements support the view that increased subsidence is primarily due to fracturing and shear failure above the pillars (and is entirely unrelated to the interaction of subsidence with faults/lineaments, as suggested by MSEC (2023))? N/A

9. Also, if yes, does the IEP think it appropriate to have none of this information discussed in the MW17&18 application (or be provided to NPWS/BCD) to enable any review/assessment of these empirical results? N/A

# Questions

10. What is the IEP's views on the SCT (2023) caveats that:

*If the mining height cannot be controlled due to spall, cavities, or operational variation then a reduction in mining height may be required. The modelling results presented above show that the subsidence is very sensitive to the mining height. Increasing the mining height from 2.8m to 3.0m resulted in an increase in the modelled subsidence of 12mm. Previous experience at Airly Mine over MW13 and MW14 resulted in the maximum vertical subsidence exceeding the model subsidence by 12mm to 15mm. Based on this experience, there may be an increased miniwall cut height from spall or operational variation contributing to additional subsidence.*

*No modelling had previously been conducted for panel widths greater than 60m*
*A 60m barrier pillar at 260m DOC is approaching 13MPa of average pillar load with the potential for the onset of failure.*

*A 60m barrier pillar would not be recommended at 70.5 void width.?*

The IEP would not use the term "very sensitive" but agrees that mining height has potential to increase subsidence. Monitoring of surface subsidence is expected to be suitable to confirm actual subsidence. Mining height may be one of the controls available to Centennial Airly to manage subsidence.

# Questions

11. What is the IEP's view on the adequacy of proposed subsidence monitoring where there are no GNSS units located above the narrow longwall panels or pillar in areas with the greatest depth of covers (270m-291m)?

The IEP believes the proposed subsidence monitoring is adequate but has no issue with additional GNSS units located in areas where the subsidence is predicted to be greatest at 270-291 m overburden depth.

8 June 2023

SCT OPERATIONS PTY LTD
www.sct.gs | ABN 23 078 328 953
WOLLONGONG OFFICE
PO Box 824 Wollongong NSW 2520 Australia
Telephone: +61 2 4222 2777 Email: contactus@sct.gs
BENDIGO | BRISBANE | NEW ZEALAND | CHINA

Jacqueline Cooke
Compliance Manager
Centennial Coal
Airly Mine
319 Glen Davis Road
Capertee NSW 2846

**AIRLY5612**

Dear Jacqueline

**MW17-18 PILLAR AND PANEL OPTIMISATION ASSESSMENT: INCREASING FROM 56M PANELS AND 50M PILLARS TO 70.5 PANELS AND 70M PILLARS**

Airly Mine requested SCT Operations Pty Ltd (SCT) to conduct a numerical modelling assessment of surface subsidence in the south-east Genowlan mining area, as an addendum work package to SCT letter report AIRLY5521_Rev1. The program of work was to determine an optimal miniwall panel width and pillar width scenario whilst keeping within subsidence limits.

Current Airly mining consent allows for a maximum subsidence of 125mm for the Genowlan mining area, which is interpreted to be 105mm (+/-20mm) when allowing for survey tolerance. Airly Mine have implemented a chosen upper design limit of 95mm (+/-20mm).

The AIRLY5521_Rev1 report indicated a maximum subsidence of 118mm (+/-20mm) for three adjacent 56m miniwall panels and two 50m barrier pillars, exceeding the allowable subsidence limit. As such, a more conservative miniwall design is to be implemented reducing the number of adjacent miniwall panels. The new proposed mining geometry to be optimised consists of two miniwall panels, MW17 and MW18.

The scope of work for this addendum study was to determine whether the extraction of MW17 and MW18 could be optimised with an increase in panel width and/or extraction height from the existing panel width and 2.8m extraction height. The following letter report presents the results of this assessment.

Figure 1 presents the conceptual mine layout for MW17-18, including depth of cover. A 260m depth model was used to represent the majority of the barrier pillar.

## 1. CONCLUSION

The numerical modelling assessment of the subsidence magnitudes for the extraction of MW17 and MW18 at Airly Mine indicate the panel geometry could be further optimised without exceeding the mining consent maximum subsidence limit of 125mm. To achieve a wider panel geometry, an increase in the barrier pillar size is also required to limit fracturing of the strata above the pillars.

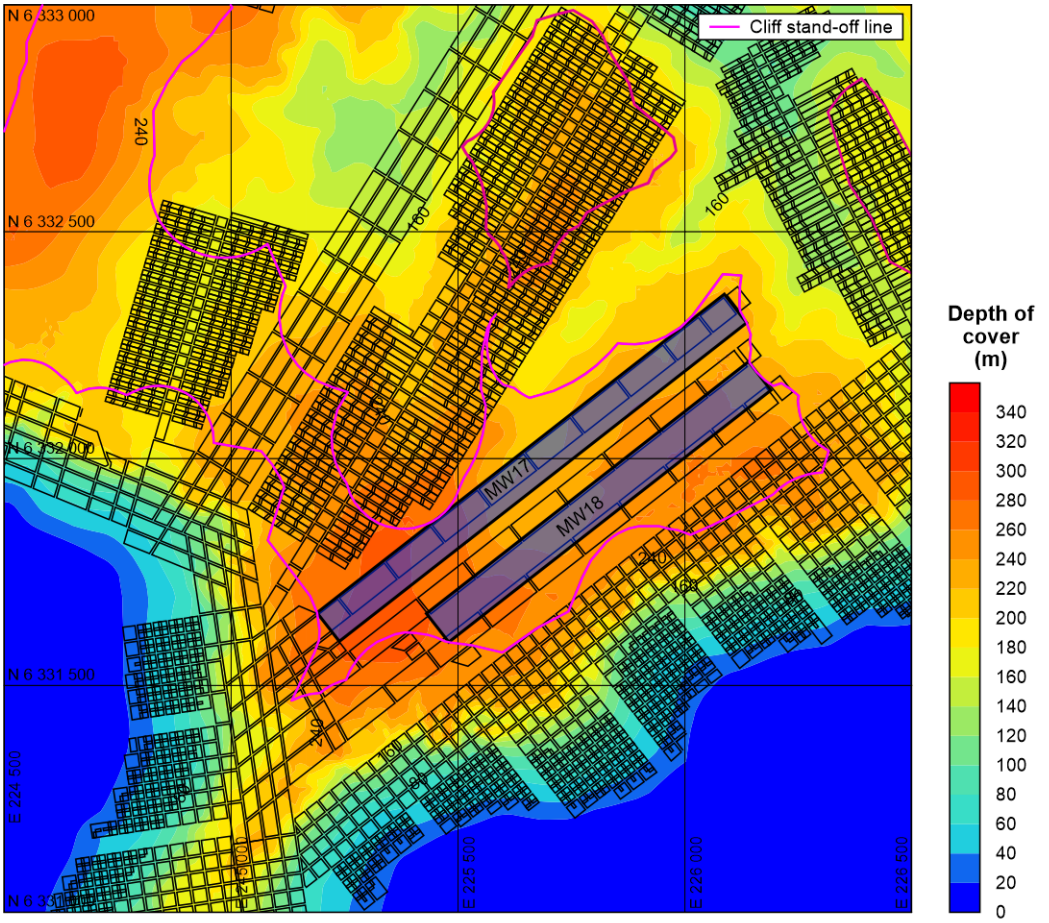



**Figure 1: Conceptual miniwall design including depth of cover to the seam.**

If the mining height can be adequately controlled, a planned geometry of a 70.5m panel void width with a 70m barrier pillar width and 3.0m extraction height will result in 88mm (+/-20mm) of surface subsidence. This is below the chosen upper design limit of 95mm (+/-20mm).

If the mining height cannot be controlled due to spall, cavities, or operational variation then a reduction in mining height may be required. A panel void width of 70.5m with a 70.0m wide barrier pillar and 2.8m extraction height resulted in 76mm (+/-20mm) of surface subsidence.

A mining height of 3.2m was also modelled for subsidence sensitivity with a panel void width of 70.5m and a 70.0m wide barrier pillar. This resulted in 95mm (+/-20mm) of surface subsidence. A mining height of 3.2m would not be recommended for MW17 and MW18 as it would likely exceed the chosen upper design limit of 95mm (+/-20mm).

The modelling results presented above show that the subsidence is very sensitive to the mining height. Increasing the mining height from 2.8m to 3.0m resulted in an increase in the modelled subsidence of 12mm. Previous experience at Airly Mine over MW13 and MW14 resulted in the maximum vertical subsidence exceeding the model subsidence by 12mm to 15mm. Based on this experience, there may be an increased miniwall cut height from spall or operational variation contributing to additional subsidence.

The potential for additional surface subsidence from adjacent first workings was also considered with 29m square pillars included in the model. The first workings added less than 5mm to the maximum subsidence for the 2.8m and 3.0m mining height models. As such, 5mm of additional subsidence should be added for when adjacent first workings are planned. The adjacent first workings in the 3.2m mining height model resulted in an additional 15mm of subsidence, with a total 115mm (+/-20mm).

The numerical modelling assessment also simulated 81.0m panel void widths with a 70.0m wide barrier pillar, however the resulting subsidence was above the chosen design limit of 95mm (+/-20mm) for both a 2.8m and 3.0m mining height and would not be recommended.

An increased mining height in the development headings can also result in increasing the predicted maximum subsidence. The subsidence can increase through either increased pillar compression or the roadway height migrating across the miniwall face through spall. Therefore, the roadway mining height may be more representative of the expected maximum subsidence. That is, if the roadway is mined at 3.0m and the miniwall is planned at 2.8m, a 3.0m mining height should be used for the subsidence assessment.

The modelling assessment used an existing numerical model, from previous Airly Mine subsidence assessments, calibrated for predictive purposes at Airly Mine. This model has been used in subsidence assessments for Mt Airly and Mt Genowlan, including a pillar width modelling assessment for the Point Hatteras Mining Area and South East Genowlan mining area.

## 2. SCOPE AND DELIVERABLES

A scope of work was provided by Centennial via email on the 4 April 2023. The scope included the requirement to conduct an addendum work package on the AIRLY5521_Rev1 report involving the south-east Genowlan (MW17-19) pillar width numerical modelling assessment.

The surface subsidence magnitude provided in AIRLY5521_Rev1 report was 118mm (+/-20mm) for the then proposed mine layout in the south-east Genowlan mining area of 3 x 56m voids and 2 x 50m pillars (MW17-19). This subsidence magnitude therefore exceeded the 125mm of subsidence as outlined in the mining consent.

Previous SCT work presented in report AIRLY5265 showed modelled subsidence results for various pillar width combinations (Figure 2) and resulted in the plan to reduce the number of adjacent miniwall panels to two. This was based on a chosen upper design limit of 95mm (+/-20mm) of surface subsidence.

No modelling had previously been conducted for panel widths greater than 60m so a multistage work program including empirical pillar load calculations, back analysis of existing modelling data and the refinement of new numerical models was proposed. The proposed work program included.

1. Use existing model results to determine the minimum required pillar width for 2 x 60m miniwall void widths.

2. Use an empirical abutment load methodology and back analysis of existing models to estimate pillar size requirements for 2 x 70.5m and 2 x 80m miniwall void widths.

3. Handover of initial results before modelling.

4. Use existing base model to run additional models to confirm the estimated pillar sizes for 70.5m and 80m void widths. Models to include:

    a. 2 x 70.5m wide miniwalls with estimated pillar width

    b. 2 x 80m wide miniwalls with estimated pillar width

    c. Additional first workings extracted on both sides of the miniwalls in the above two model scenarios.

5. Handover of numerical model results.

6. Letter report.

## 3. DESIGN ASSESSMENT

Back analysis of previous Airly numerical models and the use of empirical abutment load methodology was applied to refine the pillar size requirements for both a 70.5m and 80m miniwall void width. This assessment was also conducted to determine the required numerical model geometry for the surface subsidence assessment.

Figure 3 shows the average pillar load for varying pillar widths for 280m and 260m depth of cover (DOC). The 280m DOC was interrogated as this was the DOC for the existing Airly numerical model data. A DOC of 260m was also investigated as it represents most of the barrier pillar.

The initial high-level analysis suggested there was potential for a wider panel width by increasing the pillar width. Figure 3 shows for 260m DOC, a void width of both 70.5m and 81.0m with a 70m barrier pillar was feasible, based on the design criteria of limiting fracturing of the strata above the pillar.

A 60m barrier pillar at 260m DOC is approaching 13MPa of average pillar load with the potential for the onset of failure. A 60m barrier pillar would not be recommended at 70.5 void widths.

From the design assessment a refined modelling matrix for further analyses was determined and included.

- 70.5m wide panel, 70m wide pillar
    - 2.8m extraction height
    - 3.0m extraction height
    - 3.2m extraction height (modelled for subsidence sensitivity)
- 80.0m wide panel, 70m wide pillar
    - 2.8m extraction height
    - 3.0m extraction height

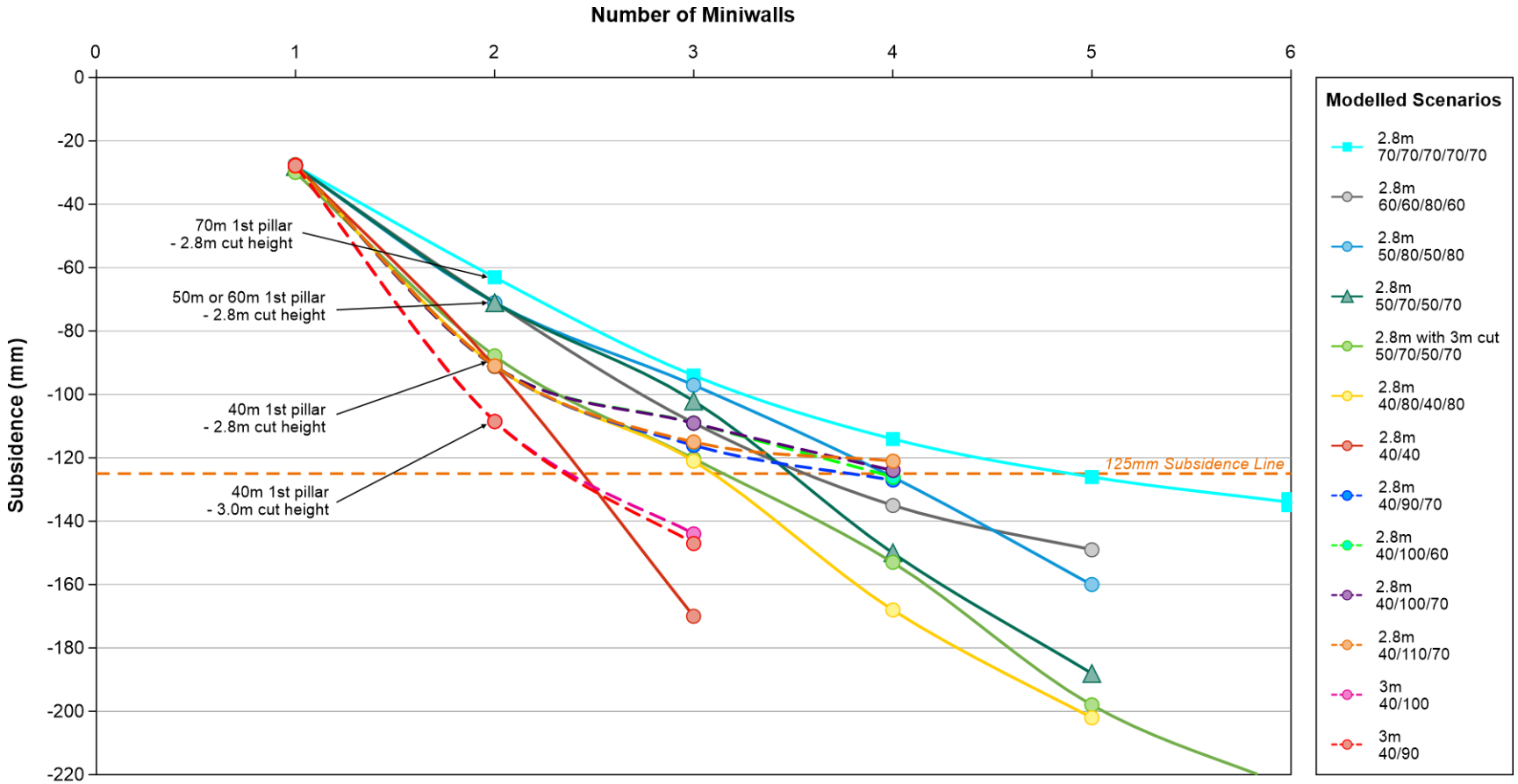



**Figure 2: Modelled subsidence results for various pillar width combinations (from SCT report Airly5262).**

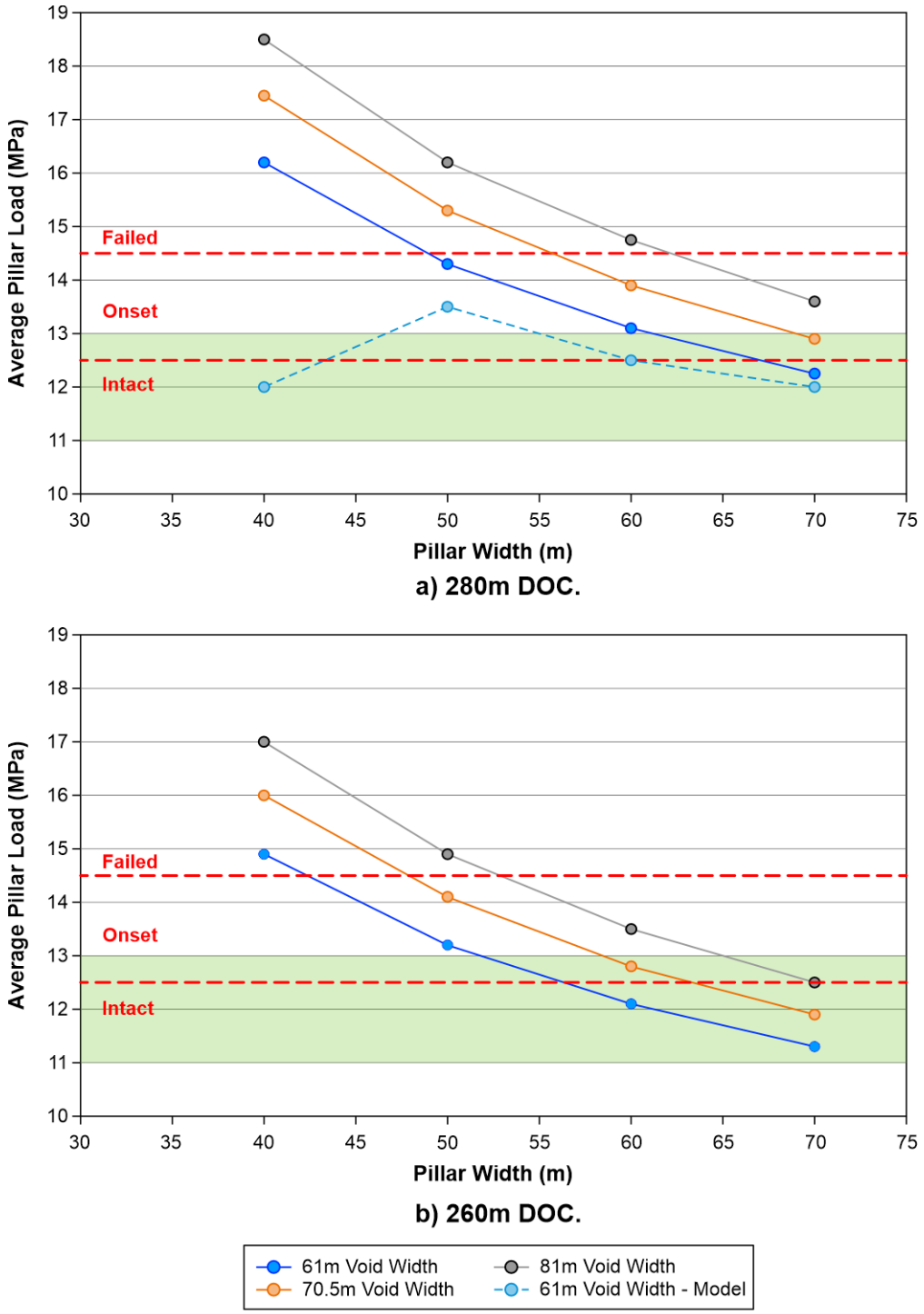



**Figure 3: Average pillar load for varying pillar widths at 280m DOC and 260m DOC.**

## 4. NUMERICAL MODELLING ASSESSMENT

This modelling assessment used the existing model parameters from the south-east Genowlan subsidence assessment (AIRLY5521_Rev1, 2022). This model was derived from earlier work (SCT 2022, 2021a and 2021b) which identified the mechanism for increased subsidence in the Mt Airly mining area to be fracturing of the strata above the pillars. The general geology was evaluated to be similar between the south-east Genowlan mining area and the Point Hatteras and Mt Airly mining areas. The depth of cover ranges from 240m to 280m for the south-east Genowlan mining area with a DOC of 260m determined to be representative for most of the barrier pillar.

The mode of rock failure following each miniwall extraction (MW17-MW18) and first workings is presented in Figure 4 for the 70.5m panel, 70m pillar and 2.8m extraction height. There is little rock failure observed in the strata above the pillar following the extraction of MW17, MW18 and the adjacent first workings, indicating elastic pillar compression. This is lower risk of increased subsidence where there is no failure above the pillar, and small variations in rock properties and stress are not likely to create significant failure above the pillar.

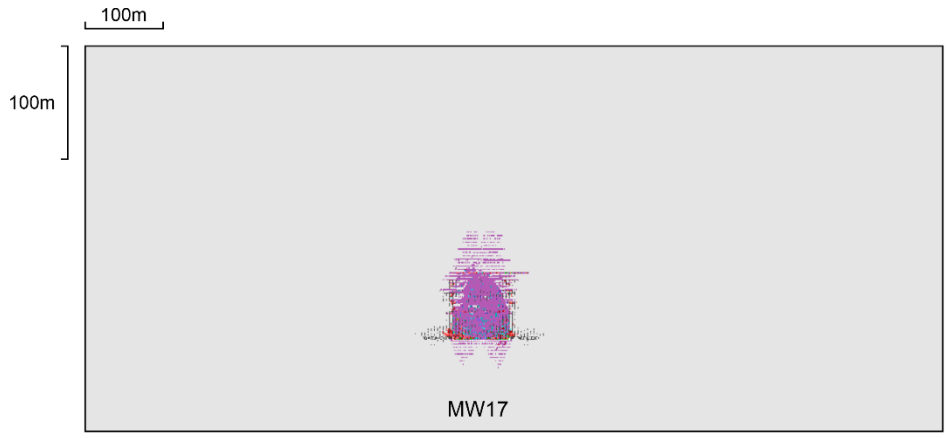
The mode of rock failure and shear strain for the 70.5m wide panel and 70m wide pillar at each extraction height is presented in Figure 5. Both the 2.8m and 3.0m extraction height indicate little to no rock failure of strata above the pillars. A caving height of 80 to 90m is reached above the miniwall.

The modelled rock failure above the pillar for the 3.2m extraction height is primarily shear failure of intact rock and pre-existing joint or cleat shear reactivation but is not extensive through the strata. The caving height has increased to 100 to 110m above the miniwall. The risk of increased subsidence for this mining geometry is slightly heightened with the modelled onset of shear failure above the pillar, causing softening of the strata. The onset of shear failure highlights that the strata above the pillar is at higher risk of increased subsidence. Slight variability in rock properties between the model and reality may vary the rock failure and subsidence outputs.

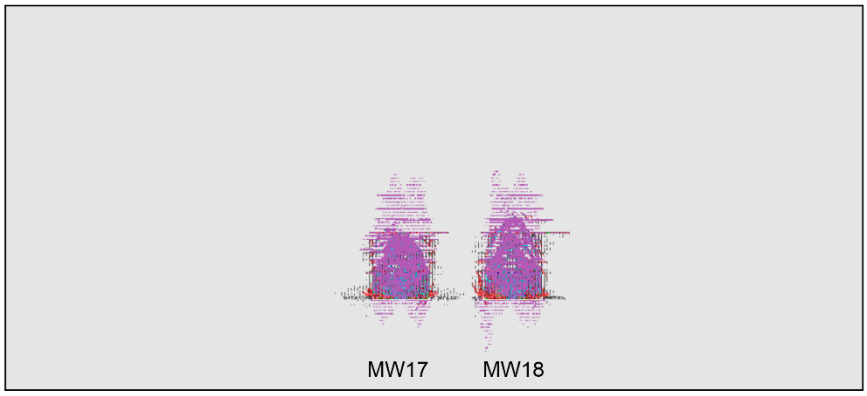
## 5. SUBSIDENCE ASSESSMENT

The modelled surface subsidence is presented in Figure 6a following the extraction of MW17-18. Figure 6b presents the maximum surface subsidence with a 20mm tolerance applied. The mining consent subsidence limit of 125mm and the Airly Mine chosen subsidence design limit of 95mm is also plotted.

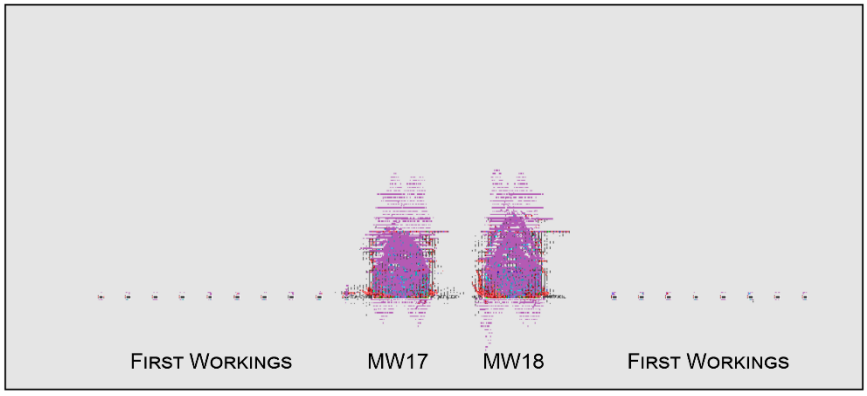
Subsidence magnitude estimates are presented in Table 1 following the extraction of each of the two miniwalls and adjacent first workings. Geometries highlighted in green achieve a maximum surface subsidence less than the chosen upper design limit of 95mm (+/-20mm). Geometries highlighted in red exceed the subsidence upper design limit of 95mm (+/-20mm).




**a) MW17.**




**b) MW17 and MW18.**




**c) First workings, MW17 & MW18.**

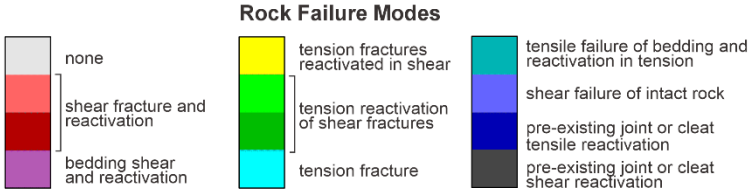



**Figure 4: Mode of rock failure following for the 70.5m wide panel, 70m wide pillar and 2.8m extraction height.**

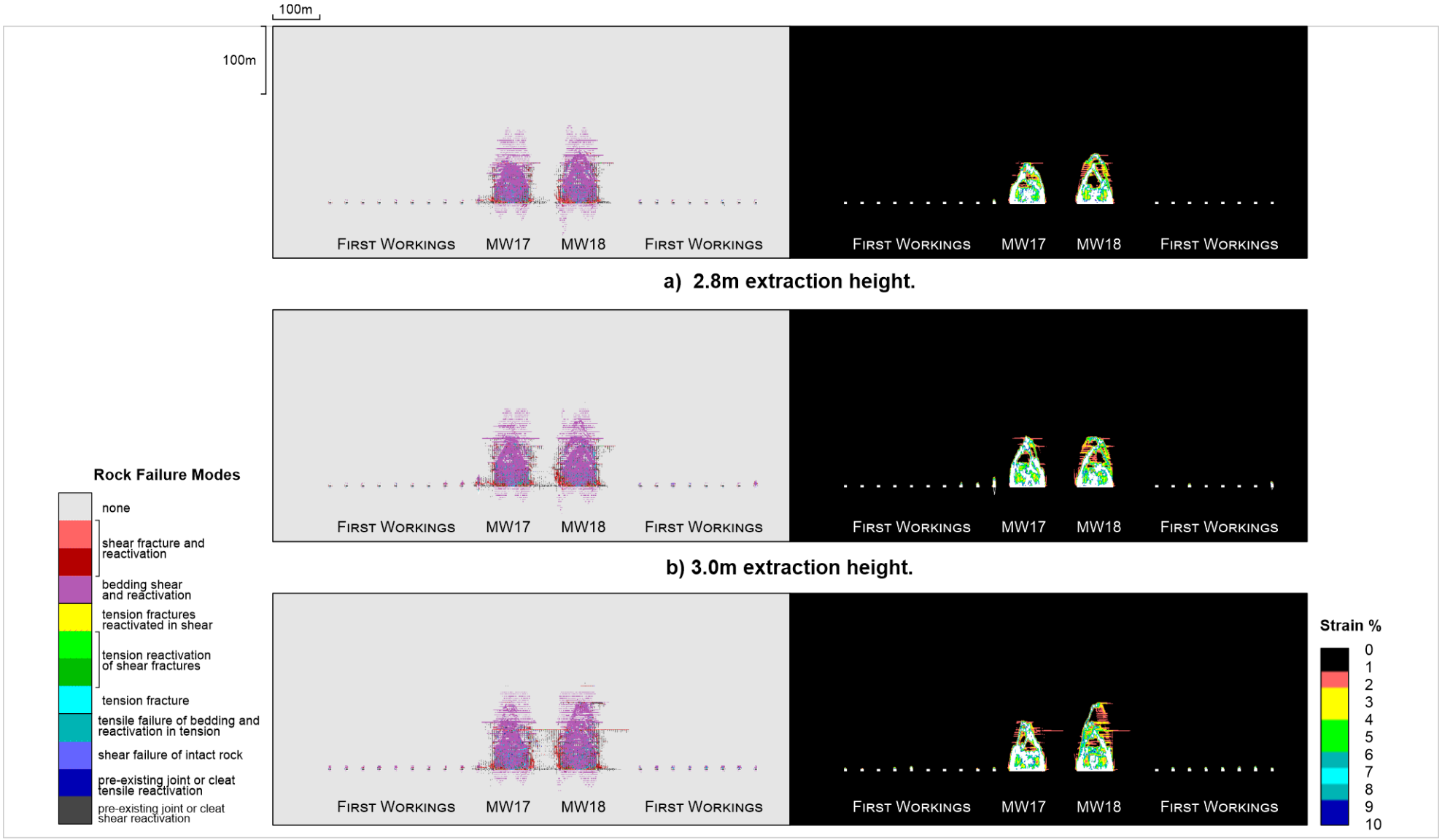
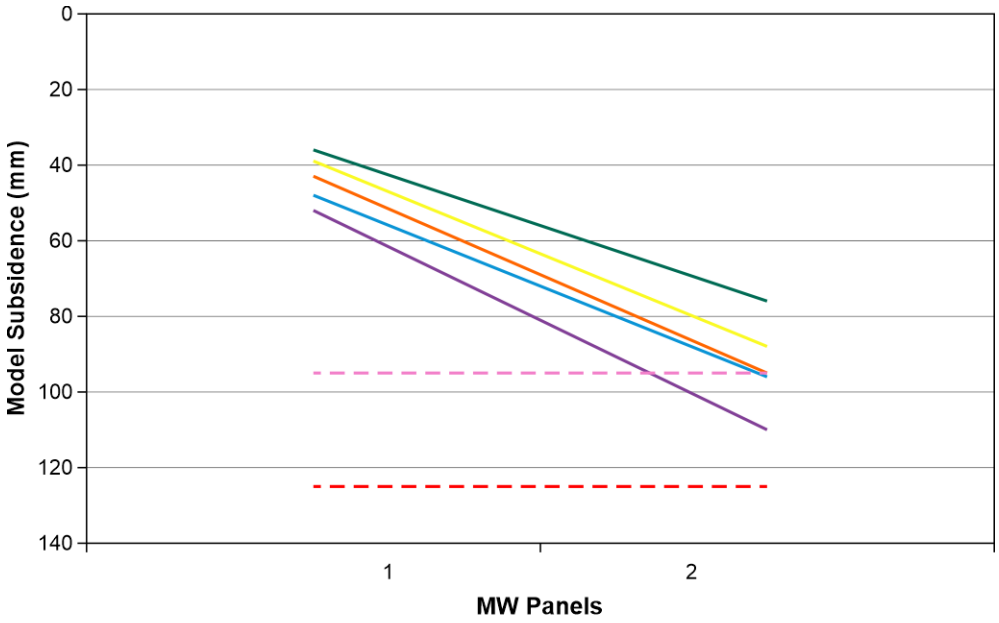
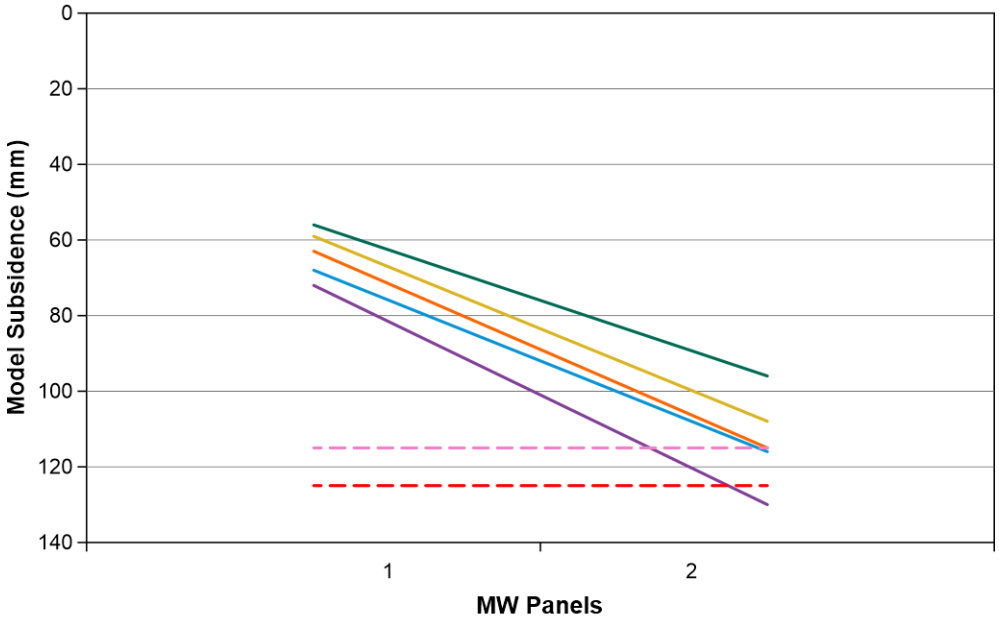



**Figure 5: Mode of rock failure and shear strain for the 70.5m wide panel and 70m wide pillar at each extraction height.**




a) Maximum Modelled Subsidence.




b) Maximum Subsidence with 20mm Tolerance.

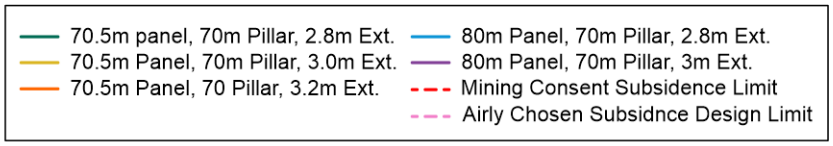



**Figure 6: Modelled surface subsidence following MW17 and MW18 extraction showing maximum modelled subsidence and maximum subsidence with 20mm tolerance.**

**Table 1. Maximum subsidence magnitude estimates based on modelling**

| Depth | Panel Width (m) | Pillar Width (m) | Ext. Height(m) | Subsidence (mm) | | | |
|---|---|---|---|---|---|---|---|
| | | | | 1 Panel | 2 Panels | +20mm Tolerance | Max Subs. (+20mm Toll. & First Workings) |
| 280 | 61.0 | 70 | 2.8 | | 63 | | 83 |
| 260 | 70.5 | 70 | 2.8 | 36 | 76 | 96 | 101 |
| 260 | 70.5 | 70 | 3.0 | 39 | 88 | 108 | 113 |
| 260 | 70.5 | 70 | 3.2 | 43 | 95 | 115 | 125 |
| 260 | 80.0 | 70 | 2.8 | 48 | 96 | 116 | N/A |
| 260 | 80.0 | 70 | 3.0 | 52 | 110 | 130 | N/A |

The modelled surface subsidence profiles are presented in Figure 7 following the extraction of MW17 and MW18 for the 70.5m panel width. The results for each extraction height have been plotted along with the chosen design limit of 95mm, and the mining consent subsidence limit of 125mm. Maximum vertical subsidence is achieved over the barrier pillar, with a slight offset towards MW18. The subsidence lines plotted do not include the +/-20mm survey tolerance.

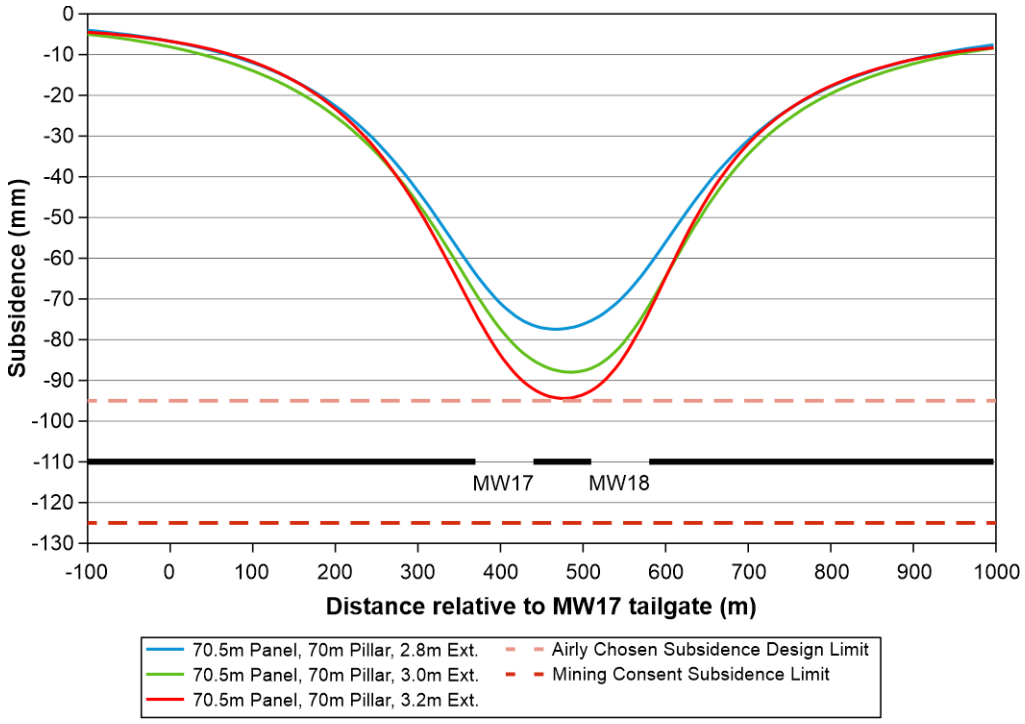



**Figure 7: Modelled surface subsidence profile following MW17 and MW18 extraction, ±20mm subsidence tolerance/natural variability should be applied to these results.**

The potential for additional surface subsidence from adjacent first workings was also considered with 29m square pillars included in the model. The first workings added less than 5mm to the maximum subsidence for the 2.8m and 3.0m mining height models. As such, 5mm of additional subsidence should be added for when adjacent first workings are planned. The adjacent first workings in the 3.2m mining height model resulted in an additional 15mm of subsidence, with a total 115mm (+/-20mm).

Yours sincerely

Adrian Rippon
Principal Geotechnical Engineer

## 6. REFERENCES


SCT 2021a. Subsidence and Pillar Geometry Modelling Assessment. SCT Report AIRLY5240, dated 20 January 2021.

SCT 2021b. Airly Mine Subsidence and Pillar Width Modelling Assessment. SCT Report AIRLY5265_Rev1, dated 18 August 2021.

SCT 2022. Assessment of subsidence for Point Hatteras pillar width redesign in relation to cliff standoff requirements. SCT Report AIRLY5368, dated 15 February 2022.

SCT 2022. South East Genowlan (MW17-19) Pillar and Panel Width Numerical Modelling Assessment. SCT Letter Report AIRLY5521_Rev1, dated 19 December 2022.

mine subsidence ENGINEERING CONSULTANTS

Centennial Coal:

# Airly Colliery – MWs17 and MW18

Subsidence Predictions and Impact Assessments for the Natural and Built Features over and near the proposed MWs 17 to 18 in support of the Extraction Plan Application

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## DOCUMENT REGISTER

| Revision | Description | Author | Checker | Date |
|---|---|---|---|---|
| 01 | Initial issue | DK | | 23-Jun-23 |
| A | Final issue | DK | | 3-Jul-23 |
| B | Amended final issue | DK | | 22-Aug-23 |
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Report produced to: Support an Airly Colliery submission of the MWs 17 & 18 Extraction Plan Application to the Department of Planning and Environment.

Background reports available at *www.minesubsidence.com*[1]:

Introduction to Longwall Mining and Subsidence (Revision A)

General Discussion of Mine Subsidence Ground Movements (Revision A)

Previous MSEC cliff impact assessment reports that supported previous Airly applications;

MSEC Report Number MSEC1185, July 2021, pages 110-124, *Airly Colliery – Cliff Impact Assessment Report - Due to proposed extraction of Miniwalls 11 and 12 in support of the Extraction Plan Application*, which included an Appendix A, **C**hronological literature review of effect of faults on subsidence and subsidence profiles.

MSEC Report Number MSEC1195, Oct 2021, pages 177-192, *Airly Colliery – MW13 to MW16 - Subsidence Predictions and Impact Assessments for the Natural and Built Features over and near the proposed MWs 13 to 16 in support of the Extraction Plan Application*, which included an Appendix G, **C**hronological literature review of known coal mining induced cliff falls.

[1] Direct link: http://www.minesubsidence.com/index_files/page0004.htm

Airly Mine (Airly) is an existing underground coal mine that is located 5 kilometres (km) north-east of the village of Capertee, 40 km north-northwest of Lithgow and 171 km north-west of Sydney. Centennial Airly Pty Limited (CA) is the operator of Airly and CA is a wholly owned subsidiary of Centennial Coal Company Limited. Airly has completed extracting Mini Wall 15A (MW15A) under the Point Hatteras area of Genowlan Mountain.

This report provides subsidence impact assessments due to the proposed extraction of the proposed mini wall panels MWs 17 & 18 (MWs 17 & 18) under the south-eastern area of Genowlan Mountain to support an Extraction Plan Application that CA will be submitting to the Department of Planning and Environment.

Initially CA tried to fit three narrow panels within the available space between the high escarpment cliffs in this south-eastern area of Genowlan Mountain, but after slightly higher than expected subsidence was measured after the extraction of MW14, it was decided to only extract two panels within this available space.

The dimensions of the proposed panel chain pillars between MWs 17 & 18 have increased considerably from the pillars that were detailed in the 2014 Environmental Impact Statement (EIS). Compared to the EIS mine layout design, the proposed width of the chain pillars between MWs 17 & 18 need to be increased from 29.5 m to 70 m, the panel void widths can be increased from 61 m to 70.5 m, and the seam thickness or height to be extracted can be increased from 2.8 m to 3.0 m.

The predicted subsidence effects for the proposed MWs 17 & 18 have been provided by Strata Control Technology (SCT) after detailed modelling using a FLAC model that was initially calibrated for the local conditions against the measured subsidence data over MWs 02 to 07. SCT have predicted in their June 2023 prediction report, SCT AIRLY5612, that the maximum vertical subsidence over the proposed narrower MWs 17 & 18 panels and wider pillars is 88 mm. These subsidence predictions by SCT from this FLAC model have been supported by the monitored incremental subsidence results over MWs 11 to 12 under Mount Airly and the monitored results over MWs 13 to 15A under Genowlan Mountain. At these low predicted subsidence ground movements, it is unlikely that the external and internal cliffs and pagoda formations that are located over and near MWs 17 & 18 will be adversely impacted by the proposed extraction of MWs 17 & 18.

***Background to MWs 17 & 18 Study***

The surface areas over Airly are characterised by steep and rugged topography with large areas of cliffs, minor cliffs, pagodas and significant rock outcrops. The surface areas around Airly is dominated by Mount Airly and Genowlan Mountain that are two large mesas that sit broadly within the landscape of the Capertee Valley.

The Capertee Valley, which measures over 30 km from north to south and east to west, is surrounded by sandstone cliffs and steep talus slopes that are similar to those found on Mount Airly and Genowlan Mountain. Both Mount Airly and Genowlan Mountain are clearly visible for tens of kilometres in all directions.

The surface topography on the top of these two mesas varies from gently undulating to steep sided valleys, major cliff lines, pagodas and gorges. Most of the surface areas over Airly are located within the Mugii Murrum-ban State Conservation Area (MMSCA) that has significant natural and cultural heritage values and contains significant mineral resources. The MMSCA was gazetted in 2011 to protect environmental and cultural heritage values while permitting mining and exploration.

The Lithgow Seam, the target coal seam, outcrops on the talus slopes around these two mesas. Airly first gained development approval to extract longwall panels beneath Mount Airly and Genowlan Mountain with up to 1.8 m of subsidence in 1993, however only headings and accessways were developed until 2019, i.e., no panels were mined. As detailed in 2014 in the Airly Mine Extension Project Environmental Impact Statement (EIS), CA developed a more conservative approach to mining throughout the lease which employed different mining methods for different areas, each targeted to suit the specific area, referred to as ‘mining zones’. The EIS report, the design of the mine layout and the initial subsidence predictions were all prepared by Golder Associates in 2014.

A key objective of this ‘zoned’ approach was to minimise the risk of impacts to the external cliff lines through appropriate mine design to minimise subsidence. The sensitive external cliffs and high escarpments that are located on the external parts of the Mount Airly and Genowlan Mountain mesas were protected by a barrier called the Cliff Line Zone of First Workings (CLZ) within which no secondary extraction was planned, and no impacts were anticipated from the planned first workings and main access headings within the CLZ as the pillars were designed to be long term stable.

Additionally, the proposed partial extraction ‘zone’ in the centre of the mesas, called the Panel and Pillar Mining Zone (PPMZ), was designed to not cause impacts to the external cliffs and escarpments since the panels were designed with very narrow panels and very wide stable pillars to result in very low levels of subsidence over this zone and since the nearest edges of the proposed mini walls within this PPMZ were located well back and away from the top or back of these external escarpments. With the low levels of subsidence over this PPMZ, only low levels of subsidence impacts were expected within this PPMZ.

The 2014 Airly EIS mine layout design was principally based on the observation that the Centennial Clarence Mine had, for over twenty years, successfully extracted similar narrow panels with stable wide pillars at similar depths of cover that resulted in very low monitored subsidence ground movements of less than 100 mm under similar high cliffs and pagodas to those at Airly with no adverse mining induced impacts. The EIS acknowledged that the seam mined at Clarence, the top Katoomba Seam, is not the target seam at Airly, but appropriate mining methods were planned to suit its geotechnical environment.

The Airly EIS advised that the Clarence Colliery design criteria was to limit subsidence to within the elastic overburden displacement behaviour of 100 mm ± 25 mm in order to result in no caving to surface, no surface cracking and, no impacts to cliff lines, pagodas, and other natural features. The Airly EIS then suggested that vertical subsidence should be limited at Airly to 100 mm, but it should not exceed 125 mm. This EIS predicted that the maximum subsidence over of the mine, with 2.8 m seam extraction from 61 m wide mini panels and 29.5 m wide chain pillars, would be less than 100 mm, while tilts would be less than 2.5 mm/m and strains would be less than 2 mm/m.

In 2016, the Department of Planning and Environment commissioned an Independent Review Panel (IRP) to review and report on the accuracy and reliability of the mine subsidence impacts presented in the 2014 EIS. The IRP advised in its July 2016 report that the various proposed partial mining systems were considered conservative by comparisons with industry standards, and these could be expected to result in low levels of surface subsidence movements, especially with proper management and high confidence monitoring. In December 2016, Airly was granted approval to extend its operations for another 20 years and this approval included the extraction of mini walls within a PPMZ with consent conditions limiting the maximum subsidence limit to 125 mm within the PPMZ zones of the Mount Airly and Genowlan Mountain mesas that were located away from the escarpments and external cliffs.

Initially CA mined the access headings around the Mount Airly PPMZ and then, in June 2019, CA commenced extracting the mini walls within the PPMZ of Mount Airly. The early mini walls were located with their nearest edges being located further than 26.5° angle of draw (AoD) from the top of the external major cliffs and escarpments. CA had hoped that, after the initial PPMZ mining proved successful, the future MW extraction might be approved closer to external cliff lines as the average measured AoD to 20 mm at the Clarence Mine was only 8°. But, so far, all the Airly MW panels have been extracted with the nearest edge more than 26.5° AoD from the external cliffs.

Unfortunately, the measured subsidence over the early Airly panels exceeded the expected maximum subsidence levels for those panels and, in January 2020, CA advised that the maximum monitored subsidence after extracting the first three mini walls, i.e., MW02, MW03 and MW04, was 185 mm, which exceeded the approved maximum subsidence limit of 125 mm. The maximum observed subsidence over each of the following mini walls continued to increase and after Airly extracted MW10 in August 2021, the maximum observed subsidence over the PPMZ of Mount Airly, had increased to 680 mm and some surface cracking had been identified over the mined panels. Fortunately, although the monitored subsidence was much higher than expected, no cliff impacts were observed.

To reduce the observed subsidence levels back to the maximum subsidence limit of 125 mm, CA engaged SCT to study the observed subsidence behaviour and advise on the necessary modifications to the panel and pillar design so that mining the remaining mini walls will not result in more subsidence than the 125 mm maximum limit.

This SCT modelling with a FLAC model confirmed that the extraction of the very narrow panel widths should have resulted in very low levels of sag subsidence. But the model also revealed that the higher-than-predicted subsidence was primarily the result of the shearing, fracturing and compression of the relatively weak strata layers that lie immediately above the chain pillars, (SCT Report AIRLY5240. Jan 2021). SCT advised that this fracturing of strata above the chain pillars was not related to pillar instability or pillar failure at the seam mining level. SCT then used this calibrated FLAC model to recommend much wider chain pillars be formed between the future panels to limit subsidence to the EIS maximum subsidence limit of 125 mm.

This modelling also implied that increased depths of cover (DoC) results in extra weight on these weaker strata layers and, hence increased DoC over the pillars contributes to higher subsidence. To arrest the increased subsidence experienced over MW02 to 10, (where the DoC ranged up to 274 m), SCT suggested a 60 m wide chain pillar was required between MW10 and MW11, (i.e., where the DoC ranged up to 255 m) and SCT suggested a 40 m pillar was required between MW11 and MW12, (where the DoC ranged up to 235 m). Subsequent monitoring over MWs 11& 12 then revealed that, after these wider 60 m and 40 m pillars were formed, they successfully reduced the measured incremental subsidence over MWs 11 and 12 and the ongoing residual subsidence to the levels discussed at the 2014 subsidence limit of 125 mm.

CA then engaged SCT to advise on the necessary modifications to the chain pillar design for MWs 13 to 16 under Genowlan Mountain, (*where the DoC ranged up to 305 m*), where the panel widths were to be 61 m and four mini wall panels were to be extracted side by side. The FLAC modelling reviewed the situation and then SCT recommended 70 m wide pillars were required between the four MWs 13 to 16 at this deeper DoC.

CA has now extracted MW13, MW14 and MW15A under the Point Hatteras region of the Genowlan Mountain and the subsequent subsidence monitoring indicates that the current subsidence levels are below the modelled subsidence levels for these three mini wall panels. It can be concluded from the monitoring results, that the FLAC model accurately analyses the complex relationships between changing material properties, panel & pillar widths and varying DoCs over the pillars.

***Current Proposal for MWs 17 & 18***

SCT was then engaged by CA to advise on a modification of the mini wall design within the available resource under the eastern side of Genowlan Mountain, (*where the DoC ranged up to 291 m*), to limit the maximum predicted subsidence to less than 125mm and to fit three panels, i.e., MWs 17, 18 & 19. The proposed panel void widths were to be reduced from 61 m to 56 m and the chain pillar widths were to be increased from 29.5 m to 50 m.

However, the maximum predicted subsidence levels were 118 mm and there was a risk that the observed subsidence could exceed the maximum subsidence limit of 125 mm. Also, at that time the measured subsidence over MWs 13 &14 had just slightly exceeded the predicted subsidence for two panels at one of the GNSS subsidence monitoring units, i.e., the measured subsidence was 70 mm compared to the model predicted subsidence of 65 mm.

CA then chose to limit the extraction in this south-eastern area of Genowlan Mountain to only two panels, i.e., MWs 17 & 18.

The new revised SCT prediction report dated June 2023, SCT AIRLY5612, found that, in order to fit two panels, both the panel widths and the pillar widths would have to modified. Compared to the EIS mine layout design, the proposed width of the chain pillars between MWs 17 & 18 have more than doubled from 29.5 m to 70 m, whilst the panel void widths have been increased from 61 m to 70.5 m, and the seam thickness to be extracted is proposed to be increased from 2.8 m to 3.0 m. The revised maximum predicted subsidence level over MWs 17 & 18 is now 88 mm.

***Impact Assessments for MWs 17 & 18***

CA then asked MSEC to prepare and provide this subsidence impact report, MSEC1351, on the likely impacts of these predicted levels of subsidence on the natural and built features that exist over and near MWs 17 & 18, based on the revised subsidence prediction work provided by SCT (2023). This subsidence impact report provides:

- predicted subsidence contours for the Extraction Plan covering parts of the Genowlan Mountain due to the proposed extraction of MWs 17 & 18, based on the subsidence modelling by SCT (2023); and
- a subsidence assessment for the natural and built features that are located over or near MWs 17 & 18.

In some cases, this subsidence impact assessment report will refer to other reports and sources of information on specific natural and built features, and these other reports should be read in conjunction with this report.

MSEC was provided with the necessary cliff identification studies that were undertaken for CA by Aerometrex (2020) and the site ground truthing verification of cliffs that was undertaken by Michael Nicholson Consulting Pty Ltd (MNC) (2022). Aerometrex, which is a geospatial tech company that specialises in aerial imagery, mapping, 3D modelling and airborne LiDAR, first identified and labelled all the external major “cliffs” according to the following specific criteria defined in the Airly Development Consent. Then, Aerometrex identified and labelled all the internal “cliffs” that were located behind the major external cliff lines that surround the mesas according to the same specified cliff definitions.

A “cliff” was defined in the Airly Development Consent for the Project (SSD_5581) as a continuous rock face, including overhangs, having a minimum length of 20 m, a minimum height of 10 m and a minimum slope of 2 to 1 (>63.4º). That is, Aerometrex listed all those rock features that had a slope greater than 2 to 1, or > 63.4 º in its lists of internal and external “cliffs”, but those rock features that had measured heights of less than 10 m, or, if the length of a rock feature was measured to be less than 20 m, were excluded from these lists. Many external major “cliffs” within the CLZ were identified and labelled and, then many internal “cliffs” were identified and labelled by Aerometrex. CA and its consultants then tabled all the internal “cliffs” over and near MWs 17 & 18.

The *Study Area* for this assessment report is defined as the surface area that is likely to be affected by the extraction of the proposed MWs 17 & 18. The extent of the Study Area has been determined as the surface area enclosed by the 26.5° AoD line from the nearest boundaries of the proposed MWs 17 & 18, i.e., the predicted 20 mm subsidence contour resulting from the extraction of the proposed mini walls. Other features that could also be subjected to far-field or valley-related effects and could be sensitive to these movements have also been assessed in this report. However, in this case with extraction within and under a mesa, the features which could be sensitive to far-field or valley-related effects, are limited to the extents of Genowlan Mountain.

A number of natural and built features have been identified within or in the vicinity of the Study Area, including; external cliffs and escarpments, internal cliffs, steep slopes, rock outcrops, pagodas, drainage lines, conservation areas, unsealed tracks and a survey control mark (trig station). The locations of these features with respect to the proposed mini walls are shown in Fig. 1.3.

***Study Findings***

The main subsidence impact findings from this report are as follows:

- ***Cliffs:*** CA is protecting all the major external cliffs that surround the south-eastern area of Genowlan Mountain, i.e., within the CLZ, from mine subsidence ground movements by only undertaking first workings within the CLZ and by not extracting mini wall panels closer to the CLZ than a 26.5º AoD behind these major external cliffs.

  CA is protecting the internal cliffs that lie over the proposed MWs 17 & 18 and near the south-eastern area of Genowlan Mountain by increasing the panel widths to 70.5 m voids and increasing the chain pillar widths to 70 m, in order to limit ground movements to low levels of subsidence of less than 125 mm, avoid surface cracking and minimise risks of impacts to these internal cliff lines, pagodas, and other natural features.

  To ground truth and verify the results of the Aerometrex cliff identification studies CA asked MNC to undertake field site inspections of all the identified cliffs near the proposed MWs 17 & 18. MNC advised (2022) that visual inspections were carried out at all the external cliffs around the mesa that were near these panels and at each of the identified internal cliffs that were located over and near these panels by either visual inspections or drone inspections where the steeply incised terrain prohibited safe access. That is, not all cliffs could be accessed by foot as the terrain around these PPMZ cliffs and pagodas was described as extremely rough and difficult to pass through, as many areas were impossible to walk on, the steeply incised terrain.

These site inspections revealed some sensitive looking features over MW17 and over the commencing end of MW18. The site inspections also revealed a high amount of natural fracturing and jointing within the rock features, i.e., each cliff line may be sub divided into sections by pre-existing natural jointing and this results in shortened cliff line lengths as per the definitions within development consent SSD 5581.

Importantly the site inspections did not reveal any large cave features or large overhangs at the identified cliff features. That is, the site inspections have supported the photographic analysis that was undertaken in 2020 by Aerometrex and there were no internal cliff features over MWs17 & 18 that would be particularly sensitivity to subsidence movements.

The results of this mining induced cliff impact assessment are based on knowledge gained from developing a data base of known mining induced cliff falls and a data base of the mining conditions and the monitored ground movements at many of these mining induced cliff fall sites in the Western and Southern Coalfields of NSW.

Information on these data bases has been included as Chapters and Appendices in many of the previous MSEC cliff impact assessment reports prepared for Airly and, since they should be readily available, they are not reproduced in this report. See MSEC Report Number MSEC1185, (MWs 11 & 12, July 2021) and MSEC Report Number MSEC1195, (MWs 13 to 16 - October 2021) that provide:

- summaries of published reports and papers that discuss coal mining induced rock falls or cliff falls,
- detailed discussion on monitored ground movements at cliffs that experienced mining induced cliff falls, and
- reviews of each of the factors that appear to influence the likelihood of mining induced cliff falls.

The previous MSEC cliff impact assessment reviews from these previous MSEC reports all concluded that, (*considering the very low levels of subsidence being predicted over the identified internal cliffs and rock features, i.e. less than 125 mm*), there was only an extremely low probability that cliff instabilities would occur at the identified and listed cliffs over those mini walls, especially since these internal cliffs were mostly relatively short, isolated cliffs that were located over solid unmined coal areas beyond the edges of the mini wall panels.

A similar review was undertaken regarding the very low levels of subsidence being predicted over the identified internal cliffs and rock features that were identified and located near and over MWs 17 & 18. This review has also concluded that there was only an extremely low probability that cliff instabilities would occur at these identified and listed cliffs over and near the proposed MWs 17 & 18, which were mostly relatively short, isolated cliffs located over solid unmined coal areas beyond the edges of the mini wall panels.

This cliff impact review also advised that because natural rock falls have been reported to occur regularly over time with ongoing weathering and erosion, it is not possible to guarantee that there would be no rock falls reported during the period of mining. However, there should only be occasional falls of small slabs of rock and, because of the very low levels of subsidence being predicted at the identified internal cliffs and rock features, there should be little chance of exceedance of these development approval conditions for cliffs.

Hence, as the predicted levels of subsidence over MWs 17 & 18 are similar to those provided in the 2014 EIS, i.e., the maximum predicted subsidence is less than 125 mm with no predicted surface cracking, the assessed levels of potential impact for the cliffs, are similar to those based on the EIS Layout. That is, at these predicted low subsidence levels, it is unlikely that the cliffs, pagodas and rock formations will be adversely impacted by the proposed mini wall extraction.

- ***Steep slopes:*** The steep slopes and rock outcrops within the Study Area are throughout the Genowlan Mountain mesa. Potential impacts on these features generally occur from increased horizontal movements in the downslope direction, potentially resulting in tension cracks appearing at the tops and on the sides of the steep slopes and outcrops, compression ridges forming at the bottoms of the steep slopes and buckling of the bedrock at the bottoms of the rock outcrops. However, given that the predicted levels of subsidence over these steep slopes and rock outcrops are very low and not greater than 88 mm, it is unlikely that the steep slopes and rock outcrops will be adversely impacted by the proposed mini wall extraction.

- ***Drainage lines:*** The upper reaches of Genowlan Creek are located above the proposed mining area. There are also other unnamed drainage lines that are located across the proposed mining area. These drainage lines are generally ephemeral.

  Since the maximum predicted subsidence is only 88 mm over these mini walls, the predicted post-mining grades along Genowlan Creek and the other drainage lines are similar to the pre-mining natural grades. It is unlikely, therefore, that there would be adverse changes in ponding or scouring resulting from the mining-related subsidence or tilt.

  It is expected that no fracturing of the bedrock is likely to be observed over the mini walls and beneath the sections of the streams that are located directly above and adjacent to the proposed mini walls. Surface water flow diversions are unlikely to occur along the sections of the streams that are located directly above and adjacent to the proposed mini walls. Further discussions are provided by the other specialist consultants on the project.

- ***Conservation Areas:*** Most of the surface areas over Genowlan Mountain are located within the MMSCA that has significant natural and cultural heritage values and contains significant mineral resources. Two threatened ecological communities have been identified on Genowlan Point which is nearby, but beyond, the Study Area. Given the predicted low levels of subsidence over the area of mesa that is affected by the proposed extraction, the proposed extraction should not cause physical impacts (such as surface cracking) that could potentially change the environment or habitat for this natural vegetation. Further discussions are provided by the other specialist consultants on the project.

- ***Built features***:

  There are unsealed roads and tracks located directly above the proposed mining area. It is expected that the potential effects of the low predicted subsidence levels would be negligible and unnoticeable on these roads, and these roads could be maintained in safe and serviceable condition throughout the mining period using normal road maintenance techniques.

  A survey control mark (Trig Station) is located near the proposed mini walls and it could experience the full range of predicted subsidence effects. It may be necessary on the completion of the proposed mini walls, when the ground has stabilised, to re-establish the positions of this state survey control marks.

***Study Conclusions***

The subsidence predictions by SCT from their FLAC model have been supported by the monitored incremental subsidence results over MWs 11 to 12 under Mount Airly, as the wider chain pillar between MWs 10 to 11 has now been shown to limit the increased subsidence levels over MWs 11 & 12 to low and negligible subsidence levels.

The monitored incremental subsidence levels over MWs 13 to MW15A over Genowlan Mountain are also lower than the predicted low levels of subsidence for three panels, with no observed surface cracking, rock falls, or cliffs falls.

Hence no observed surface cracking, rock falls, or cliffs falls are expected over the proposed new extraction panels that have also been designed with the wider chain pillars.

That is, at these low predicted subsidence ground movements, it is unlikely that the external and internal cliffs and pagoda formations over and near MWs 17 & 18 and the other natural and man-made features that are located over and near MWs 17 & 18 will be adversely impacted by the proposed extraction of MWs 17 & 18.

Nevertheless, it should be remembered as discussed in the EIS (2014) and the IRP report (2016) there could still be occasional natural rock falls of small slabs of rock. But, because of the very low levels of subsidence being predicted at the identified internal cliffs and rock features, there should be little chance of exceedance of the development approval conditions for cliffs.

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## 1.1. Background to Study

Airly Mine (Airly) is an existing underground coal mine that is located 5 kilometres (km) north-east of the village of Capertee, 40 km north-northwest of Lithgow and 171 km north-west of Sydney. Centennial Airly Pty Limited (CA) is the operator of Airly and CA is a wholly owned subsidiary of Centennial Coal Company Limited.

The surface areas over Airly are characterised by steep and rugged topography with large areas of cliffs, minor cliffs, pagodas and significant rock outcrops. The topography is dominated by Mount Airly and Genowlan Mountain which are two large mesas that sit broadly within the landscape of the Capertee Valley, which measures over 30 km from north to south and east to west. The valley is surrounded by sandstone cliffs and steep talus slopes similar to those found on Mount Airly and Genowlan Mountain. Both Mount Airly and Genowlan Mountain are clearly visible for tens of kilometres in all directions.

The surface topography on top of the two mesas varies from gently undulating to steep sided valleys, major cliff lines, pagodas and gorges. Most of the surface areas over Airly are located within the Mugii Murrum-ban State Conservation Area (MMSCA) that has significant natural and cultural heritage values and contains significant mineral resources. The MMSCA was gazetted in 2011 to protect environmental and cultural heritage values while permitting mining and exploration.

Airly gained development approval in 1993 to extract longwall panels with up to 1.8m of subsidence beneath Mount Airly and Genowlan Mountain. Before extracting these longwalls, Airly initially commenced extracting coal using bord and pillar mining methods around the base of Mount Airly, the first of two large mesas that Airly planned to mine beneath. However, only trial mining was undertaken on some initial access headings and first workings when CA acquired the mine in 1997. Further trial mining was undertaken in 1998 with the coal being transported by road to the Mount Piper Power Station. Further development occurred in 2009 with the construction of a rail loop and other surface infrastructure, however, mining continued using only bord and pillar methods on access headings while mine planning progressed.

As part of the Airly Mine Extension Project EIS in 2014, CA developed a conservative approach to mining throughout the lease which employed different mining methods in different areas, each targeted to suit each specific area, referred to as ‘mining zones’. The EIS report was predominantly based on the premise that low levels of subsidence within each of the mining zones would avoid surface cracking and minimise risks of impacts to cliff lines, pagodas, and other natural features, as had been successfully undertaken for twenty years at the Centennial Clarence Mine (Clarence).

A key objective of this conservative approach was to minimise risk of surface impacts through appropriate mine design to reduce subsidence. Sensitive high cliffs and escarpments located on the external parts of the Mount Airly, and Genowlan Mountain mesas were protected by a Cliff Line Zone (CLZ) of First Workings (i.e., no secondary extraction). The Panel and Pillar Mining Zones (PPMZs), located in the centres of the mesas, were designed with mini wall extraction of narrow panels (around four times narrower than conventional longwalls) and large chain pillars that were designed to limit subsidence.

This 2014 EIS report, which was prepared by Golder Associates, predicted the maximum subsidence over the PPMZ areas of the mine, after the extraction of 2.8 m of the Lithgow Seam, with 61 m wide mini wall panel widths and 29.5 m chain pillars, as shown in Fig. 1.1 would be less than 110 mm, with tilts of less than 2 mm/m and strains of less than 2 mm/m. It was assessed that, at these low subsidence values, no surface cracking, rock falls or cliff impacts were expected.

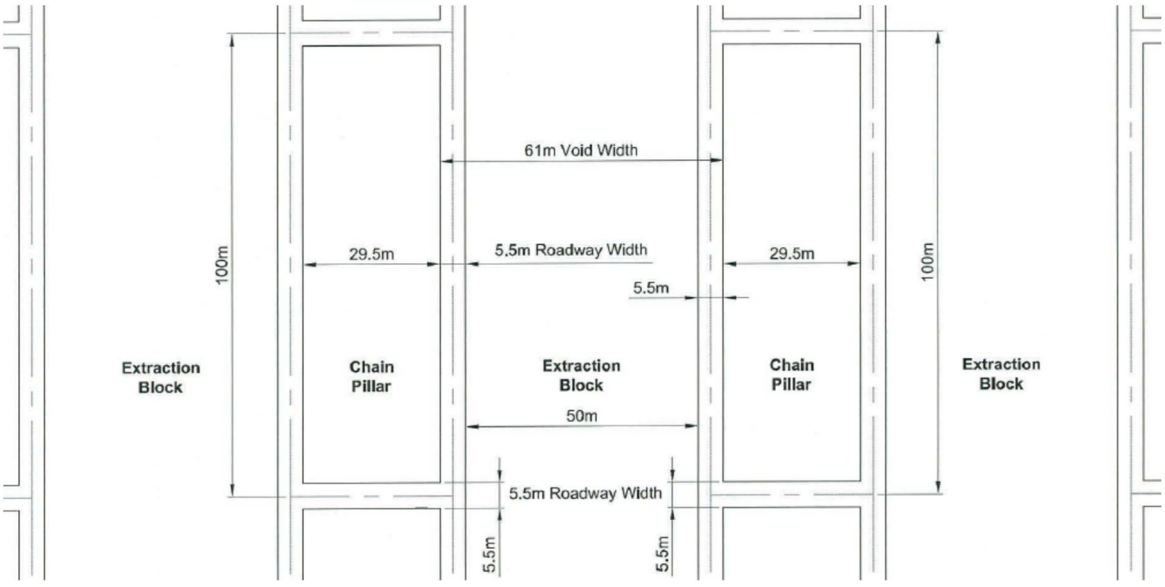


**Fig. 1.1 Typical mini wall panel and pillar design layout (EIS, 2014)**

In 2016, the Department of Planning and Environment commissioned an Independent Review Panel (IRP) to review and report on the accuracy and reliability of mine subsidence impacts presented in the EIS. The IRP comprised Dr Ken Mills (Strata Control Technology, SCT), Professor Ismet Canbulat (University of NSW, UNSW) and Don Kay (Mine Subsidence Engineering Consultants, MSEC). The IRP's report, titled "*Report of the Independent Review Panel established to review and report on the accuracy and reliability of mine subsidence impacts on sensitive features across the Airly Mine Extension Project Application Area*", dated July 2016, advised the proposed partial mining systems were considered conservative by comparisons with industry standards and could be expected to maintain surface subsidence movements at low levels with proper management.

The IRP noted the experience of the monitored surface impacts at Clarence Colliery where, over many decades at subsidence levels of less than 100 mm, there were no perceptible impacts to the many overlying cliffs and pagodas. This experience at Clarence was considered credible and consistent with the observations that cliff formations have some small tolerance to ground movements. Based on this low monitored maximum subsidence limit of 100 mm, and an observation that the accuracy of surveying in such remote terrain areas was generally + 25 mm, then the upper limit of 125 mm was selected as a consent condition for the maximum subsidence limit for Airly.

Even though the IRP report noted that cliff formations often experience rock falls due to natural weathering and erosion at relatively rapid rates, (hence full protection, even with an ultra-conservative mine design was not possible), the report advised the proposed methods of extraction therefore had the potential to avoid significant impacts on the cliffs, steep slopes and pagodas. The report advised that high confidence subsidence monitoring over the initial panel and pillar mining areas was recommended to confirm the levels of observed ground movement are as predicted and the protection zones proposed are appropriate to provide a level of protection to cliff formations.

In December 2016, Airly was granted approval to extend its operations for another 20 years and this approval included the extraction of mini walls within a panel and pillar zone beneath the Mount Airly and Genowlan Mountain mesas that were set back from the massive external cliff lines. The location of these mining zones with respect to the external cliff lines are shown in Fig. 1.2 below. The 2016 Airly approval required the setting up of a further IRP that would provide advice to Airly on the preparation of Extraction Plans and their implementation in order to meet the performance measures, particularly those relating to cliffs and pagoda formations, to the satisfaction of the Department of Planning, Industry and Environment.

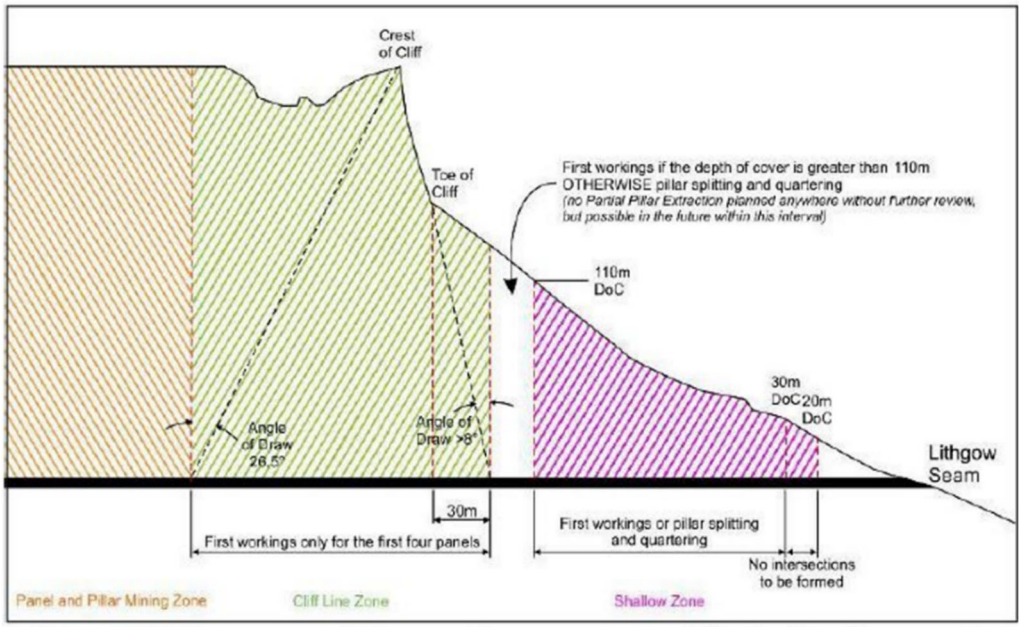


**Figure C: IRP recommendations and current proposal for the first four panels**

**Fig. 1.2 Current setback strategy to protect major escarpments in the CLZ based a 26.5° AoD from the back of the major external cliffs surrounding the mesa (CA, IRP and Catalyst)**

Before extraction commenced in the PPMZ, CA provided an updated subsidence prediction report that was prepared by Strata[2] (March 2019), advising that the maximum short-term subsidence over the 2019 Airly Extraction Plan Area was likely to be 60 mm and the long-term maximum subsidence was predicted to be 70 mm and the maximum short-term subsidence over the whole Airly mine was likely to be 70 mm and the long-term maximum subsidence was predicted to be 110 mm. This report advised that the subsidence estimates for Airly were initially put forward by Strata Engineering (2012) and by Golder Associates in the EIS (2014) and it confirmed the 2014 EIS advice that, at these low subsidence values, no surface cracking, rock falls or cliff impacts were expected, (Strata[2], March 2019).

**Table C-1: Comparison of Subsidence Outcomes for the Approved EIS and Current Extraction Plan for the Mt. Airly Panel and Pillar Mining Zone**

| Prediction | Depth Range (m) | Vertical Subsidence (mm) | | Tilt (mm) | Strain (mm) | | Fractured Zone Height (m) | Surface Cracking? | Other Impacts? |
|---|---|---|---|---|---|---|---|---|---|
| | | Medium-Term | Long-Term | | Tensile | Compressive | | | |
| 2014 SIA / EIS | 160-300 | ≤ 70 | ≤ 110 | <3 | <2 | <2 | ≤ 70 | None expected | None Expected |
| 2019 Extraction Plan | 160-270 | ≤ 60 | ≤ 70 | <2 | <1 | <1 | ≤ 60 | | |

Whilst the mine design was based on the successful experience in other locations, especially Clarence Colliery, the mini wall mine design was considered to be unique in a mesa environment and the requested high confidence and high accuracy subsidence monitoring was set up to be undertaken over the initial mini wall mining areas.

## 1.2. Subsidence monitoring over MWs 02 to 10 and redesign of MWs 11 and 12

However, in January 2020 after extracting the first three mini walls on Mount Airly, i.e., MW02, MW03 & MW04, CA advised that monitoring had just revealed that the maximum subsidence limit of 125 mm had been exceeded.

CA then asked MSEC to undertake a site inspection of the surface areas over these three mined mini walls to confirm if there were any noticeable impacts from the increased subsidence. This initial site inspection was undertaken by Don Kay of Mine Subsidence Engineering Consultants (MSEC) on 4th March 2020 and no subsidence impacts were identified on the surface over the Mount Airly mesa resulting from the increased observed subsidence.

No changes were made to the design of the mini wall workings and, after Airly extracted Mini Wall 5, (MW05), in April 2020, the maximum observed subsidence had increased to 297 mm. After MW06 was extracted in September 2020, the maximum observed subsidence had increased to 548 mm and one small surface crack was found on the Mount Airly mesa over MW01. After Airly extracted MW07 in November 2020, the maximum observed subsidence was 612 mm, and, after MW08 was extracted, in February 2021, the maximum observed subsidence was 655 mm. After Airly extracted MW09 in May 2021, the maximum observed subsidence had increased to 670 mm and after Airly extracted MW10 in August 2021, the maximum observed subsidence had increased to 680 mm. More surface cracks were found after MW10 was extracted, but no cliff falls have been observed.

To reduce the observed subsidence levels back to the predicted maximum subsidence limit of 125 mm, CA engaged SCT to study the observed subsidence behaviour and advise on the necessary modifications to the panel and pillar design so that mining the remaining mini walls will not result in more subsidence than this 125 mm limit.

After calibrating the UDEC model, SCT confirmed that the model predicted very low levels of sag subsidence after extraction of the narrow, very subcritical, panel widths. But the model revealed that the higher than predicted observed subsidence was primarily the result of the compression or squashing of the relatively weak strata layers immediately above the chain pillars, (SCT Report AIRLY5240. Jan 2021). Hence SCT recommended much wider chain pillars needed to be formed between the future mini wall panels.

The modelling indicated that increased depths of cover (DoC) resulted in extra weight on these weak strata overlying the chain pillars and this contributes to the higher subsidence and, therefore, wider chain are needed where the DoCs are greater. SCT advised that the much wider pillars should reduce subsidence levels back to the predicted subsidence limits set in the 2014 EIS. To arrest the increased subsidence experienced over MW02 to 10, (*where the DoC ranged up to 274 m)* and much higher than predicted subsidence occurred, SCT suggested a 60 m wide chain pillar was required between MW10 and MW11, (*where the DoC ranged up to 255 m*) and SCT suggested a 40 m pillar was required between MW11 and MW12, (*where the DoC ranged up to 235 m*). The panel widths for MW11 and MW12 remained the same at 61 m wide.

Subsequent subsidence monitoring after ongoing residual monitoring has now revealed that these wider 60 m pillars successfully reduced the measured incremental subsidence over MWs 11 and 12 to levels at the 2014 EIS predicted levels of 125 mm.

## 1.3. Observed Surface Cracking and Small Fall over and near MWs 02 to 10

While surface cracking and a small rock fall has been observed over Mount Airly over MWs 02 to 12, i.e., where the measured subsidence exceeded the maximum subsidence limits of 125 mm, no surface cracking or rock falls have been observed over the areas where Airly formed the wider pillars to limit subsidence to less than 125 mm. (As discussed in more detail in Chapter 2.)

## 1.4. Mini wall design for MWs 13 to 16 under Point Hatteras and Genowlan Mountain

CA then engaged SCT to advise on the necessary modifications to the mini wall design for MWs 13 to 16, (*where the DoC ranged up to 305 m*). That modelling recommended that the chain pillar widths be substantially increased from 29.5m to 70 m wide to limit strata failures in the weaker strata layers above the pillars 70 m wide pillars and the panel widths could remain at 61 m.

CA has now extracted MW13, MW14 and MW15A under the Point Hatteras region of the Genowlan Mountain. Subsidence monitoring over MWs 13 and 14 indicated that the levels were close to the model predicted subsidence levels after two panel were mined and monitoring after MW15A was extracted showed the observed subsidence was less than the predicted for three panels. Hence, it can be concluded from the monitoring results, that the FLAC model accurately analyses the complex relationships between changing material properties, panel & pillar widths and varying DoCs over the pillars.

While surface cracking has been observed over Mount Airly where the measured subsidence exceeded the initial maximum subsidence limits, no surface cracking or rock falls have been observed over the areas where the wider pillars were formed, and the observed subsidence was limited to less than 125 mm.

## 1.5. Proposed mine layout plan for the MWs17 & 18 south eastern area of Genowlan Mountain

SCT was then engaged to advise on a modification of the mini wall layout design to fit three panels within the available resource under the southeastern side of Genowlan Mountain and to limit the maximum predicted subsidence to less than 125mm over the then proposed three panels that were to be called MWs 17, 18 and 19, (*where the DoC ranged up to 291 m*).

- Compared to the EIS design for MWs 02 to 10, (*where the DoC ranged up to 274 m*), the panel void widths proposed by SCT for MWs 17 & 18, were to be reduced from 61 m to 56 m and the chain pillar widths were to be increased from 29.5 m to 50 m.
- Compared to the mini wall design for MWs 13 to 16, (*where the DoC ranged up to 305 m*), the panel void widths proposed by SCT for MWs 17 & 18, are to be reduced from 61 m to 56 m and the chain pillar widths were reduced from 70 m to 50 m.

SCT (2022) predicted that the maximum vertical subsidence over the proposed MWs 17, 18 and 19 would be 118 mm with a subsidence tolerance of +/-20mm. This was considered by SCT to be a conservative estimate of subsidence for the MW17-19 mining area given the modelled depth of cover was 280m, while actual depth of cover ranges from 240m to 280m. Also, at that time the measured subsidence over MWs 13 &14 had just slightly exceeded the predicted subsidence for two panels at one of the GNSS units, peg GM03, i.e., the measured subsidence was 70 mm compared to the model predicted subsidence of 65 mm.

It was also noted that the current subsidence levels observed over MWs 13 to 15A are below the predicted subsidence levels modelled by SCT for three panels, however, CA has already chosen to extract two panels in this area, i.e., MWs 17 & 18. SCT was then re-engaged to advise on a modification of the mini wall layout design to fit two panels within the available resource under the southeastern side of Genowlan Mountain.

- Compared to the EIS design for MWs 02 to 10, (*where the DoC ranged up to 274 m*), the panel void widths proposed by SCT for MWs 17 & 18, (*where the DoC ranged up to 291 m*), were to be increased from 61 m to 70.5 m, (an increase of 16%), the chain pillar widths were to be increased from 29.5 m to 70 m, (an increase of 137%), and the thickness of the seam to be extracted has been increased from 2.8m to 3.0m, (an increase of 7%).
- Compared to the mini wall design for MWs 13 to 16, (*where the DoC ranged up to 305 m*), the panel void widths proposed by SCT for MWs 17 & 18, are to be increased from 61 m to 70.5 m and the chain pillar width between MWs 17 & 18 have remained the same at 70 m.

Fig. 1.3 shows the locations of the extracted and proposed panels over an old aerial photograph of the Mount Airly and Genowlan Mountain mesas. The outlines of the extracted mini wall panels, i.e., MWs 2 to 12 under the Mount Airly mesa and MW 13, MW14 and MW15A under the Point Hatteras region of the Genowlan Mountain mesa, are drawn in green. The outlines of the proposed mini walls panels, i.e., MWs 15B to 16 under the Point Hatteras region of Genowlan Mountain and MWs 17 & 18 under the Genowlan Mountain, are drawn in orange.

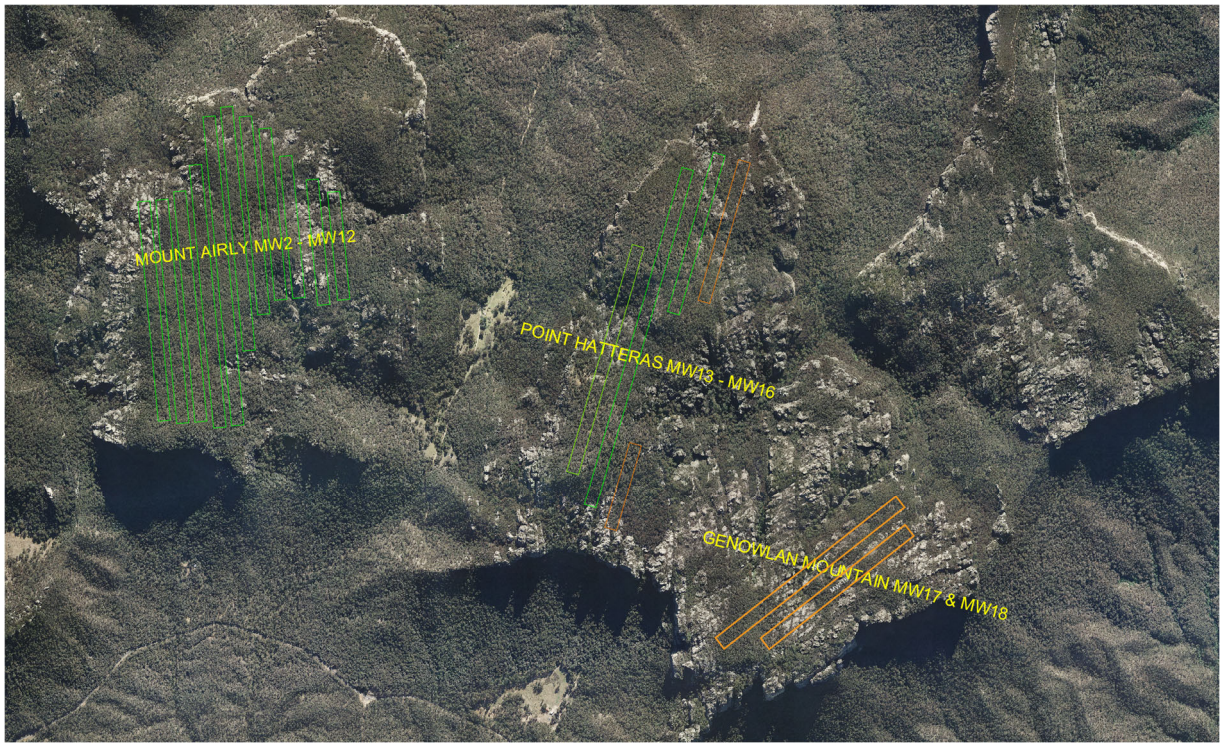


**Fig. 1.3 Aerial photograph showing locations of the approved panels, MWs 2 to 16, and proposed panels, MWs 17 & 18, over an old aerial photograph showing Mount Airly mesa (left) and Genowlan Mountain mesa (right) (CA & MSEC)**

It should be noted that the mini wall panels have all been located outside the CLZ, i.e., they are more than 26.5° from the back of the external cliff lines of the Mount Airly and Genowlan Mountain mesa, to provide a barrier to protect the major surrounding escarpments of the mesas and restrict the levels of subsidence that can be expected at these major external cliff lines to less than 20 mm.

Fig. 1.4 shows the locations of the proposed MWs 17 & 18 that are positioned over Genowlan Mountain within the PPMZ (CA & Catalyst). This plot also shows the:

- A 26.5° AoD line from the top of external major cliffs down to the seam level to set back the CLZ/PPMZ boundary (dashed purple line);
- The proposed MWs 17 & 18 panel boundaries; and the
- The predicted 20mm subsidence contour line (blue line), which was based on a 26.5° AoD drawn upwards from the edges of the proposed mini wall panels to the surface.

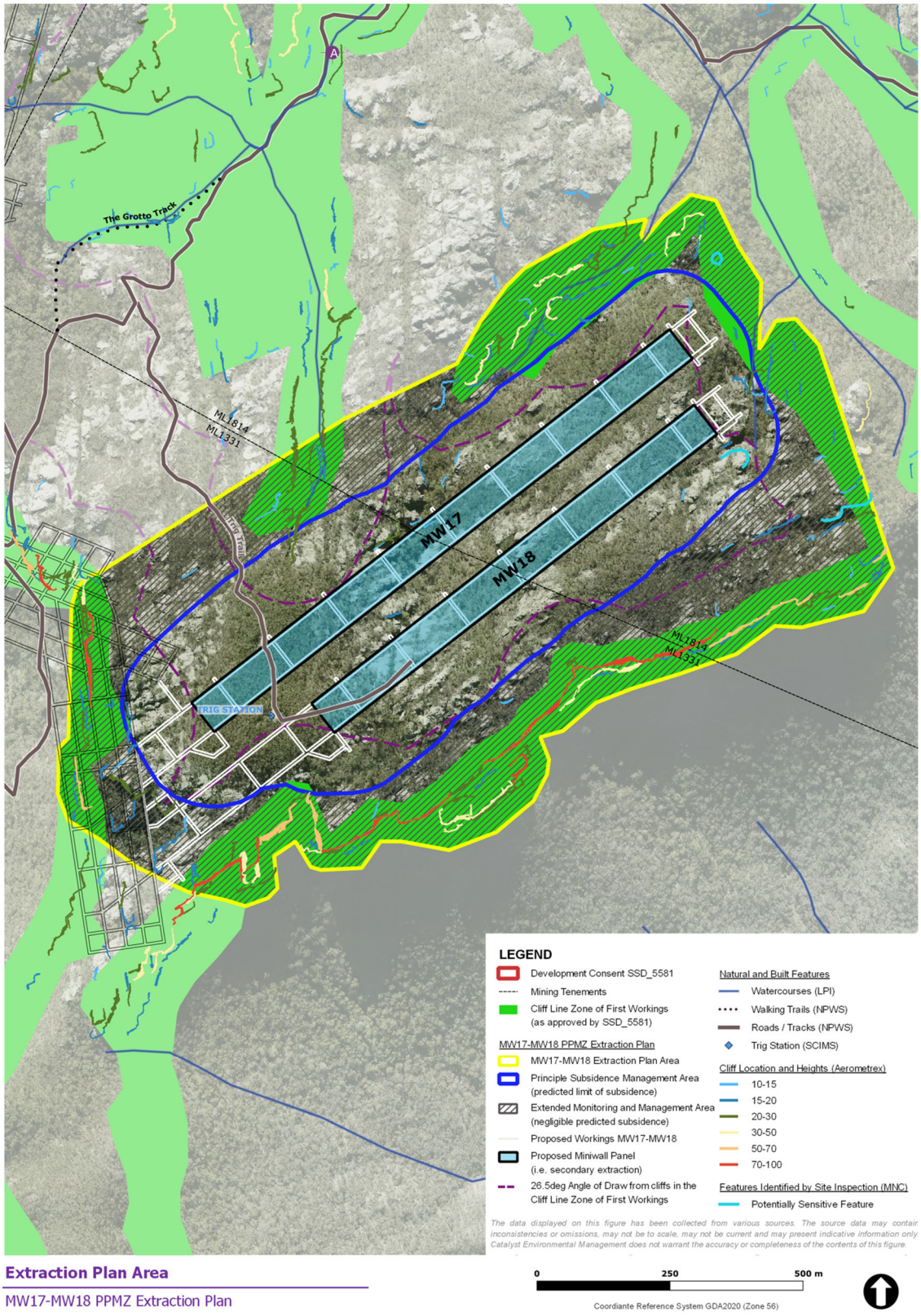


**Fig. 1.4 Airly Mine layout showing location of MWs 17 & 18 (CA & Catalyst)**

## 1.6. Mining geometry for MWs17 & 18

A summary of the dimensions for the proposed mini walls is provided in Table 1.1. The mini walls will be extracted from the north-east to the south-west (i.e., retreat mining towards the main headings).

**Table 1.1 Geometry of the proposed mini walls**

| Mini Wall | Overall void length including installation heading (m) | Overall void width including first workings (m) | Overall tailgate chain pillar width (m) |
|---|---|---|---|
| MW17 | 1140 | 70.5 | - |
| MW18 | 912 | 70.5 | 70 |

It should be noted that the overall void widths provided in Table 1.1 include the headings (i.e., first workings). The actual widths extracted by mini wall mining (i.e., second workings) are 10 m narrower than those provided in the above table. The actual lengths of mini wall extraction (i.e., excluding the installation heading) are approximately 8 m shorter than the overall void lengths indicated in this table.

The dimensions of the proposed MWs 17 & 18 adopted for the Extraction Plan Application (as provided in Table 1.1 are different to those detailed in the 2014 EIS Application as CA have adjusted the panel widths and widened the pillar widths to limit the maximum subsidence target of 125 mm that was detailed in the EIS.

## 1.7. Subsidence Impact Assessment Report for MWs17 & 18

MSEC were asked by CA to prepare and provide this Subsidence Impact Assessment Report, MSEC1351, to support the Extraction Plan and to:

- provide subsidence contours for the proposed MWs 17 to 18 based on the predicted subsidence profiles prepared by Strata Control Technology (SCT) using a FLAC numerical model;
- identify and review the natural and built features located near the proposed mini walls;
- provide subsidence predictions for each of these natural and built features based on the SCT modelling;
- compare the predictions with those presented in the EIS Application; and
- review and update the impact assessments, in conjunction with other specialist consultants, for each of these natural and built features.

This report provides the subsidence information that will support the Extraction Plan Application which will be issued to the Department of Planning and Environment. In some cases, this report will refer to other sources of information on specific natural and built features, and these reports should be read in conjunction with this report.

MSEC were also asked to prepare and provide this cliff impact assessment report on the likely effects of the predicted levels of subsidence on the “internal” cliffs, based on the Aerometrex cliff identification studies (2020), the Michael Nicholson Consulting Pty Ltd (MNC) ground truthing study (2022) and the subsidence prediction work provided by SCT (2023) for MWs 17 & 18. Site ground truthing verification of the heights, widths and shapes of the cliffs over and near MWs 17 & 18 was undertaken by MNC in 2022.

The cliff impact assessments that are presented in this report include:

- Discussions on the phase 1 external and the phase 2 internal cliff” identification process processes, i.e., assessments as to which cliffs fitted the criteria of “cliff” or “minor cliff” as per the definitions in the Development Consent;
- Results of the site inspections of the internal cliffs and nearby other cliffs for any sensitive features (i.e., cave features, overhangs, etc.);
- Determinations of the suitability of the setbacks to secondary extraction from cliffs in the CLZ;
- Assessments of the stability of cliff lines and pagodas and the risk of impact for each cliff; and
- Determinations as to whether the predicted subsidence levels on each cliff will result in impacts complying with the performance criteria in the consent.

Chapter 1 provides a general introduction to the study, which also includes a description of the mining geometry and geological details of the area.

Chapter 2 provides the geological background to the study.

Chapter 3 provides a general background to subsidence studies and introduces terminology for subsidence studies.

Chapter 4 discusses the early Airly subsidence prediction studies and the MWs 02 to 12 monitoring results over Mount Airly and the MWs 13 and 15A monitoring results over the Point Hatteras areas of Genowlan Mountain.

Chapter 5 defines the Study Area and provides a summary of the identified natural and built features within this area.

Chapter 6 details the subsidence predictions over MWs17 to 18. It also compares the SCT (2023) maximum predicted subsidence effects resulting from the extraction of the proposed mini walls compared with those provided in the EIS Application (2014).

Chapter 7 discusses the predictions and impact assessments for each of the natural features that have been identified within the Study Area and compares them with those in the EIS Application.

Chapter 8 provides the predictions and impact assessments for each of the built features that have been identified within the Study Area and compares them with those in the EIS Application.

Chapter 9 Conclusions to the Study Area.

## 2.1. Geomechanical properties of the coal seam and the immediate floor and roof

The Airly Mine is located on the western margin of the Sydney Basin and beneath two massive star shaped mesas, being the Mount Airly mesa and the Genowlan Mountain mesa. Airly and these mesas are also located within the landscape of the Capertee Valley, which is a large, broad-floored canyon measuring over 30 km from north to south and east to west.

These two elevated and isolated mesa landforms have relatively level flat-topped surfaces that stand sharply above massive vertical cliffs that surround the mesas and above the surrounding Capertee Valley terrain.

Much of the plateau surface areas and the massive vertical cliffs are formed in the Burra-Moko Head Sandstone of the Narrabeen Group. These cliffs have formed because these massive sandstone strata layers weather slowly and they are underlain by lower strength units that weather more readily.

These lower units comprise interbedded claystones, siltstones and shales within the basal Narrabeen Group and the lower Illawarra Coal Measures.

The following discussions on coal, floor and roof properties were reproduced and summarised from various reports by Golder Associates and Strata[2]. Those reports should be referred to for more detailed geological information.

Geological cross sections through the cliffs at Airly are shown in the following sketches, Fig. 2.1 and Fig. 2.3.

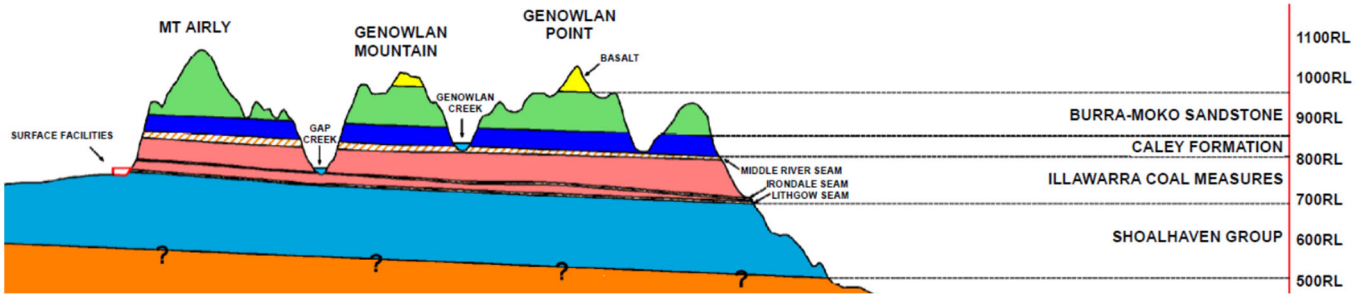


**Fig. 2.1 Cross Section through mesas showing typical Stratigraphy at Airly Mine (Source: CA)**

A generalised identification of the major geological layers at Airly is shown in Fig. 2.2.

It can be seen in Fig. 2.3 that there are many coal seams above the Lithgow Seam and they all outcrop below the cliffs and above the floor of the Capertee Valley.

Although other seams are present, the only coal seam deemed to be of significant economic importance is the Lithgow Seam, which is located in the lower part of the ICM.

| Period | | Group | Sub-group | Formation |
|---|---|---|---|---|
| Tertiary | | | | Flood basalt |
| Triassic | | Narrabeen | Grose | Burra-Moko Head Sandstone |
| | | | | Caley Formation |
| Permian | Late | Illawarra Coal Measures | Wallerawang | Middle River Seam |
| | | | Charbon | Moolarben Seam |
| | | | | Baal Bone Formation |
| | | | | Upper Irondale Seam |
| | | | | Irondale Seam |
| | | | | Long Swamp Formation |
| | | | Cullen Bullen | Lidsdale Seam |
| | | | | Lithgow Seam |
| | | | | Marangaroo Conglomerate |
| | | | Nile | Gundangaroo Formation |
| | | | | Coorongooba Creek Sandstone |
| | | | | Mount Marsden Claystone |
| | Early | Shoalhaven | | Berry Siltstone |
| | | | | Snapper Point Formation |
| Lower Devonian | | | | Shales, tuffs and limestones |

**Fig. 2.2 Stratigraphic column for the Western Coalfield (Source: CA)**

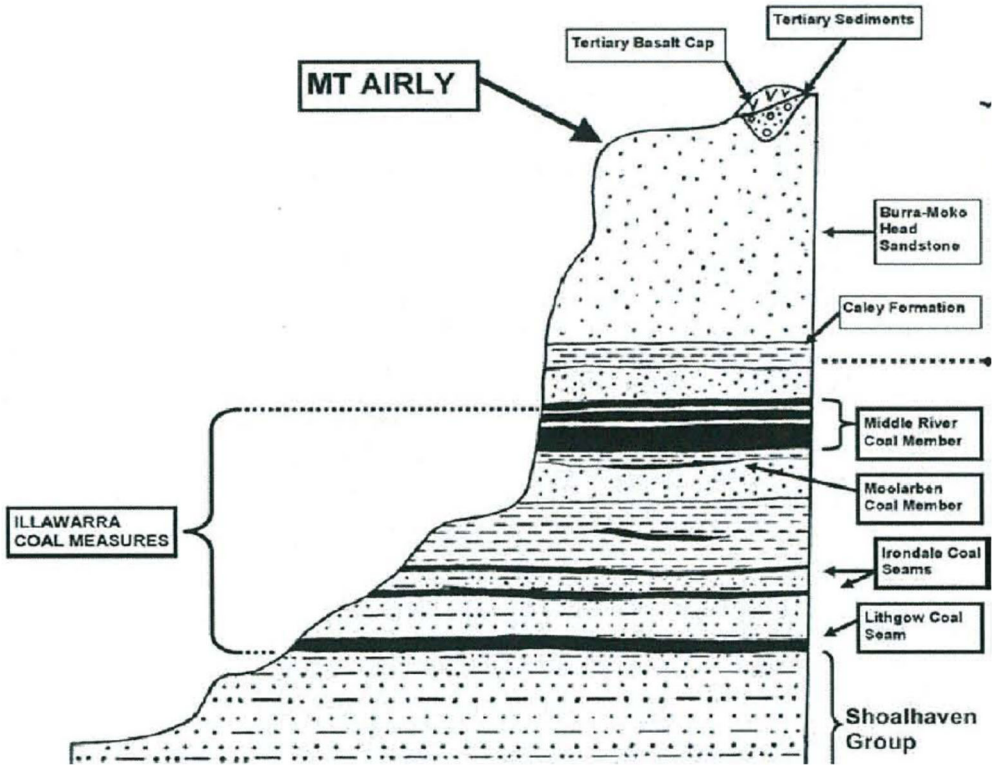


**Fig. 2.3 Typical Stratigraphy at Mount Airly cliffs (Source: Golder Associates – NSW DTIRIS)**

All of the existing and proposed workings in Airly Mine are located in the Lithgow Seam. In the extracted mini wall area, the combined Lithgow and Lidsdale seam is 4.8 m to 5.9 m thick, averaging 5.4 m and thinning to the south-east. Of this the Lithgow Seam, i.e., plies LT1 to LT3, constitutes the base of the combined seam and averages 3.4 m in thickness. This is of higher quality and is the target for mining.

The planned development height within the Lithgow Seam is 2.8 m to 3 m in accordance with the approved EIS, approximately mid-way between the LW1 claystone band and the lower LW2 claystone band, the latter being typically ~0.1 m thick. This results in a roof bolt horizon typically comprised of 0.3 m of (LT3) top coal, overlain by 0.4 m of LW1 claystone and the Lidsdale Seam with its thin claystone and mudstone bands. The LT3 Ply has a lower portion of saleable coal while the upper portions is very dull and high ash.

The Lidsdale Seam (Ply LT4) is of low quality, being characterised by persistent claystone, mudstone and siltstone bands. The LW1 claystone separates the LT3 and LT4 Plies and averages 0.4 m in thickness. The Lidsdale Seam (Ply LT4) averages 1.6 m in thickness.

The normal mining height within the Lidsdale Seam at Airly is 2.8 m from the Lithgow Seam floor, although the heading development height in the Panel and Pillar Zone increases to 3 m. The 3.0 m development mining height places the roof horizon approximately midway between the LW1 claystone and the lower LW2 claystone band, the latter being ~0.1 m thick. This results in a roof bolt horizon typically comprised of 0.3 m of LT3 top coal, overlain by 0.4 m of LW1 claystone and finally the Lidsdale Seam with its dirt bands.

The Lidsdale Seam is typically capped by a carbonaceous mudstone band, which is approximately 0.6 m thick.

The first 10 m of overlying roof within the extraction area is comprised typically of interbedded siltstones and sandstones, with occasional thin mudstone and coal bands. Rock strength tends to improve with height into the roof; Uniaxial Compressive Strength (UCS) values of approximately 30 MPa are typical to a height of about 3 m above the seam, then strength increases to approximately 40 MPa. The remainder of the Permian overburden above, averaging 100 m in thickness, is composed of interbedded mudstone, siltstone and sandstone units with thin coal seams. Material strengths are typically of the order of 30 to 40 MPa.

The Triassic capping overburden is up to 200 m thick and is dominated by thickly bedded to massive sandstones (Burra-Moko Head Sandstone), with occasional thin claystone and mudstone beds and lenses (claystone in both roof and floor is discussed further below). The sandstone UCS is typically around 30 MPa, with pronounced weaker and stronger bands of up to approximately 60 MPa. Generally, the fine-grained units are better cemented and therefore stronger than the coarse-grained sandstone conglomerate units.

The floor of the Lithgow Seam is the “Marangaroo Conglomerate”, which is typically comprised of siltstone grading downwards into sandstone. The immediate floor is predominantly a silty sandstone with a UCS of 20 to 50 MPa, underlain by weaker, medium to coarse grained sandstone beds of the Marangaroo Conglomerate with UCS values of typically 20 MPa. The silty sandstone has very little sensitivity to moisture. This floor has been assessed as moderate to strong, with no significant issues expected in the proposed workings of the extraction area with regard to the floor bearing capacity (and none experienced in the several years of splitting and quartering at Airly mine since 2011). Further discussions on lithology and material properties have been provided in other specialist reports by both Golder Associates, Strata[2] and SCT.

Fig. 2.4, Fig. 2.5 and Fig. 2.6 show the variations in depths of cover over Mount Airly and Genowlan Mountain.

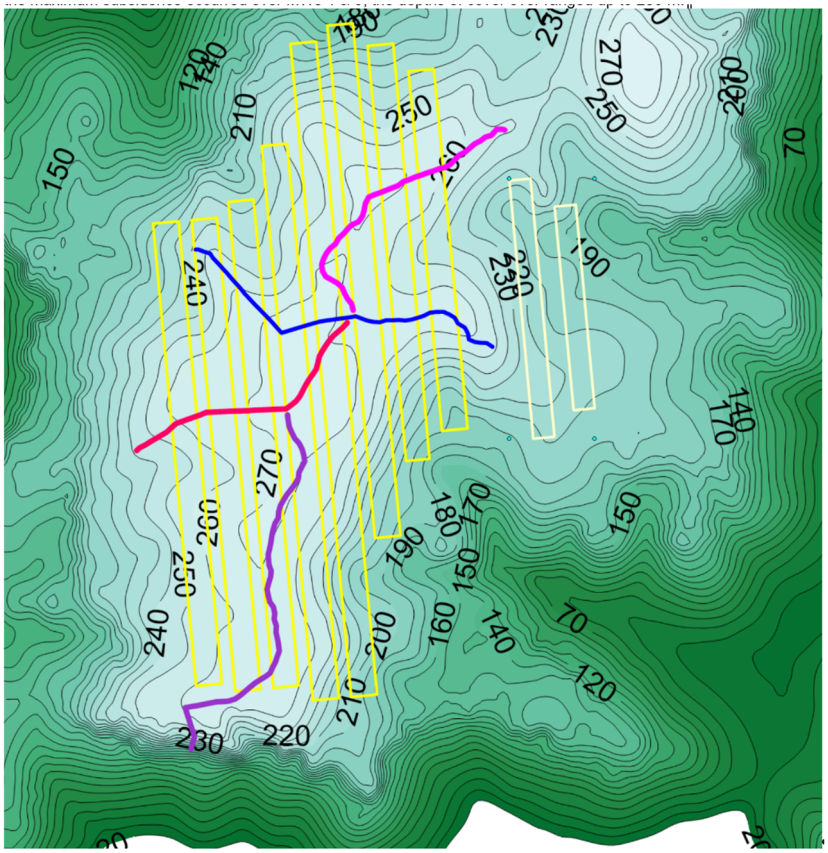

**Fig. 2.4 Depths of cover over MWs 02 to 12 on Mount Airly (MSEC)**

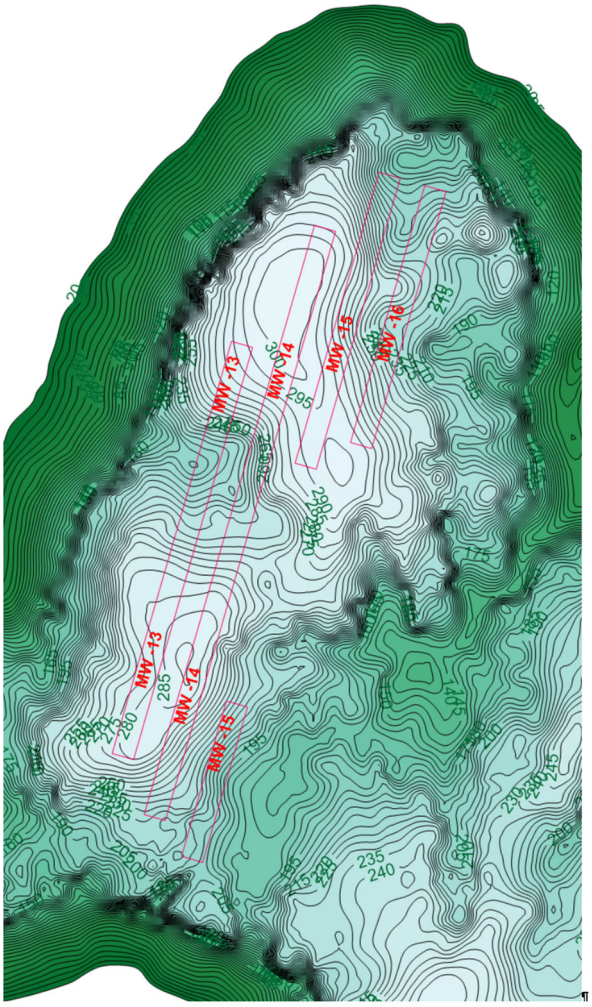


**Fig. 2.5 Depths of cover over MWs 13 to 16 at Point Hatteras on Genowlan Mountain (MSEC)**

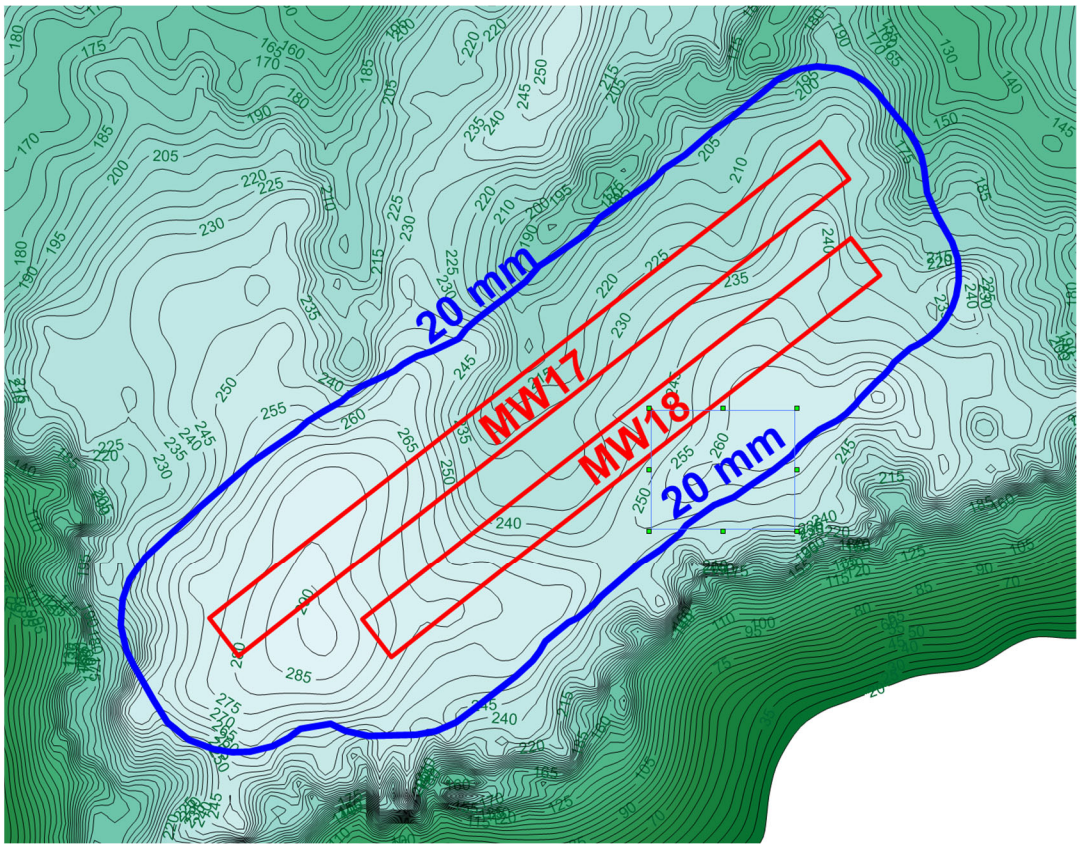


**Fig. 2.6 Depths of cover to the Lithgow Seam near MWs 17 & 18 (MSEC)**

### 2.1.1. Geological structures

The locations of the identified geological structures (primarily faulting) at the coal seam level in Airly Mine before mining at Airly and after underground mining commenced are shown in Fig. 2.8. These identified faults appear to have contributed to the increased levels of subsidence over Mount Airly. It can be noted that far more faults were found after underground mining commenced.

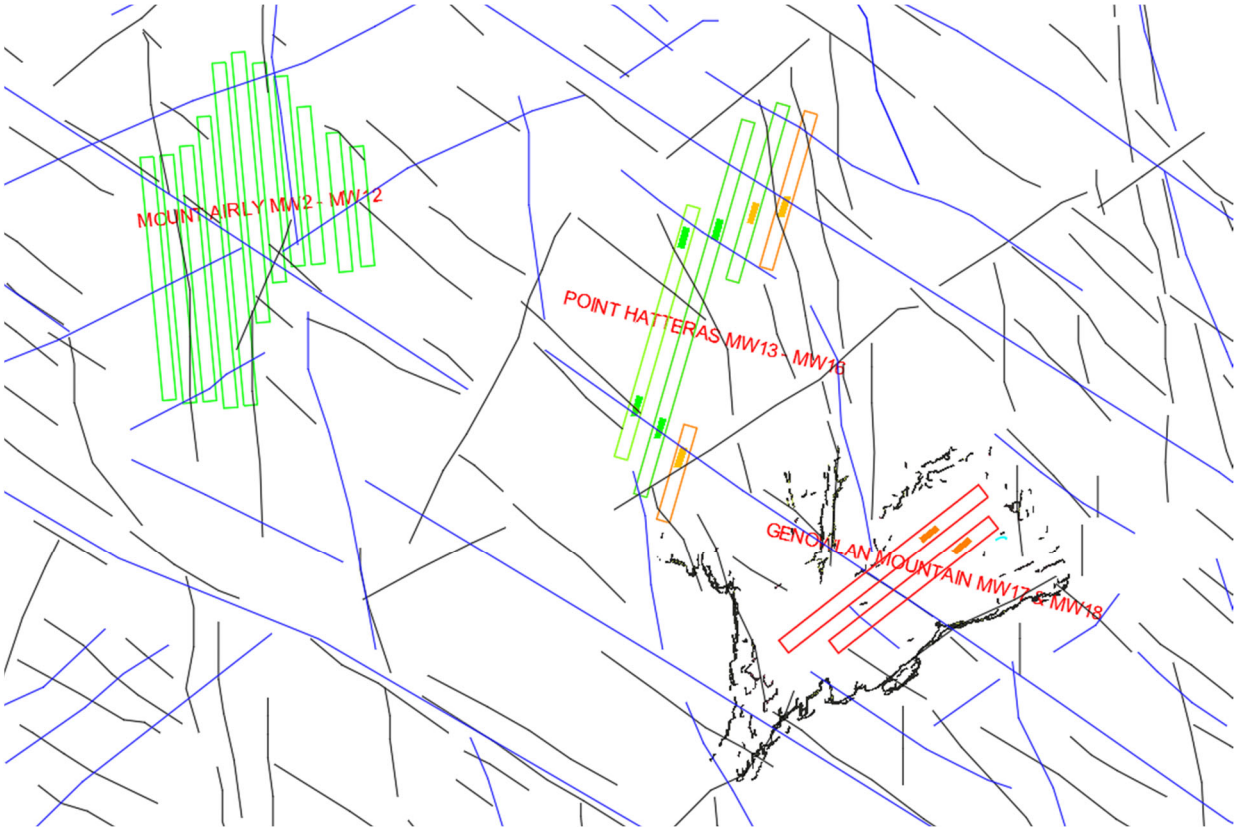


**Fig. 2.7 Identified geological structures at Airly before panel extraction, i.e. in EIS with current mined panel boundaries (Source: CA, 2022)**

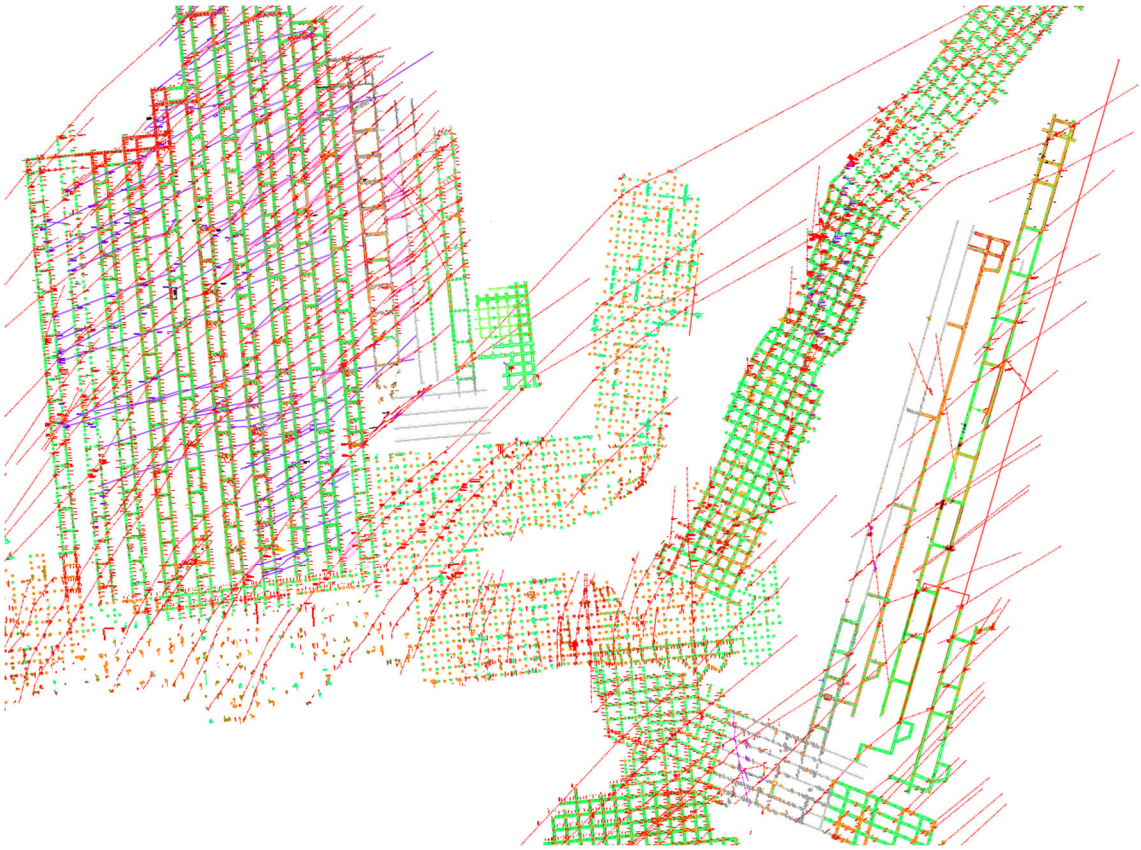

**Fig. 2.8 Identified geological structures underground, i.e. at seam level at Airly (Source: CA, 2022)**

Fig. 2.10, which shows a closer view of identified faults over a portion of MWs 2 to 9, highlights that many normal faults occur across Mount Airly at a spacing of approximately every 50 m, with a throw of 0.2 to 0.7 m and a dip of between 20 to 50° towards the south east. In other words, most of the mini wall pillars have at least one fault in them or immediately above them and some of pillars have two faults cutting across them. It can be noted that the area where the maximum subsidence was coincided with an area that has the greatest depth of cover and had several pillars with two faults crossing through them.

### 2.1.2. Potential effects of faults on subsidence development at Airly Mine

The presence of these regularly spaced faults with throws on average of 0.3 m and with average dip angles of 45° could have resulted in shearing and subsidence along the dip of these faults. Increased horizontal strata movements were observed towards the south-east, and this could have led to increased failures in the relatively weak strata layers over the pillars, (as sketched Fig. 2.9).

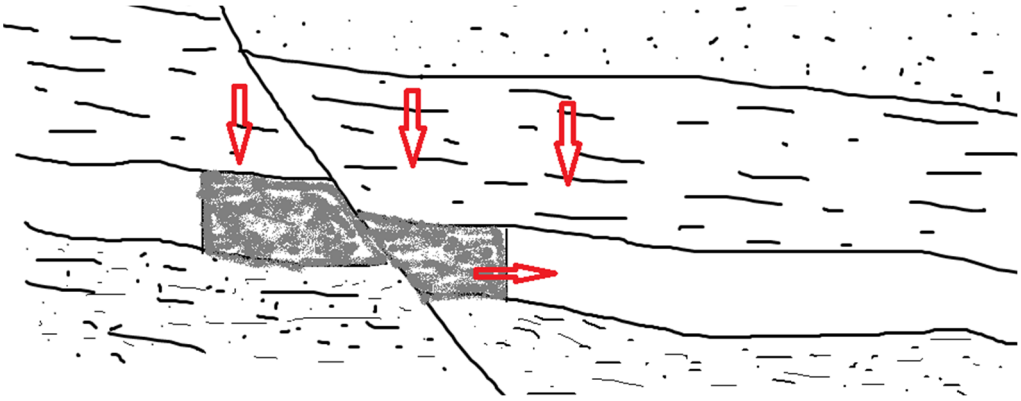

**Fig. 2.9 Possible increased vertical & horizontal movements along faults at pillars (MSEC).**

Similar faults have now been identified in the mine workings under Genowlan Mountain (MWs13-16). The throw direction and magnitudes of the Genowlan faults appear to be similar to the Mount Airly faults, but the spacing between the Genowlan faults may be slightly further apart.

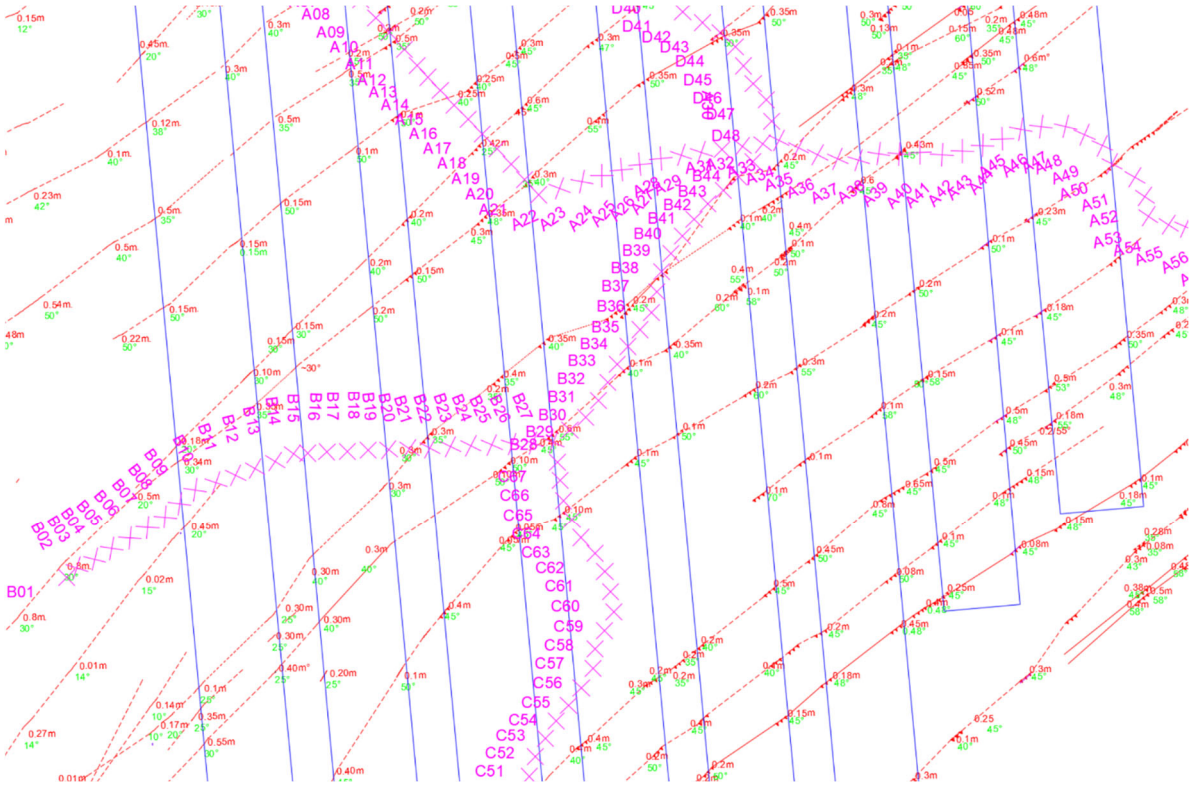

**Fig. 2.10 Detailed view on faults over MWs2-9 near the B-A Line over Mount Airly (CA & MSEC)**

Because of their possible influence on increasing subsidence levels and modifying the shapes of the observed subsidence and horizontal movement profiles over Mount Airly and, since they could also contribute to increased levels of subsidence over Genowlan Mountain, an extended literature review was undertaken on the effects of faults on subsidence profiles and subsidence development.

The results of this literature review was presented in various MSEC reports that were included in previously submitted Airly applications, such as in Appendix A of our MSEC Report Number: MSEC1169, (Feb 2021), pages 70 to 79 or in Appendix D of our MSEC Report Number: MSEC1195, (Oct 2021), pages 103 to 112.

As is discussed in those reviews, whilst there are many published papers that indicated that sudden changes in overburden geology, such as faults and dykes, changed the observed profiles of mine subsidence over and near mined panels, the effect is not generally significant - apart from some extreme cases with large faults or dykes. It appears that the presence of the larger faults can increase the amount of observed sag subsidence over the mined panels on one side of the fault and reduce the observed subsidence on the other side of the fault. Changes to the observed subsidence profiles were commonly reported in cases where the faults extend from the seam up to the surface. These changes to the subsidence profiles generally developed immediately but in some cases they occurred gradually over time, with greatest rates of change occurring when the surface areas were directly mined beneath.

This review also found that most mining companies prefer not to mine through large faults, but mining regularly occurs through small faults - as is being undertaken at Airly. In these cases, the observed surface subsidence profiles, over these small faults are not very different from the observed profiles over similar panels with no faults, and the observed subsidence did not vary much from the levels that were expected.

The following sections provide overviews of conventional and non-conventional mine subsidence effects and the methods that have been used to predict these movements. Further information is also provided in the background reports entitled *Introduction to Longwall Mining and Subsidence* and *General Discussion on Mine Subsidence Ground Movements* which can be obtained from *www.minesubsidence.com*.

## 3.1. Overview of conventional subsidence effects

The normal ground movements resulting from the extraction of panels (i.e., longwalls or mini walls) are referred to as conventional or systematic subsidence effects. These effects are described by the following parameters:

- **Subsidence** usually refers to vertical displacement of a point, but subsidence of the ground actually includes both vertical and horizontal displacements. These horizontal displacements in some cases, where the subsidence is small beyond the panel goaf edges, can be greater than the vertical subsidence. Subsidence is usually expressed in units of *millimetres (mm)*.
- **Tilt** is the change in the slope of the ground as a result of differential subsidence and is calculated as the change in subsidence between two points divided by the distance between those points. Tilt is, therefore, the first derivative of the subsidence profile. Tilt is usually expressed in units of *millimetres per metre (mm/m)*. A tilt of 1 mm/m is equivalent to a change in grade of 0.1 %, or 1 in 1000.
- **Curvature** is the second derivative of subsidence, or the rate of change of tilt, and is calculated as the change in tilt between two adjacent sections of the tilt profile divided by the average length of those sections. Curvature is usually expressed as the inverse of the **Radius of curvature** with the units of *1/kilometres ($km^{-1}$)*, but the values of curvature can be inverted, if required, to obtain the radius of curvature, which is usually expressed in *kilometres (km)*.
- **Strain** is the relative differential horizontal movements of the ground. **Normal strain** is calculated as the change in horizontal distance between two points on the ground, divided by the original horizontal distance between them. Strain is typically expressed in units of *millimetres per metre (mm/m)*. **Tensile strains** occur where the distances between two points increase and **Compressive strains** occur when the distances between two points decrease. So that ground strains can be compared between different locations, they are typically measured over bay lengths that are equal to the depth of cover between the surface and seam divided by 20.

  Whilst mining induced normal strains are measured along monitoring lines, ground shearing can also occur both vertically and horizontally across the directions of monitoring lines. Most of the published mine subsidence literature discusses the differential ground movements that are measured along subsidence monitoring lines; however, differential ground movements can also be measured across monitoring lines using 3D survey monitoring techniques.
- **Horizontal shear deformation** across monitoring lines can be described by various parameters including horizontal tilt, horizontal curvature, mid-ordinate deviation, angular distortion and shear index. It is not possible, however, to determine the horizontal shear strain across a monitoring line using 2D or 3D monitoring techniques. High deformations along monitoring lines (i.e., normal strains) are generally measured where high deformations have been measured across the monitoring line (i.e., shear deformations), and vice versa.

The **incremental** subsidence, tilts, curvatures and strains are the additional parameters which result from the extraction of each mini wall. The **cumulative** subsidence, tilts, curvatures and strains are the accumulated parameters which result from the extraction of a series of mini walls. The **total** subsidence, tilts, curvatures and strains are the final parameters at the completion of a series of mini walls.

The **travelling** tilts, curvatures and strains are the transient movements as the mini wall extraction face mines directly beneath a given point.

## 3.2. Far-field movements

The measured horizontal movements at survey marks which are located beyond the mined panel goaf edges and over solid unmined coal areas are generally greater than the observed vertical movements at those marks. These horizontal movements are often referred to as *far-field movements*.

Hence far-field horizontal movements are associated with the release of in situ horizontal stresses towards the mined void. Higher levels of far-field horizontal movements are associated with areas with higher in situ horizontal stresses.

Far-field horizontal movements tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain. These movements generally do not result in impacts on natural features or built environments, except where they are experienced by large structures which are very sensitive to differential horizontal movements.

In some cases, higher levels of far-field horizontal movements have been observed where steep slopes or surface incisions exist nearby, as these features influence both the magnitude and the direction of ground movement patterns.

Similarly, increased horizontal movements are often observed around sudden changes in geology or where blocks of coal are left between mini walls or near other previously extracted series of mini walls due to concentrations of in situ horizontal stresses. In these cases, the levels of observed subsidence can be slightly higher than normally predicted, but these increased movements are generally accompanied by very low levels of tilt and strain.

Far-field horizontal movements and the method used to predict such movements are described further below.

## 3.3. Overview of non-conventional subsidence effects

Conventional subsidence profiles are typically smooth in shape and can be explained by the expected caving mechanisms associated with overlying strata spanning the extracted void. Normal conventional subsidence movements due to mined panel extraction are easy to identify where mini walls are regular in shape, the extracted coal seams are relatively uniform in thickness, the geological conditions are consistent and surface topography is relatively flat.

As a general rule, the smoothness of the profile is governed by the depth of cover and lithology of the overburden, particularly the near surface strata layers. Where the depth of cover is greater than 300 m, the observed subsidence profiles along monitoring lines are generally smooth. Where the depth of cover is less than 100 m, the observed subsidence profiles along monitoring lines are generally very irregular. Very irregular subsidence movements with very high levels of tilts, curvatures and strains are often observed at very shallow depths of cover where the collapsed zone above the extracted mini walls extends up to or near to the surface.

Irregular subsidence movements are occasionally observed at the deeper depths of cover along an otherwise smooth subsidence profile. The cause of these irregular subsidence movements can be associated with:

- geological structures or changes in surface geology;
- steep topography; and
- valley-related mechanisms.

Non-conventional movements due to geological conditions, steep topography and valley-related movements are discussed in the following sections.

### 3.3.1. Non-conventional subsidence movements due to geological conditions

It is believed that most non-conventional ground movements are a result of the reaction of near surface strata to increased horizontal compressive stresses due to mining operations. Some of the geological conditions that are believed to influence these irregular subsidence movements are the blocky nature of near surface sedimentary strata layers and the possible presence of unknown faults, dykes or other geological structures, cross bedded strata, thin and brittle near surface strata layers and pre-existing natural joints. The presence of these geological features near the surface can result in a bump in an otherwise smooth subsidence profile and these bumps are usually accompanied by locally increased tilts, curvatures and strains.

Even though it may be possible to attribute a reason behind most observed non-conventional ground movements, there remain some observed irregular ground movements that still cannot be explained with the available geological information. The term “anomaly” is therefore reserved for those non-conventional ground movement cases that were not expected to occur and cannot be explained by any of the above possible causes.

It is not possible to predict the locations and magnitudes of non-conventional anomalous movements. In some cases, approximate predictions for the non-conventional ground movements can be made where the underlying geological or topographic conditions are known in advance. It is expected that these methods will improve as further knowledge is gained through ongoing research and investigation.

### 3.3.2. Non-conventional subsidence movements due to steep topography

Non-conventional movements can also result from increased horizontal movements in the downslope direction where panels are extracted beneath steep slopes. In these cases, elevated tensile strains develop near the tops and sides of the steep slopes and elevated compressive strains develop near the bases of the steep slopes. Potential impacts resulting from the increased horizontal movements include the development of tension cracks at the tops and sides of the steep slopes and compression ridges at the bottoms of the steep slopes.

Further discussions on the potential for downslope movements for the steep slopes within the Study Area are provided in Section 7.5.

### 3.3.3. Valley-related effects

The streams within the Study Area may be affected by valley-related movements, which are commonly observed along streams in the NSW coalfields. Valley bulging movements are a natural phenomenon, resulting from the formation and ongoing development of the valley, as illustrated in Fig. 3.1. The potential for these natural movements is influenced by the geomorphology of the valley.

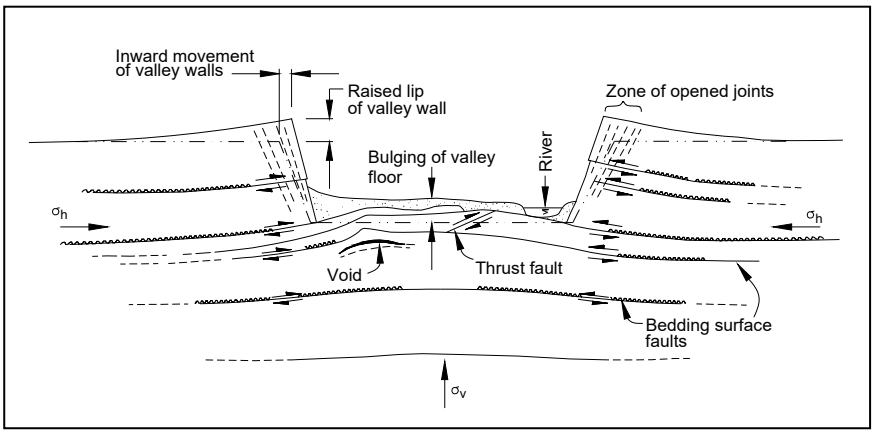


**Fig. 3.1 Valley formation in flat-lying sedimentary rocks (after Patton and Hendren 1972)**

Valley-related movements can be caused by, or accelerated by, mine subsidence as the result of a number of factors, including the redistribution of horizontal in situ stresses and downslope movements. Valley-related movements are normally described by the following parameters:

- **Upsidence** is the reduced subsidence, or the relative uplift within a valley which results from the dilation or buckling of near surface strata at or near the base of the valley. The magnitude of upsidence, which is typically expressed in the units of *millimetres (mm)*, is the difference between the observed subsidence profile within the valley and the conventional subsidence profile which would have otherwise been expected in flat terrain.
- **Closure** is the reduction in the horizontal distance between the valley sides. The magnitude of closure, which is typically expressed in the units of *millimetres (mm)*, is the greatest reduction in horizontal distance between any two points on the opposing valley sides.
- **Compressive strains** occur within the bases of valleys as a result of valley closure and upsidence movements. **Tensile strains** also occur in the sides and near the tops of the valleys as a result of valley closure movements. The magnitudes of these strains, which are typically expressed in the units of *millimetres per metre (mm/m)*, are calculated as the changes in horizontal distance over a standard bay length, divided by the original bay length.

The predicted valley-related movements for the streams due to the proposed mini walls can be determined using the empirical method outlined in ACARP Research Project No. C9067 (Waddington and Kay, 2002), referred to as the 2002 ACARP method in this report. More recently, the empirical prediction method has been refined based on further research undertaken as part of ACARP Research Project No. 18015 (Kay and Waddington, 2014), referred to as the 2014 ACARP method in this report.

However, it is unlikely that valley upsidence and closure ground movements will be measurable in the valley floor areas of Capertee Valley beyond the major escarpments that surround the mesas or over the two mesas at Airly for several reasons. These valley upsidence and closure ground movements were first observed in the Southern Coalfields, and they were found to be due to redistributions of in situ horizontal stresses around mined openings and the incised valleys. These movements were found to be associated with longwall mining with wide panels that cause considerable changes to the ground stresses around the longwall panels. These movements are also found to be associated with areas with higher in situ horizontal stress than is expected within the Airly mine workings and the strata layers overlying the panels at Airly.

That is, at Airly, the valley related movements are expected to be negligible because the:

- coal seams outcrop around the mesas well above the floor of the Capertee Valley,
- in situ horizontal stresses within the mine workings and the overlying strata have already been partially relaxed during the weathering and erosional processes that formed these mesas; and
- proposed panels will be very sub-critical in width causing far less redistribution of horizontal stresses.

Further details can be obtained from the background report entitled *General Discussion on Mine Subsidence Ground Movements* which can be obtained at [www.minesubsidence.com](http://www.minesubsidence.com).

## 4.1. Background to early subsidence engineering studies over Mount Airly MWs 2 to 12

The selected method of mining that was proposed for Airly was unusual in that very narrow sub-critical panels were to be extracted with strong stable chain pillars in order to minimise surface subsidence and minimise the impacts on the surface areas of Mount Airly and Genowlan Mountain. Most partial extraction systems and longwall panels are designed with much wider panels than Airly. That is, this mine design is unique. It would have been very disappointing for the designers and CA that far greater levels of subsidence were measured over MWs02 to MW10 at Mount Airly instead of the very low target subsidence limits. Hence, it is important to appreciate why the increased levels of subsidence measured at Airly were much higher than was predicted.

The 2014 Airly EIS was based primarily on the empirical modelling by Strata Engineering in 2012 and Golder Associates in 2014 that was backed up by some numerical modelling with using the "LaMODEL" numerical model. This empirical modelling determined that sag subsidence would be very small and the subsidence caused by the squashing or compression of the strata layers in the chain pillars and the strata layers above and below the seam would also be small. This empirical modelling was predominantly based on the successful monitoring and modelling that was undertaken for similar mine layouts and similar maximum subsidence targets under similar cliff lines at the Centennial Clarence Mine, which is located approximately 50 kms to the south from Airly.

First it should be appreciated that few mined panels are extracted at the very narrow panel widths proposed in the 2014 EIS and, hence, there was little empirical subsidence monitoring data to compare the predicted design against, apart from the continuing successful experience at the Clarence mine (White, (2014) and Hill & White, (2017). This Clarence subsidence monitoring data was used by Strata Engineering (2012), and later Golder Associates (2014), and Strata$^2$ (2020) to support the initial proposed mine layout designs for the Airly Mine. However, as discussed in Section 1.1, in early 2019 CA advised that the maximum monitored subsidence after extracting the first three mini walls, i.e., MW02, MW03 and MW04, had reached 185 mm which exceeded the Airly subsidence limit of 125 mm.

As required by TARP triggers, when the observed subsidence exceeded the predicted levels, CA sought advice on why these increased levels of subsidence occurred. A report by Strata$^2$, (May 2020), titled "*Panel and Pillar Mining Zone: Updated Subsidence Model*", Report No: AIR-015-Rev1, advised that two methods of subsidence estimation were used for the PPMZ mini walls: an empirical model and a numerical approach (LaMODEL). This report advised that the empirical methods were based on a Western Coalfields database of low span (W) to DoC (H) ratio panels. For this report the monitoring results of panels in the Lithgow seam were plotted separately to those from the Katoomba seam and at very low W/H ratios significantly higher subsidence was noticed over the Lithgow seam. This report advised that the earlier predictive methods used missed the full influence of the weaker strata layers that overlie the chain pillars and the influence of the many geological faults. Instead, the Airly mine planning heavily relied on the data measured at the nearby Clarence Mine.

Strata$^2$ (2020) advised that the empirical prediction utilised a database of subsidence results over panels with low span (W) to depth (H) ratios, focussing largely on Western Coalfield experiences. Strata$^2$ (2020) advised later, i.e., after the increased levels of subsidence were recorded over MWs 02 to 04 that the empirical predictive curves that were used had relied heavily on the Clarence subsidence data set. Later Strata$^2$ advised that studies had now revealed that the overburden geology at Airly was not similar as Clarence mined the Katoomba seam while Airly mined was the Lithgow seam. Strata$^2$ (2020) also advised that factors affecting the difference in subsidence between the two Western Coalfield seams were that:

- the thickness of the Permian overburden is 50% greater in the case of the Lithgow Seam at Airly, compared to the Katoomba Seam at Clarence (i.e., around 90m versus 60m). Also, the immediate and near roof of the Katoomba Seam is stiffer and more competent; factors that would be expected to result in less subsidence; and
- the Katoomba Seam is one of the strongest Australian coals, whereas the Lithgow Seam is of average strength. The stronger the seam, the less potential for rib softening at the margins of the extracted area.

Strata$^2$ advised (2020) that their Western Coalfields empirical mine subsidence database, which was relied on for the empirical mine panel design, predominantly included mine subsidence surveying data from mines that operated in the Katoomba Seam, such as Clarence. They later recognised that the thickness of Permian strata in the immediate roof was approximately 50% greater in the case of the Lithgow Seam at Airly, as opposed to the Katoomba Seam at Clarence (i.e., around 90m versus 60m). It was also noted that the near roof of the Katoomba Seam was stiffer and more competent, which are both factors that would be expected to result in less subsidence.

Finally, after reviewing the pillar compression results from Airly, Strata$^2$ advised that it became clearer that the behaviour of the Katoomba Seam pillars was very different from that of the Lithgow Seam pillars.

Based on the modelling that was undertaken in 2019 and 2020 for CA by Dr Chengguo Zhang of UNSW, using the two-dimensional model UDEC, Zhang concluded that the increased subsidence was mainly caused by the squashing and shearing within the weaker coal seams, shales, mudstones, and claystones that overlie the coal seams. Dr Zhang also found that the regular spaced faults that were identified within the seam (refer to Section 2.1.1 and Section 2.1.2 ) had a significant effect on both the magnitude of mining-induced subsidence and the shape of the mining profiles over the mined panels. He advised that his UDEC modelling results did not match the observed levels of subsidence until he included the influence of these faults in his models and then, the UDEC modelling results matched the observed subsidence levels well.

As discussed in Section 2.0, further mathematical modelling was undertaken in 2020 by Yvette Heritage of SCT in 2021 using FLAC. This new modelling indicated that the increased subsidence that was measured over MWs 2 to 10, resulted from failures, not within the pillars, but within the weaker than expected overburden strata layers that overlie the chain pillars. This modelling that was undertaken by SCT in 2021, using the FLAC 2D programme, (refer to SCT Report AIRLY5240, dated 20 January 2021 and SCT Report AIRLY5265, August 2021), was first aimed at calibrating the FLAC model against the observed subsidence measured over MWs 2 to 7 and, then this model was used to predict the likely subsidence over MWs 11 and 12 under Mount Airly and then MWs 13 to 16 and MWs17 & 18 under the Genowlan Mountain. (Refer to Fig. 1.3 for these locations).

Fig. 4.1 shows the subsidence monitoring and the FLAC modelling results over MWs 02 to 07 from this SCT 2021 study. It can be noted that the model matched the maximum subsidence observed, however the shapes of the observed subsidence profiles tend to be steeper than the predicted or modelled profiles, particularly over the initial goaf edges. It can also be noted that areas of uplift, of up to 20 mm, were observed around the subsidence bowl.

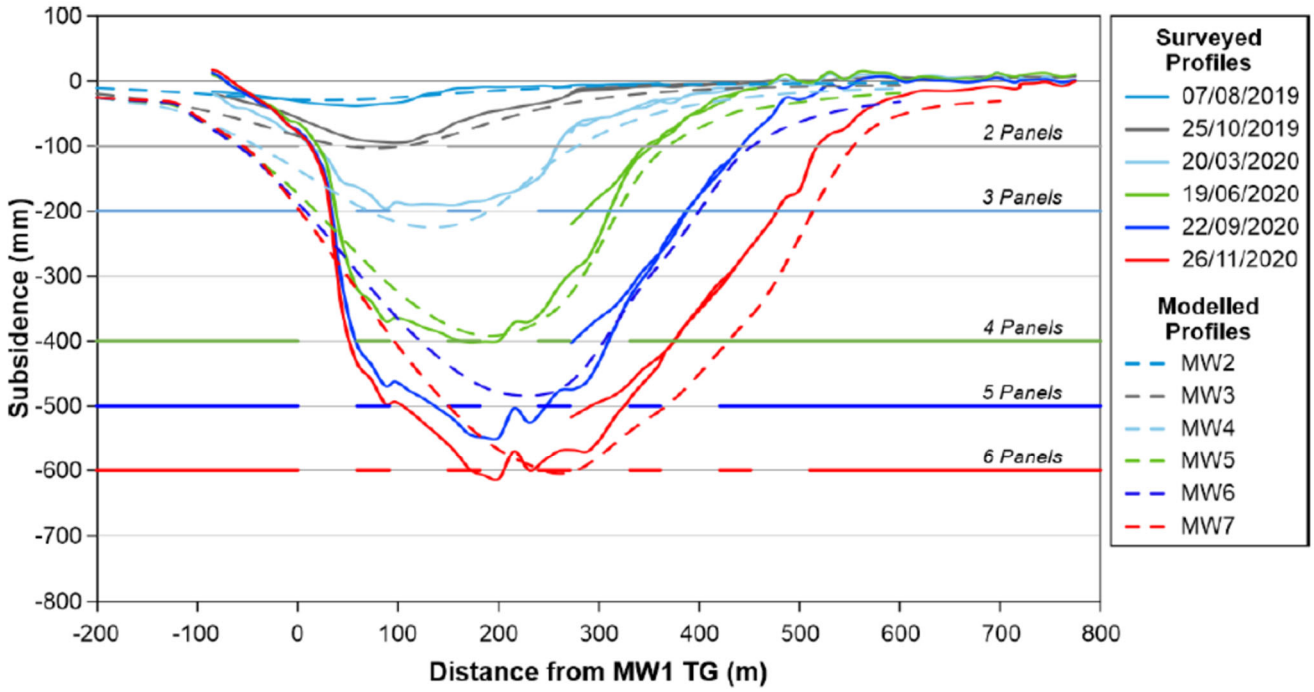


**Fig. 4.1 SCT FLAC modelling results over MWS 02 to 07 along the combined B-A Line (SCT, 2021)**

This FLAC modelling confirmed that the increased subsidence was rock failure and softening of the strata above the pillars which then compressed under the abutment load. SCT advised that this fracturing of the weaker strata layers reduced the stiffness of the strata, and the increased subsidence was not related to pillar instability or pillar failure at the coal seam mining horizon level.

Heritage, Y, et al, (SCT and Centennial, 2022), presented a paper at the 2022 MSTS Conference that confirmed the modelling showed the subsidence was caused by fracturing of strata 30-35m above the pillars (between the caved zones). That is, the SCT FLAC modelling indicated that the main factors contributing to the fracturing of the strata above the pillars and causing the increased subsidence was a function of the weak strata properties, depth of cover, pillar width and reduced confinement due to adjacent goafs. SCT advised that the key control mechanism that can be used to reduce surface subsidence for these panels was to widen the chain pillar widths in order to result in an elastic response for the pillar loading and to minimise the fracturing and rock mass damage of the strata overlying the pillars.

SCT modelling advised that, with the mini wall panel widths of 61 m (rib to rib) and much wider chain pillar widths of 70 m (solid), the predicted subsidence, after four side by side mini walls are extracted, i.e., for MWs 13 to 16, (*where the DoC ranged up to 305 m*), would be 115 mm, which was only 10 mm less than the EIS maximum subsidence prediction of 125 mm. However, SCT advised that this modelling was undertaken using the DoC of 280 m which represents the upper range of strata depth and abutment loading and this modelling should be conservative.

CA has now extracted MW 13, 14 and 15A under the Point Hatteras region of the Genowlan Mountain. MW13 was extracted with low levels of subsidence that were less than 40 mm, i.e., similar to the levels of subsidence measured over MW02 at Mount Airly.

Subsidence monitoring over MWs 13 and 14 after MW14 was fully extracted indicated that the monitored subsidence levels were close to the SCT FLAC predicted subsidence levels for the first two mini wall panels, see detailed monitoring result below.

Subsidence monitoring to date after MW15A was extracted indicates that the monitored subsidence levels are much lower than to the SCT FLAC predicted subsidence levels for three mini wall panels, see details below.

## 4.2. Monitoring results over Mount Airly MWs 2 to 12

A summarised discussion of the monitoring results over MWs 2 to 12 was presented in Section 1.1 and further details of this monitoring are presented below.

CA has successfully carried out extensive subsidence monitoring over Mount Airly and Genowlan Mountain. Fig. 4.2 shows the layout of MWs 02 to 12, the locations of the four survey lines over Mount Airly, i.e., the A, B, C and D Lines. The combined B-A cross line has been predominantly used to show the subsidence levels over MWs02 to 12.

Fig. 4.3, shows where the mini wall face was for the available subsidence monitoring dates in blue and it shows the dates in **red** when extraction started in each of the MW panels commenced and when it was completed. It can be noticed that the monitored survey dates didn't always coincide with when the face completed extraction within each mini wall and in those cases the survey dates chosen by MSEC for the end of each panel has been highlighted with a blue ellipse.

The incremental subsidence per panel would have been slightly more or less for some panels if the survey had been undertaken when the face completed each mini wall, but these differences are not significant.

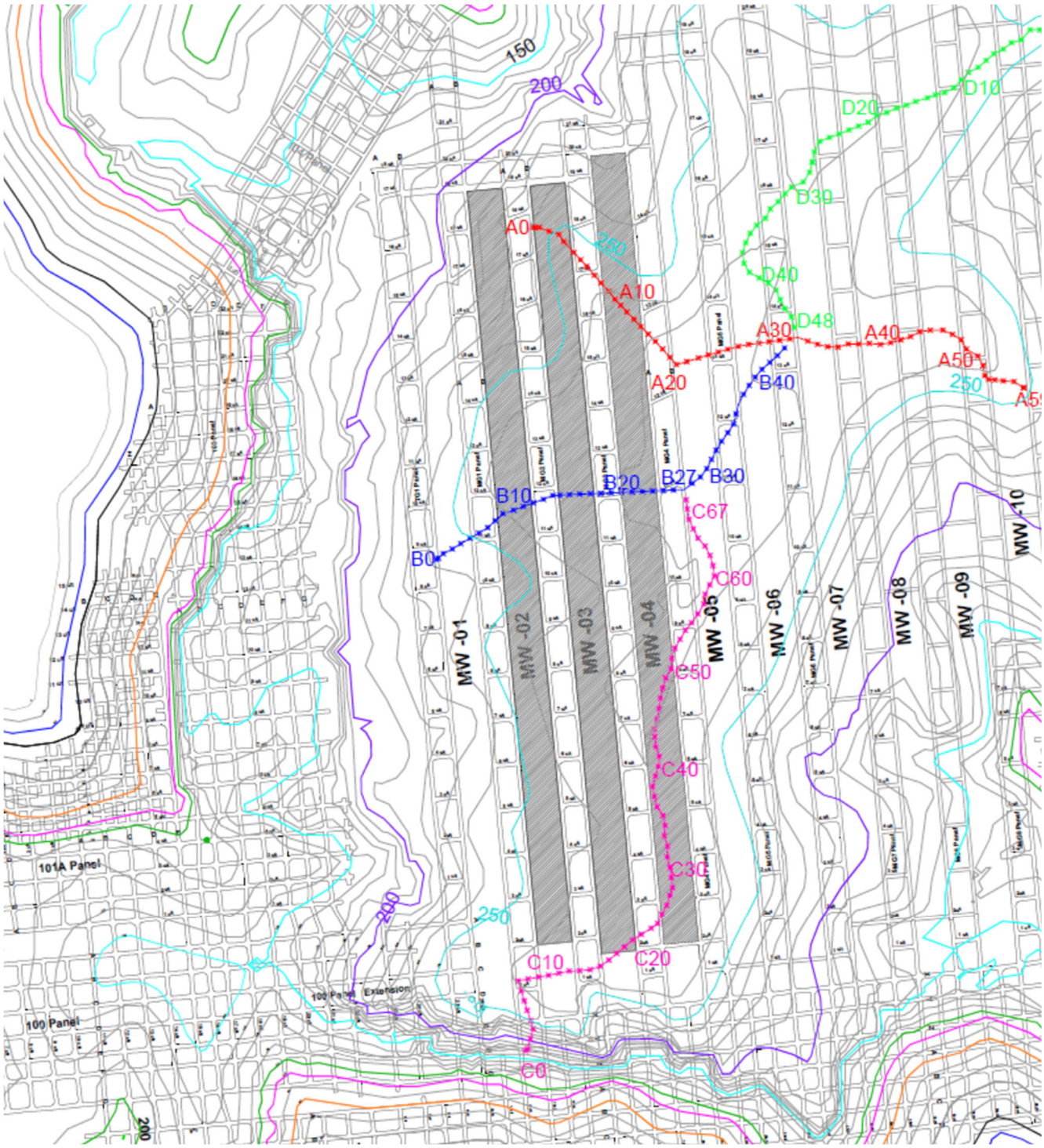


**Fig. 4.2 Location of A, B, C & D Monitoring Lines and pegs over MWs 02 to 04, Mount Airly (Strata²).**

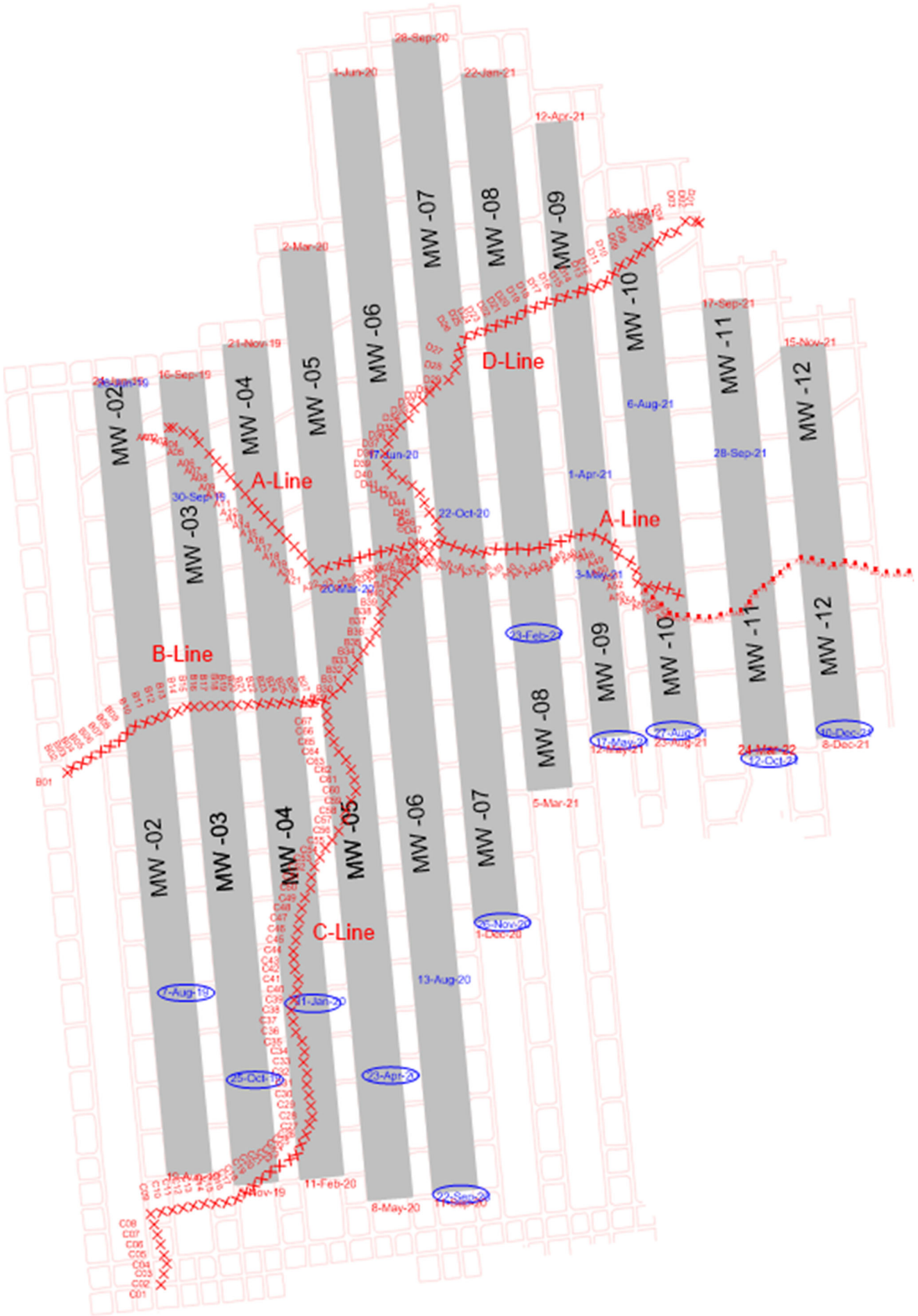


**Fig. 4.3 MWs02 to MW 12 mine plan, survey monitoring pegs and face positions at available survey dates over Mount Airly (MSEC)**

Due to the failure of the weaker than expected strata layers that lay immediately over the chain pillars and it can be noted, from Table 2.1, Table 2.2, Fig. 4.4 and Fig. 4.5, that increased subsidence of up to 727 mm has been measured over MW05 one year after MW12 was extracted.

The magnitudes of the maximum observed subsidence over each mini wall are shown in Table 2.1 below.

**Table 2.1. Measured maximum total and incremental subsidence over the extracted mini walls**

| Extraction Plan Area | Panel | Survey Date | Panel Extraction End Date | Maximum Subsidence (mm) | Incremental Subsidence (mm) |
|---|---|---|---|---|---|
| | MW2 | 7-Aug-19 | 19-Aug-19 | 38 | 38 |
| | MW3 | 25-Oct-19 | 5-Nov-19 | 95 | 63 |
| | MW4 | 31-Jan-20 | 11-Feb-20 | 186 | 104 |
| | MW5 | 23-Apr-20 | 8-May-20 | 297 | 144 |
| Mount | MW6 | 22-Sep-20 | 11-Sep-20 | 548 | 289 |
| Airly | MW7 | 26-Nov-20 | 1-Dec-20 | 612 | 177 |
| | MW8 | 23-Feb-21 | 5-Mar-21 | 655 | 123 |
| | MW9 | 17-May-21 | 12-May-21 | 670 | 164 |
| | MW10 | 27-Aug-21 | 23-Aug-21 | 680 | 131 |
| | MW11 | 12-Oct-21 | 12-Oct-21 | 690 | 77 |
| | MW12 | 10-Dec-21 | 8-Dec-21 | 713 | 44 |
| | MW12 + 1 yr | 12-Jan-23 | 8-Dec-21 | 727 | 52 |
| Point | MW13 | 1-Feb-22 | 24-Mar-22 | Approx. 38 * | 38 |
| Hatteras * | MW14 | 16-Dec-22 | 15-Dec-22 | Approx 75 * | 52 |
| | MW15A | 12-June-23 | 10-Jun- 23 | Approx 86 * | Approx 50 |

* continuous data from the GNSS monitoring units

Table 2.2 shows similar data to Table 2.1, but it includes the observed subsidence at the goaf edges of the mined void, i.e., the initial goaf edge (IGE) and the advancing goaf edge (AGE) subsidence values for the total subsidence profile and for the incremental panel.

This table also details the names of the pegs where the maximum subsidence was measured. The values in Table 2.1 and Table 2.2 were determined from the subsidence monitoring for the best available survey monitoring dates, see Fig. 4.3.

**Table 2.2 Further details on Observed Subsidence Profiles over MWs 2 to 12**

| Mini Walls | Survey monitoring Date | IGE Tot Subs | Max Tot Subs | At Peg | AGE Tot Subs | IGE Incr Subs | Max Incr Subs | At Peg | AGE Incr Subs |
|---|---|---|---|---|---|---|---|---|---|
| MW2 | 7-8-19 | 31 | 38 | B12 | 36 | 31 | 38 | B12 | 36 |
| MW2-MW3 | 25-10-19 | 62 | 95 | B15 | 65 | 30 | 63 | B17 | 57 |
| MW2-MW4 | 31-1-20 | 78 | 186 | B16 | 115 | 21 | 104 | B18 | 83 |
| MW2-MW5 | 23-4-20 | 83 | 297 | B21 | 100 | 7 | 144 | B21 | 72 |
| MW2-MW6 | 22-9-20 | 80 | 548 | B21 | 126 | -10 | 289 | B28 | 110 |
| MW2-MW7 | 26-11-20 | 82 | 612 | B22 | 105 | 4 | 177 | B42 | 90 |
| MW2-MW8 | 23-2-21 | 90 | 655 | B22 | 78 | 12 | 123 | A33 | 72 |
| MW2-MW9 | 17-5-21 | 73 | 670 | B26 | 82 | -10 | 164 | A38 | 68 |
| MW2-MW10 | 27-8-21 | 82 | 680 | B28 | 42 | 0 | 131 | A45 | 53 |
| MW2-MW11 | 12-10-21 | 88 | 699 | B28 | 10 | 7 | 77 | A49 | 40 |
| MW2-MW12 | 10-12-21 | 85 | 713 | B28 | 22 | 0 | 44 | A75 | 25 |
| MW12+1 yr Residual Subs | 12-1-23 | 99 | 727 | B28 | 37 | 6 | 52 | A46 | 16 |

These increased levels of subsidence over MWs 2 to 12 can be best appreciated when viewing Fig. 4.4, which shows the observed total subsidence, tilt and strain profiles plotted as perpendicular distances from the initial goaf edge of MW2 and it shows the incremental subsidence profiles along the combined B-A Line cross section across the Mount Airly mesa after extracting MWs 02 to 12,.

The incremental subsidence profiles in Fig. 4.5 show the additional subsidence over MWs 2 to 12 caused by the extraction of each panel. It can be noted that additional subsidence was monitored over or above MW2 as each mini wall was extracted up to MW08. That is, when MW09 was extracted, additional subsidence was observed over the six pervious mini walls, i.e., MWs 03 to 09. Similarly, when MW09 was extracted, additional subsidence was observed over MWs 04 to 10.

These plots indicate that the subsidence generated by spanning over the narrow panel voids was very small, i.e., in the order of 30 mm, but the additional squashing or compression of the strata layers above, in and below the chain pillars was considerable, particularly after MW6 was extracted.

Fig. 4.5 also shows that the greatest amount of incremental subsidence per mini wall panel was measured when MW06 was extracted, i.e., on the 22-Sep-20, when up to 289 mm extra subsidence was measured since MW05 was surveyed on 23-Apr-2022. The next highest measured incremental subsidence per panel was monitored at 177 mm when MW07 was extracted. There could be several factors contributing to why the maximum incremental subsidence was monitored when MW06 was extracted rather than the other mini walls, such as:

- The date of the monitoring survey used for the MW06 incremental subsidence was the first panel to match the date when all extraction in MW06 was completed, (the previous surveys were monitored too early at about 80% of the panel length), and hence a slight extra amount of extra subsidence was attributed to MW06;
- Up to 160 mm incremental subsidence was measured over MW02 when MW06 was extracted, which indicates that the strata over the pillar between MW02 and MW03 must have failed as MW06 was extracted and then the strata over the other chain pillars also failed most at that time. (This extra subsidence may have been associated with when the thick Bura-Moko Head Sandstone unit failed);
- After MW06 was extracted the overall total span between the tail gate of MW02 and the main gate of MW06 was 362 m and, using an average DoC of 265 m, this distance represents about 1.4 times the DoC, and this indicates the total span over MW02 to MW06 had just became supercritical. Hence, it may be that the overlying stronger Burra-Moko Head Sandstone was able to span over the voids until MW06 was extracted, but, then, as MW06 was mined, this thick sandstone beam couldn't span the widening void and started to fail causing increased loading on the strata over each of the chain pillars and this resulted in the higher than expected incremental subsidence when MW06 was extracted.
- Other possible factors include the greatest DoCs occurred over MW04, MW05 and MW06 and the chain pillars between MWs 04 and 05, had several large faults with the greatest throws of 0.7m.

After extensive consultations, a revised mine design for the Mount Airly mesa was approved in 2021 for MWs 11 and MW12, which most importantly included a substantially increased chain pillar width between MW10 and MW11. Panel widths for all mini walls remained the same at 61 m wide. Whilst the chain pillars for MWs 02 to 10 were 29.5 m wide, the large chain pillar width between MW10 and MW11 was 60 m. The chain pillar width between MW11 and MW12 was 40 m.

Fig. 4.6, below, shows the observed total subsidence contours over the Mount Airly mesa after MWs 02 to 12 (2021).

It could be assumed that the asymmetry of the observed subsidence profiles could be a result of the influence of the angle of the many faults that were discovered in the workings in Mount Airly and in Genowlan Mountain.

Another interesting phenomenon can be noted that around the edges of the subsidence bowls the measured subsidence often shows that as the strata over the bowl subsided downwards, parts of the edges around the bowl were lifted upwards, i.e., higher than their position before mining. This small amount, i.e., up to 36mm of uplift, complicates the calculations of increments and in some cases, the increment of subsidence can be large than the total subsidence at these pegs.

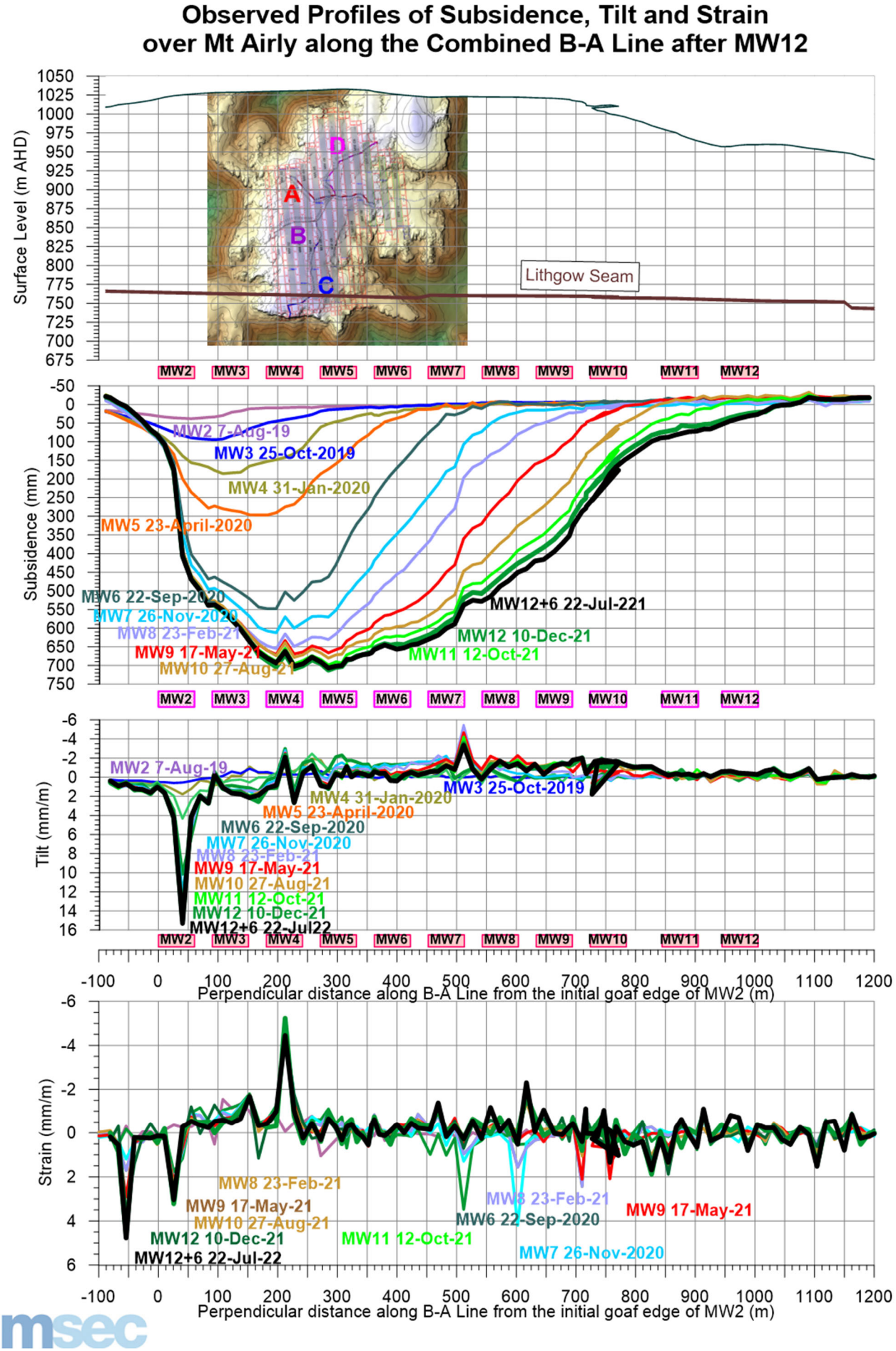


**Fig. 4.4 Observed total and incremental subsidence profiles after MWs 02 to 12 (MSEC)**

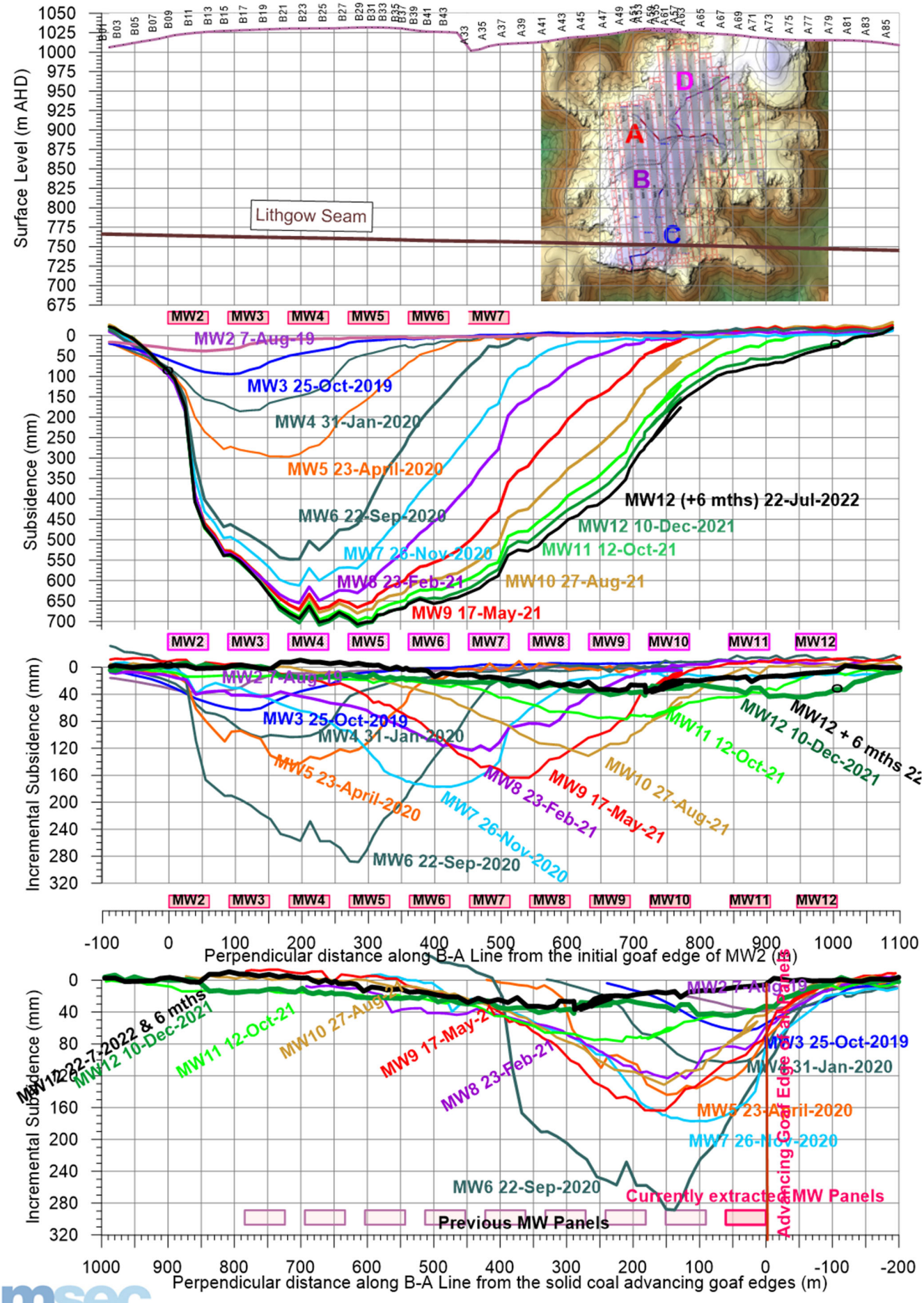


**Fig. 4.5 Observed total and incremental subsidence profiles after MWs 02 to 12 (MSEC)**

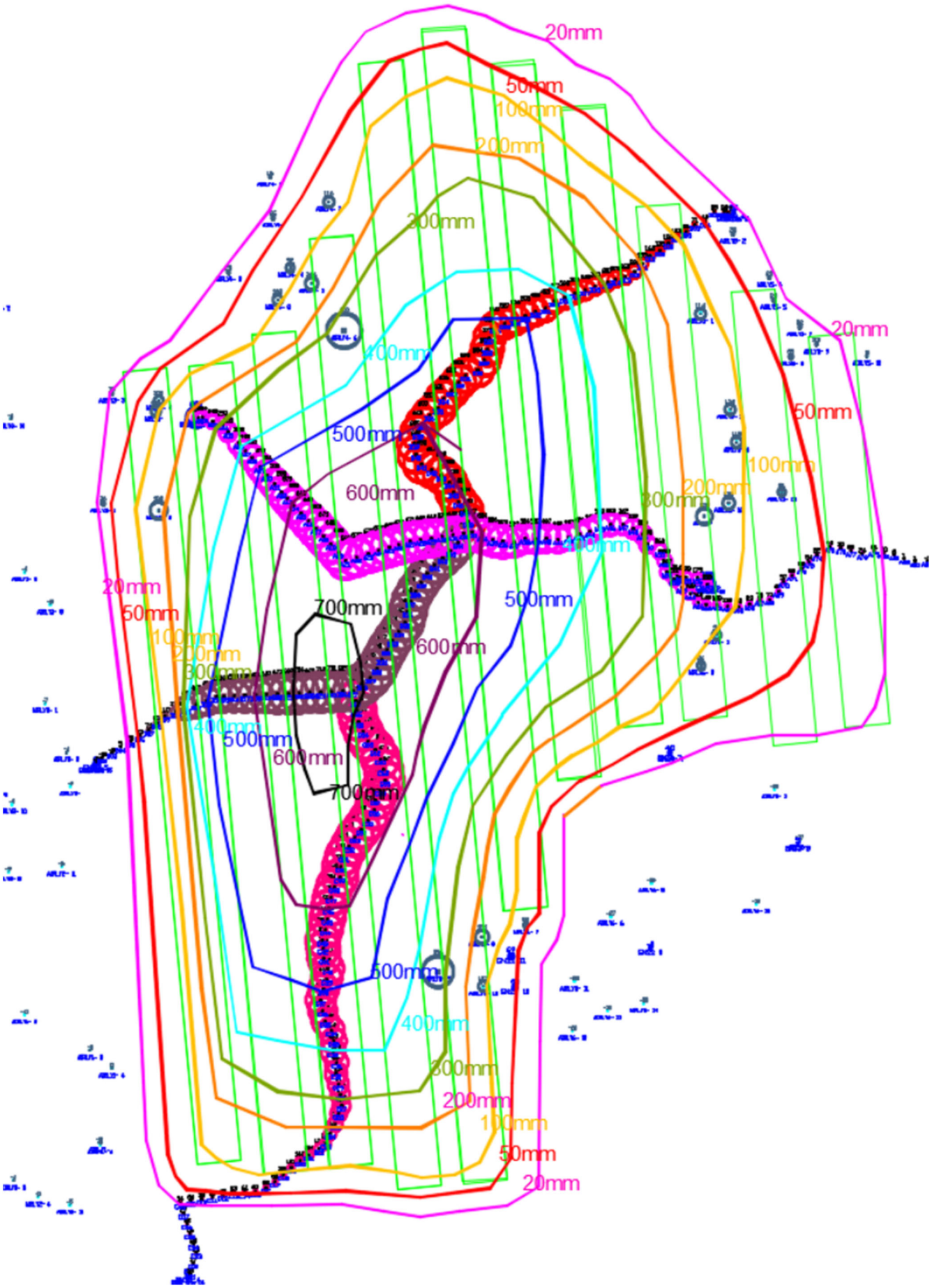


**Fig. 4.6 Observed total horizontal movement contours after MWs 02 to 12 (MSEC)**

Fig. 4.7, below, shows both the observed horizontal movement contours after MWs 02 to 12 were extracted.

It can be noted that the highest horizontal movements, (up to approx. 300 mm), were over MWs2 &3, which is where the tilts were the highest, and the direction of these movements were towards the east and south, i.e., the direction of the throw of the many faults. The magnitudes of the measured horizontal movements in the other direction, (up to 90mm), were much lower. It can also be noted that the strata over MWs02 to 09 was predominantly moved towards the east.

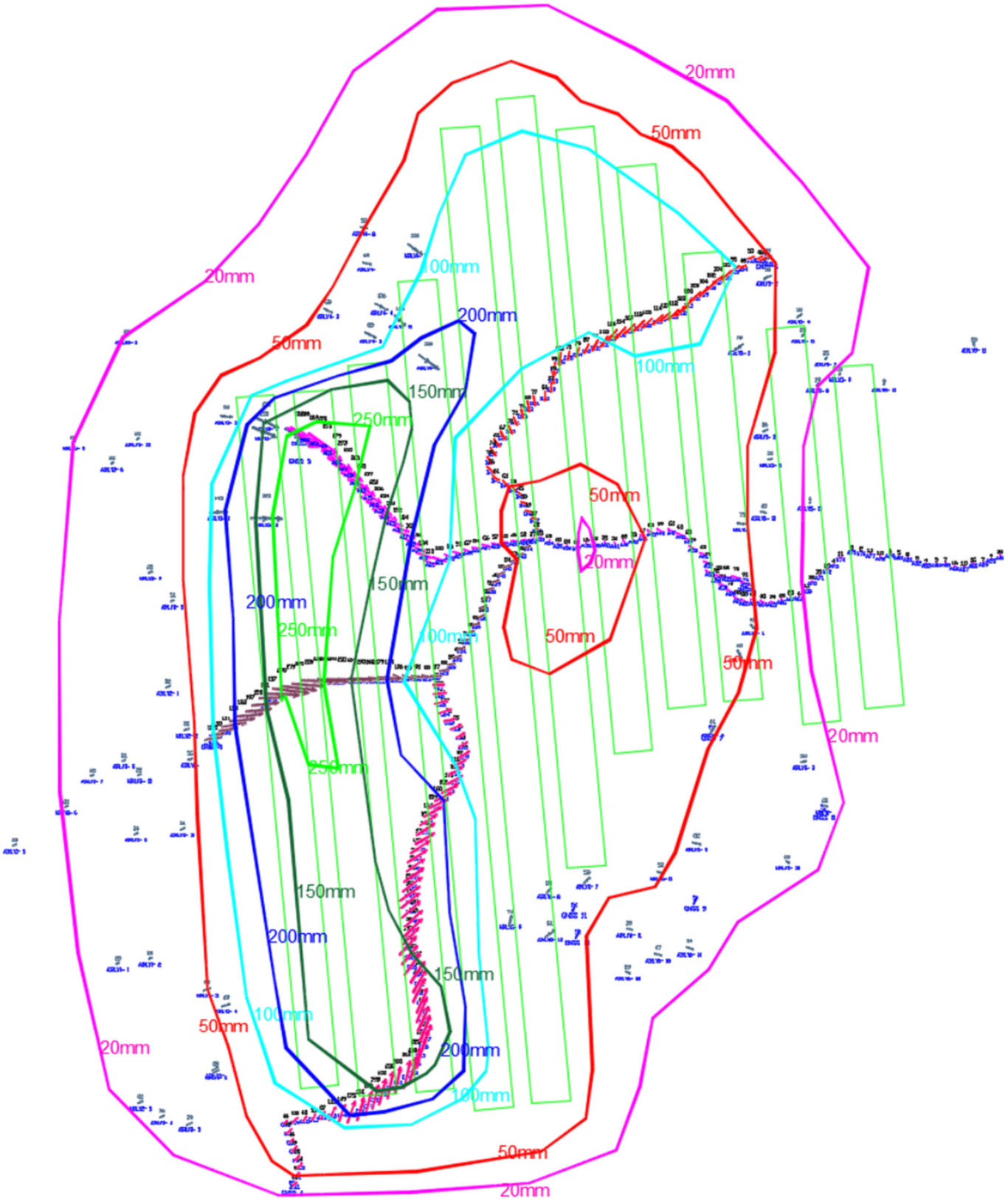


**Fig. 4.7 Observed horizontal movement contours after MWs 2 to 9 (MSEC)**

Fig. 4.8, shows the observed horizontal movements after MWs 02 to 12 were extracted.

The highest horizontal movements were measured over MWs 02, 03 & 04 and the ground was directed towards the east and south, (up to approx. 300 mm) and this is where the measured tilts were the highest. This direction also matches the direction of the throw of the many faults.

The magnitudes of the measured horizontal movements in the other directions, (up to 90mm), were much lower. It can also be noted that the strata over MWs 02 to 09 was predominantly moved towards the east.

It should also be noted that very low subsidence and horizontal movements were monitored over MWs 11 and 12 and this also confirms that the FLAC model closely analysed the complex relationships between changing strata material properties, panel & pillar widths and varying abutment loads and DoCs over the pillars.

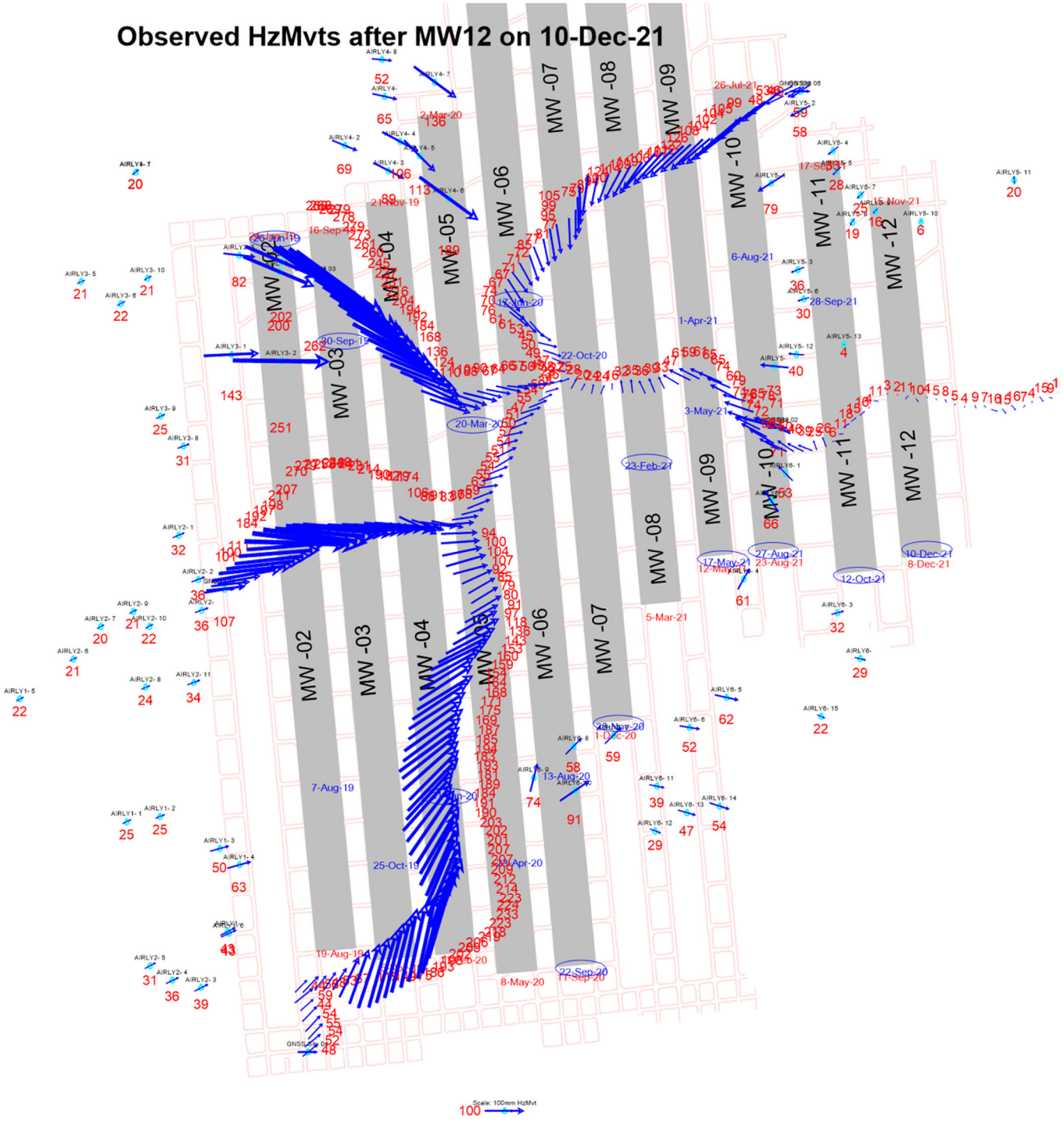


**Fig. 4.8 Observed horizontal movements after MWs 2 to 12 (MSEC)**

## 4.3. Comparison of subsidence monitoring results for MW11 & MW12 against predictions

The report, SCT AIRLY5240, dated January 2021, advised that the mining geometry over MWs 10 to 12 needs to limit vertical subsidence to approximately 100 mm and not exceed 125 mm. SCT then recommended wider pillars and predicted, using the calibrated FLAC model, that the extra subsidence caused by extracting MW11 and 12 would not exceed 125mm over MWs11 &12. SCT wrote this report as MW08 was being extracted and, hence, this report included the plots presented in Fig. 4.9 that predicted the subsidence profiles for MW08 to 12.

From this plot, the incremental subsidence caused by extracting MWs 11 & 12 can be calculated as the difference, between the total SCT predicted subsidence after MW12 (shown in green) from the total observed subsidence after MW10 was extracted (shown in blue for 60m barrier and 40m pillar). Fig. 4.9 indicates that this FLAC model predicted an extra subsidence of up to 85 mm would occur due to the extraction of MWs 11 & 12, (see additional subsidence values in red in Fig. 4.9). As drawn in Fig. 4.9, the:

- predicted total subsidence over the main gate of MW10, after MW10 is extracted, is 95 mm after MW10 is extracted, and 160 mm after MW12 is extracted. Hence the incremental subsidence due to extracting MWs11 and 12 is predicted to be 65 mm, as highlighted in red in Fig. 4.9, i.e., 160 mm – 95 mm,
- the maximum incremental subsidence predicted over the MW11 panel, due to the extraction of MWs 11 and 12, is predicted to be 80 mm and 85 mm,
- the predicted maximum incremental subsidence over the chain pillar between MWs 11 and 12, due to the extraction of MWs 11 and 12, is 75 mm, and
- the predicted total subsidence over the main gate of MW12, after MW12 is extracted, is 75 mm as highlighted in yellow in Fig. 4.9, (60 mm – 10 mm).

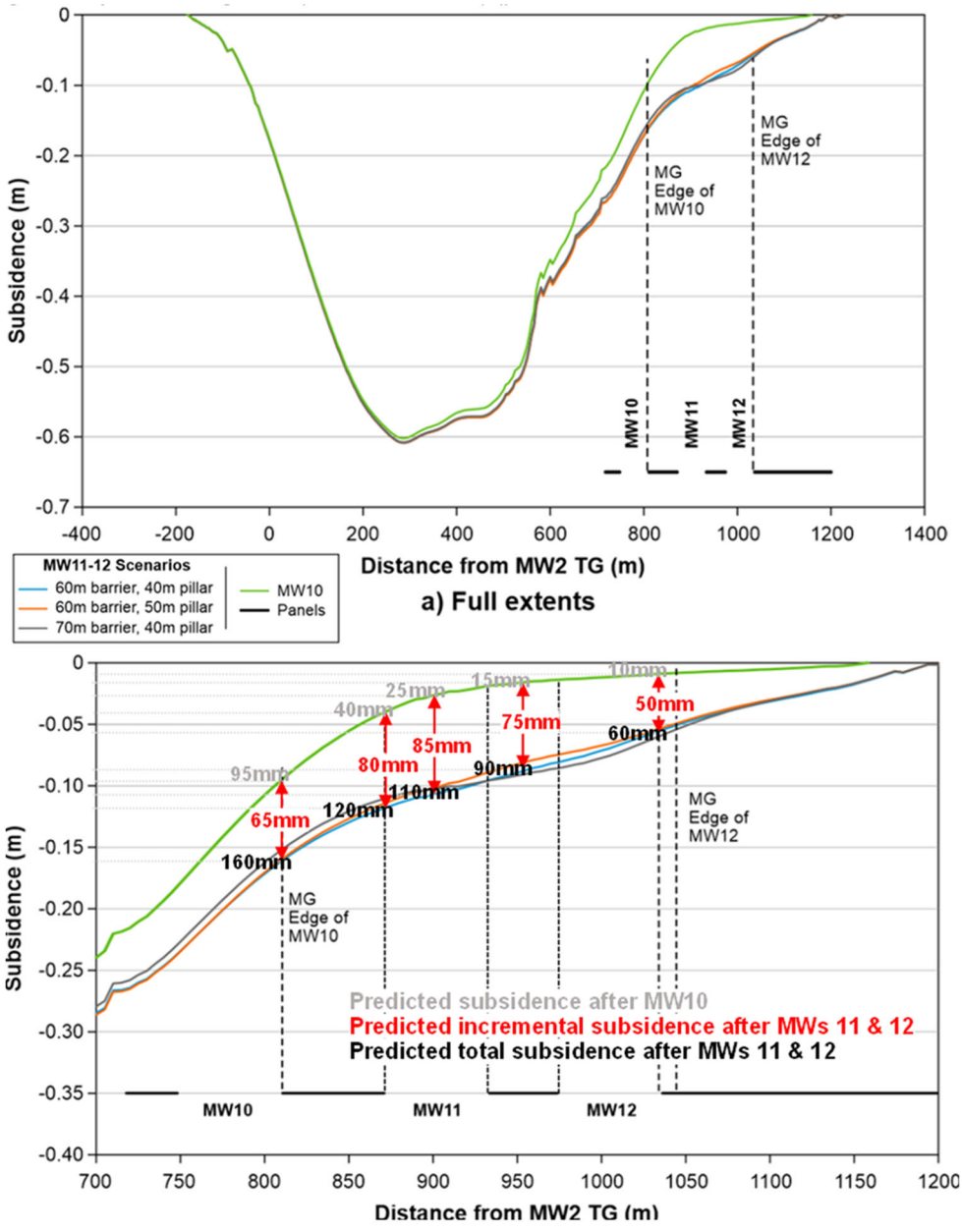


**Fig. 4.9 Predicted subsidence profiles after MWs 11 & 12 (SCT)**

Fig. 4.10, shows the observed total subsidence profiles along the combined B-A Line after MWs 11 to 12 were extracted, at the end of MW12 extraction in Dec 2021, plotted as perpendicular distances from the initial goaf edge of MW2.

Fig. 4.10 also shows the incremental subsidence profiles of MW11, MW12 and the combined MWs11 & 12, at the end of MW12 extraction in Dec 2021, plotted from the initial goaf edge of MW2 and the advancing goaf edges of each panel.

It can be noted, from Fig. 4.10, that the observed total subsidence over MW11 and MW12, at the end of MW12 extraction in Dec 2021, was less than 125mm and the maximum observed incremental subsidence due to the extraction of MWs 11 & 12 combined was less than 80 mm.

Fig. 4.11 shows the observed total subsidence profiles on 22-July-2023, i.e., 6 months after MWs 11 to 12 were extracted, along the combined B-A Line, plotted as perpendicular distances from the initial goaf edge of MW2. Although the measured residual subsidence over MW8 to MW10 has increased more than 125 mm, it can be noted that the observed subsidence over MW11 and MW12, 6 months after MW12 was extracted, is not less than 80 mm, but it is less than 125mm.

Fig. 4.12 shows:

- Plots of the observed incremental subsidence along the BA-Line after MW12 was extracted.
  - The solid lines show the observed incremental subsidence profiles over MWs 02 to 12 since MW10 was extracted, (up to 166 mm so far).
  - The dotted lines show the observed residual subsidence profiles, after all extraction in MW12 was extracted (up to 52 mm so far).
- Plots of the observed total subsidence profiles along the BA-Line after MWs 2 to 12 were extracted (up to a maximum of 713 mm over MW04 just after MW12 was extracted), plus
- Plots of two extra subsidence profiles that were surveyed by CA to assess the extra residual subsidence that occurred 6 months and one year after MW12 was extracted.
  One survey that was undertaken on 22-Jul-2022 at about 6 months after MW12 was extracted and recently another survey was completed on 23-Jan-2023 at about 12 months after MW12 was mined (up to a maximum of 727 mm over MW04 one year after MW12 was extracted);
- A plot, in dark blue, of the predicted incremental subsidence, since MW10 was extracted, as predicted by SCT, AIRLY5240, 20-Jan-2021, over MW2 to MW12. This predicted incremental subsidence line was digitised from the published subsidence curves in Fig 18 from SCT's Report, i.e., it is the difference between the predicted total subsidence profile after MW11 & 12 is extracted (a blue line in Fig 18) and the measured SCT MW10 (a green line).

Unfortunately, Fig. 4.12 shows that the ongoing residual subsidence over MWs 02 to MW10 has now reached 166 mm with this maximum value being located over MW9 and up to 95 mm over MW11. These measured incremental subsidence values exceed the predicted incremental subsidence values shown in dark blue above from Fig. 18 of SCT's report AIRLY5240, 20 Jan 2021. That is, the black coloured Observed IncSubs (MW12-MW10) line (23-Jan-23) now exceeds the blue coloured Predicted IncSubs line (MW12-MW10) over most of MW11 and parts of MW12. It can be noted that the rate of residual subsidence is reducing, and further surveys over MWs 02 to MW10 could reveal that this ongoing subsidence will stop soon.

The words in this SCT report, AIRLY5240, say "the models indicate that less than 100mm of subsidence is anticipated over MW12" and this is mostly true as is shown in Fig. 4.12, except where the maximum observed IncSubs (MW12-MW10) over MW11 is 105 mm. However, this exceedance is small and further surveys over MWs 02 to MW10 could reveal that this ongoing subsidence will stop soon.

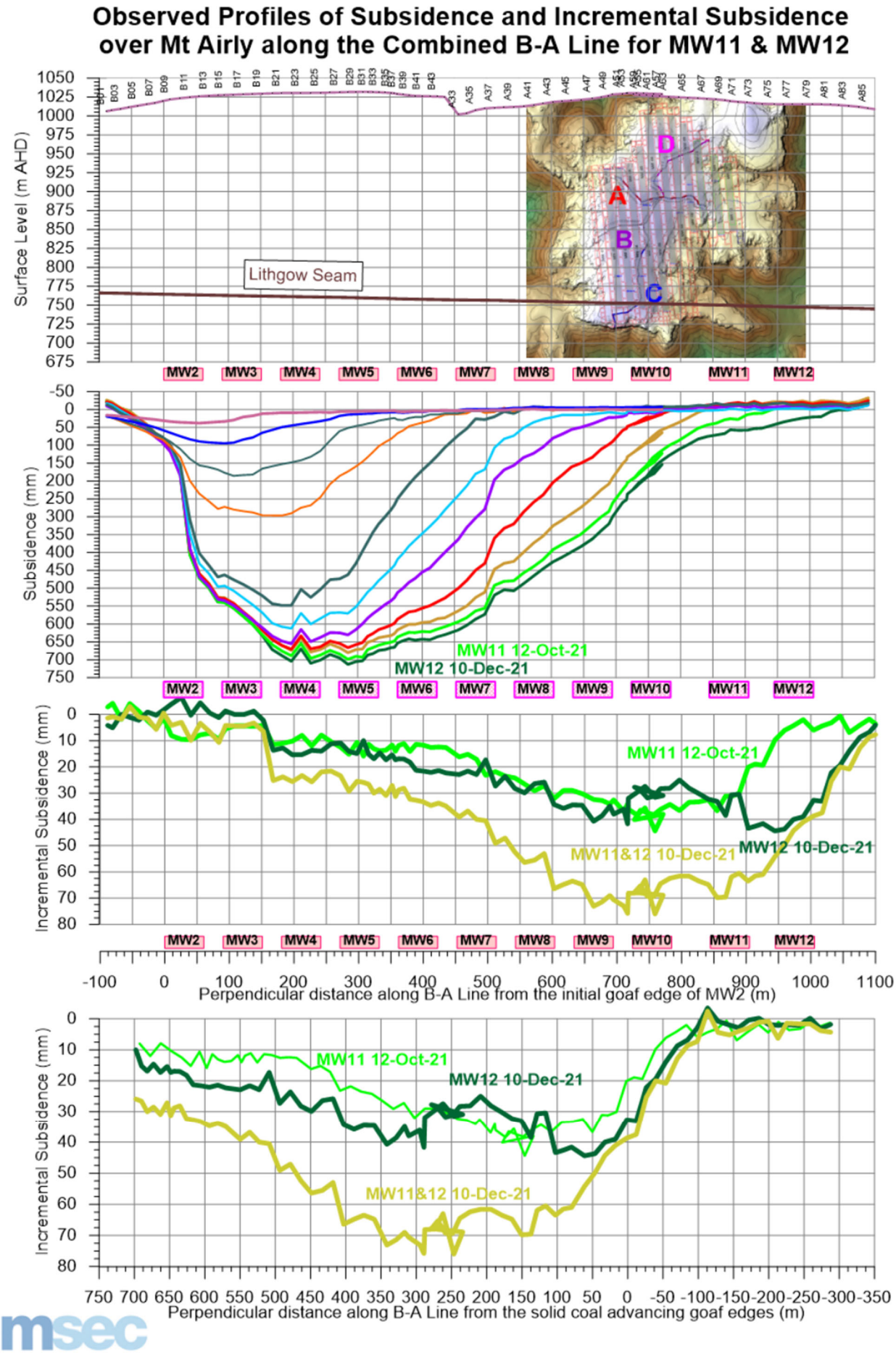


**Fig. 4.10 Observed total and incremental subsidence profiles immediately after MWs 11 and 12 (MSEC)**

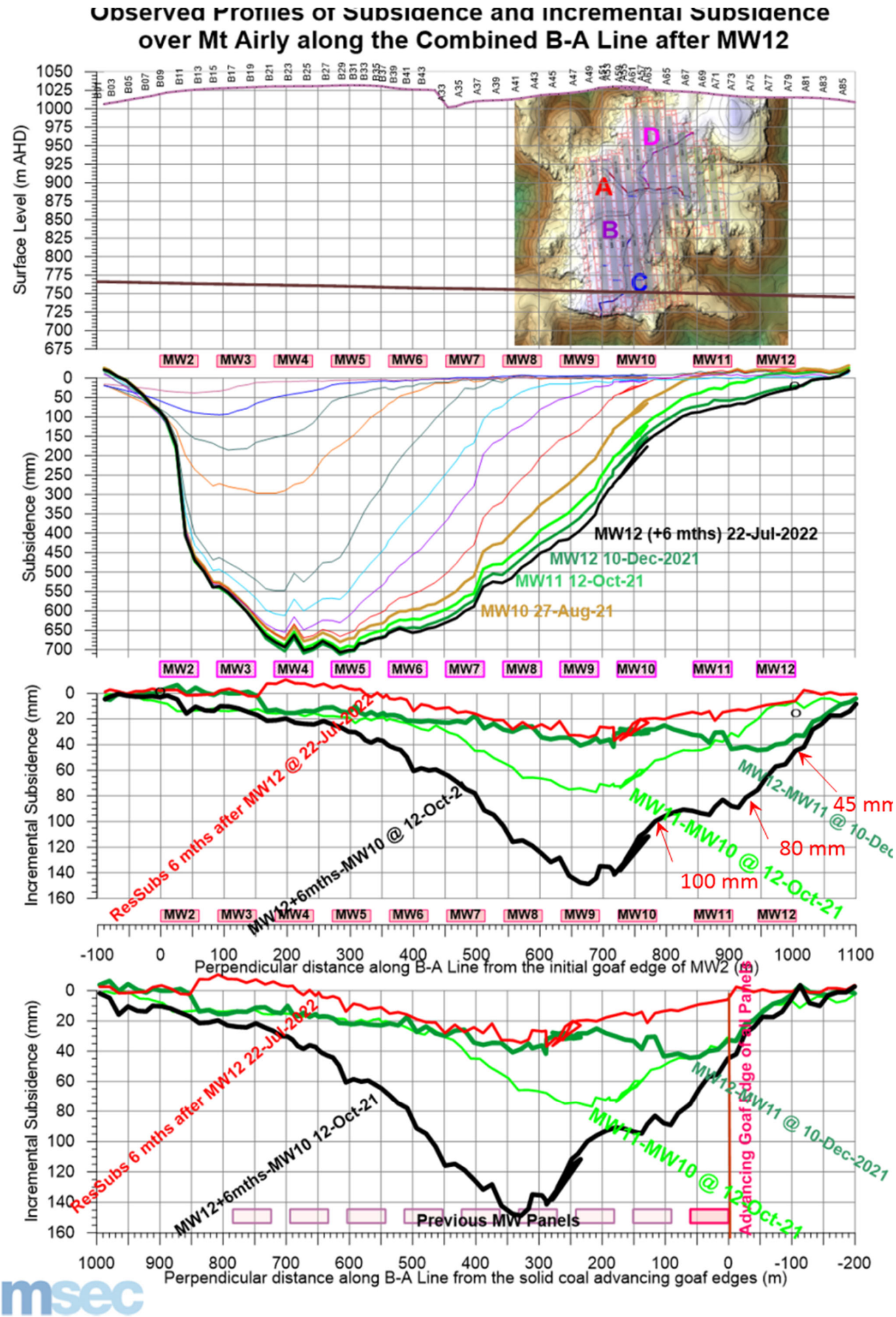


**Fig. 4.11 Observed total and incremental subsidence profiles 6 mths after MWs 10 to 12 (MSEC)**

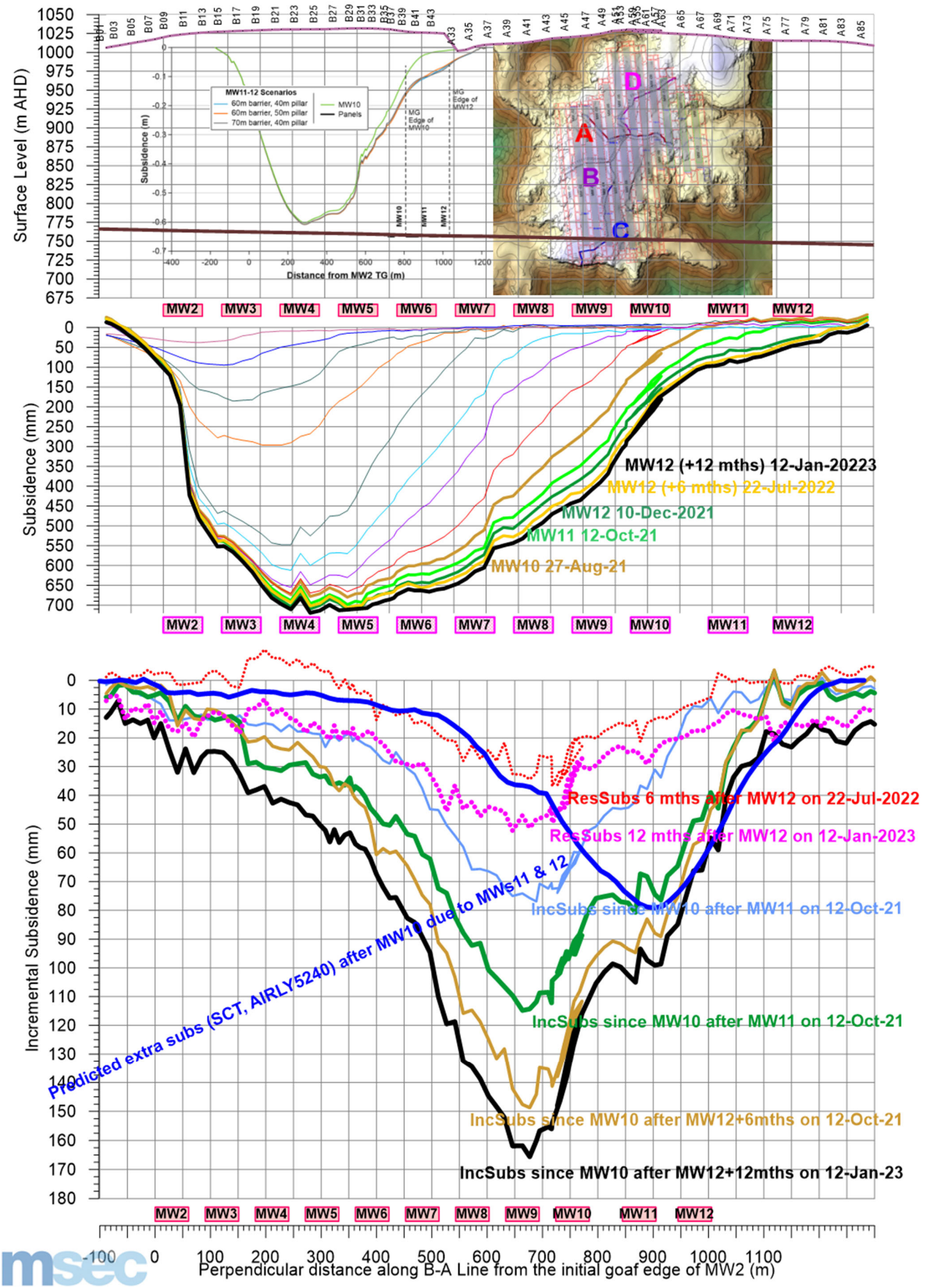


**Fig. 4.12 Observed total and incremental subsidence profiles 12 mths after MWs 10 to 12 (MSEC)**

## 4.4. Comparison of subsidence monitoring results for MW13 & MW14 against predictions

Fig. 4.13 shows predicted subsidence profiles over one to five mini wall panels based on the SCT modelling (SCT Report AIRLY5265, Aug 2021).

In this report, SCT advised that the predicted subsidence profiles in Fig. 4.13 predicts the maximum vertical subsidence for inside the extent of the mined mini walls quite well but the modelled subsidence profiles outside the panels overestimates the vertical subsidence due to boundary effects.

That is, the SCT model over-predicts the subsidence outside the mining area and, therefore, over-predicts the predicted limit of vertical subsidence as is shown in Fig. 4.13.

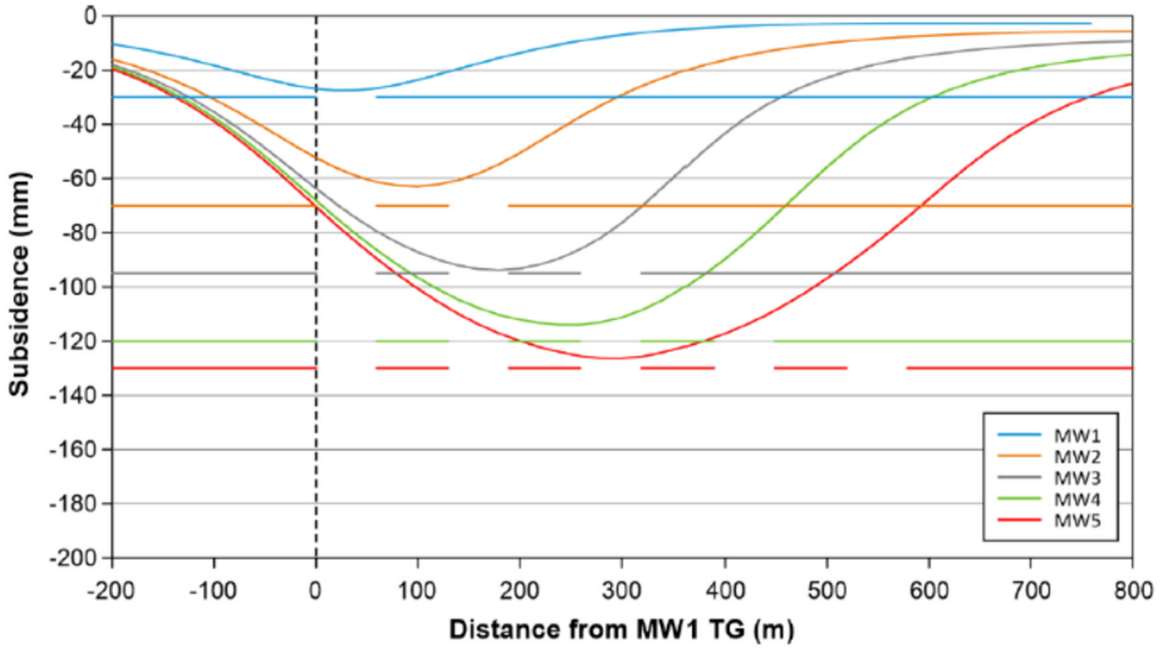


**Fig. 4.13 The FLAC modelling results of 61 m wide mini wall panels with 70m wide chain pillars and 2.8 m extraction height (SCT, 2021)**

CA extracted MWs 13 and MW 14 during 2022. MW 15A was extracted during 2023.

Daily subsidence monitoring is being undertaken over the Point Hatteras area of Genowlan Mountain using 34 GNSS survey stations.

These 34 GNSS survey stations are monitored remotely and daily by CA.

Fig. 4.14 shows the locations of the all the GNSS stations and the location of a monitoring cross line, i.e., GM01 to GM07, that is highlighted in yellow.

Where only two panels are located side by side than less subsidence is expected than in locations where four panels are located side by side.

Fig. 4.14 shows that, due to the extraction of parts of these mini walls being stopped short of various cliffs, only a short length of these panels has four adjacent mini walls, i.e., ~170 m of MWs 13, 14, 15A & 16.

Similarly, there are only short distances where three adjacent mini walls occur, i.e., MWs 14, 15A and 16 and MWs 13, 14 and 15B.

Monitoring data from the GNSS pegs named, GM01 to GM07 form a cross line for five survey dates is presented in Fig. 4.14 to show the current subsidence trends. The subsidence monitoring to date over MWs 13 and 14 along the monitoring line GM01 to GM07, (with MW14 almost fully extracted), shows that the observed subsidence levels are slightly higher, but very close to the predicted subsidence levels over MWs 13 and 14.

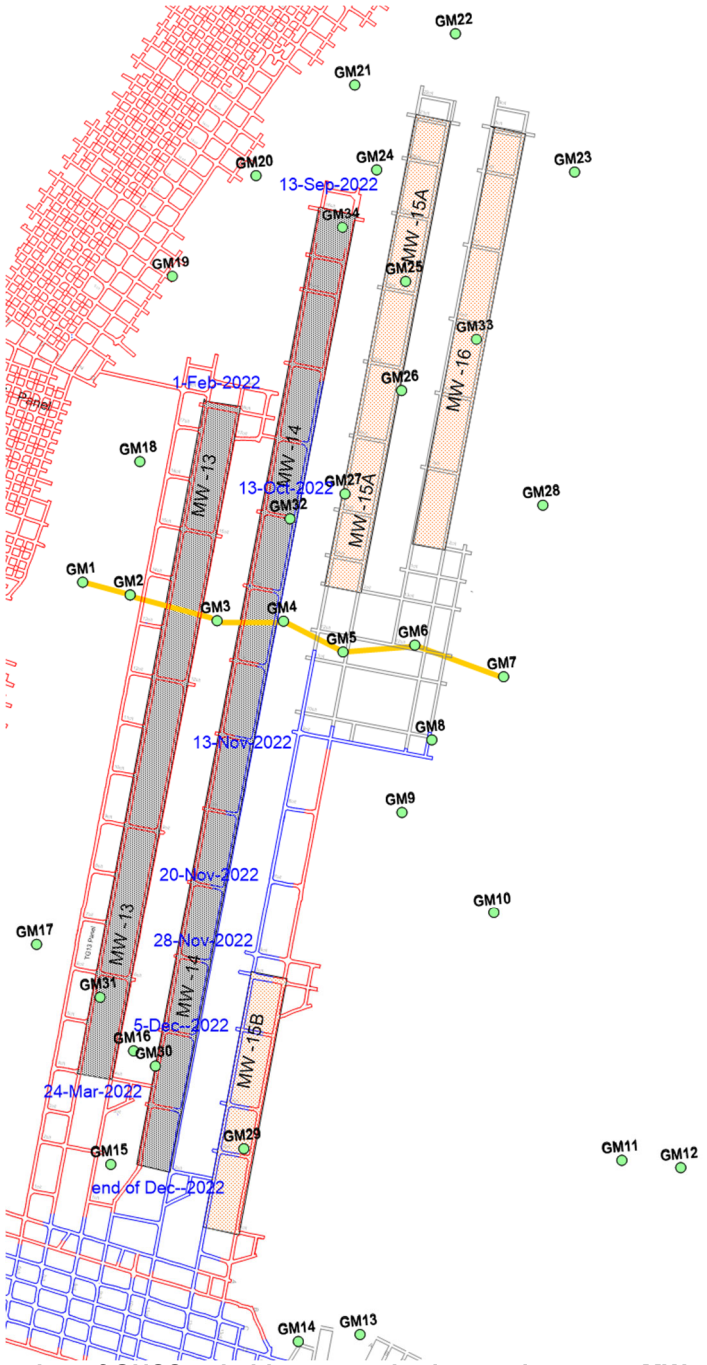


**Fig. 4.14 Location of GNSS subsidence monitoring stations over MWs 13 to 16 (MSEC)**

It can be noted that this yellow-coloured monitoring cross line GM01 to GM07 does not pass over MWs 15A and 16 and, hence, this monitoring line is mainly be used to show the results over MWs 13 and 14. It will not be used to show the maximum subsidence over MWs 13 to 16. Instead, a new monitoring cross line showing the subsidence results from six GNSS units, GM01, GM02, GM03, GM32, GM27 and GM28 will be used to show the subsidence results over MWs 13, 14, 15A and 16.

Hence the subsidence predictions, relating to 4 adjacent mini walls in Fig. 4.14 only applies to limited length over this series of panels and, given the necessity for end effects at the goaf commencing ends and goaf finishing ends, the full predicted subsidence levels for 4 adjacent panels of 115 mm for 4 adjacent mini walls may not actually occur.

Fig. 4.15 shows the observed subsidence along a subsidence line between GNSS stations, GM01 to GM07, i.e., a cross line over MW13 on 19-Apr-22 and over MWs 13 to MW14 on four monitoring dates between Nov 13 to 5 Dec 2022. All extraction in MW14 finished on 15 Dec 2022. At this time the maximum subsidence over MWs 13 & 14 is 70 mm.

Fig. 4.15 includes two **red** coloured possible total subsidence profiles after MWs13 and MW14 were extracted, which may have been monitored if more survey pegs could have been installed over this mesa.

Fig. 4.15 also includes a **red** coloured **dotted** line that shows the possible incremental subsidence profile due to the extraction of MW14, which may have been monitored if more survey pegs could have been installed.

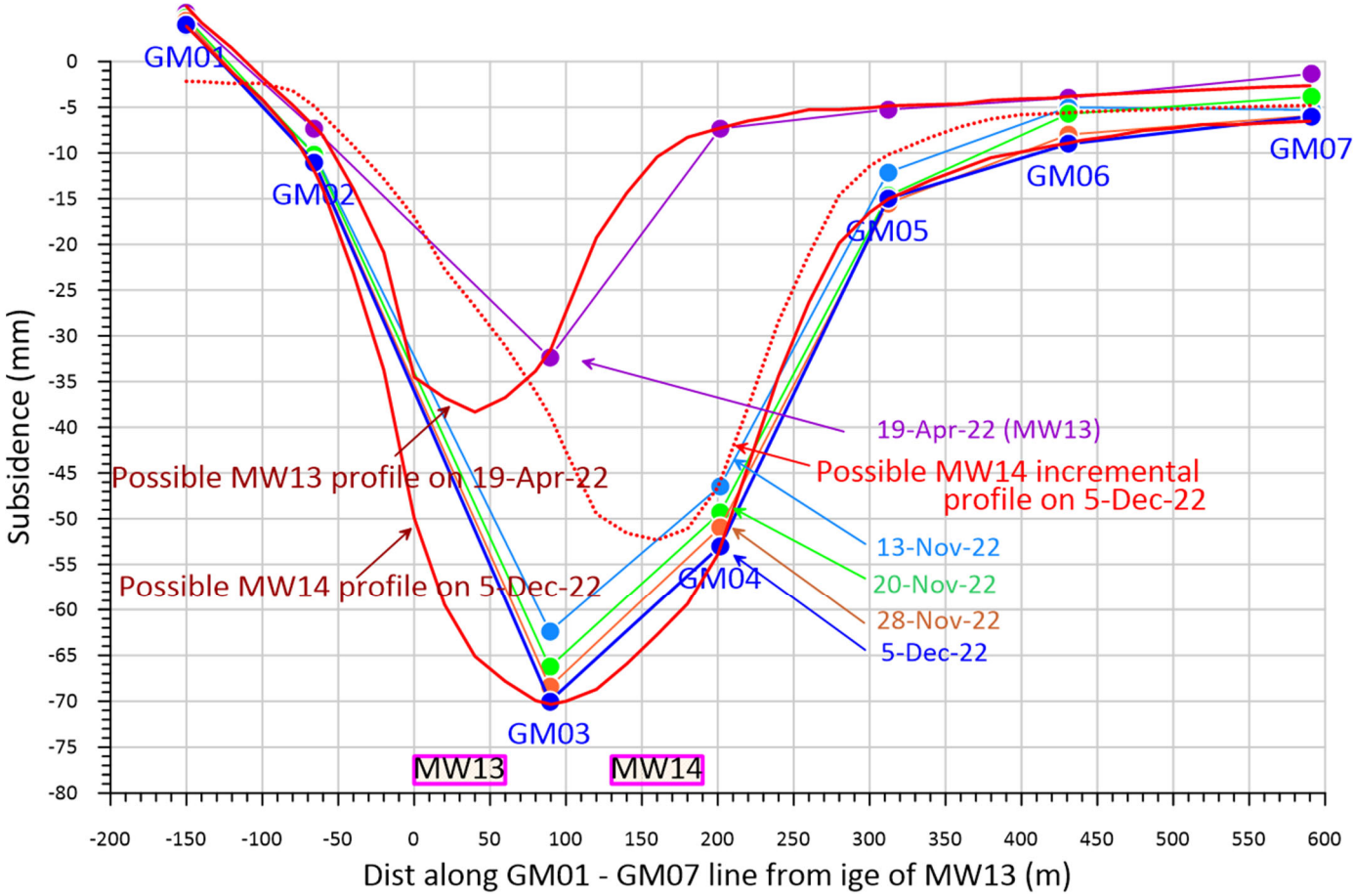


**Fig. 4.15 Recent observed subsidence profiles across MWs 13 and 14 at stations GM01 to GM07 (MSEC)**

Fig. 4.16 replots Fig. 4.15 and it includes a **blue** coloured **dashed** line that shows SCT predicted subsidence profile after the extraction of MWs13 & 14 that was digitised off Fig. 4.13.

Hence, the subsidence monitoring over MWs 13 and 14 as at the end of 2022, along the monitoring line GM01 to GM07, (with MW14 extracted), shows that the observed subsidence levels, are very close to but slightly higher than the SCT predicted maximum subsidence levels over MWs 13 & 14 of 63 mm as shown in Fig. 4.13.

It can also be noted that the observed subsidence over the initial goaf edge of MW13 and the advancing goaf edge of MW14 in Fig. 4.15 are less than the subsidence predicted in the FLAC model in Fig. 4.13.

In this regard SCT explained that this model predicts the maximum subsidence value better than it predicts the subsidence around the edges of the mined panels. SCT recommended that CA use actual angle of draw data around the edges of the mined panel for prediction of site-specific locations.

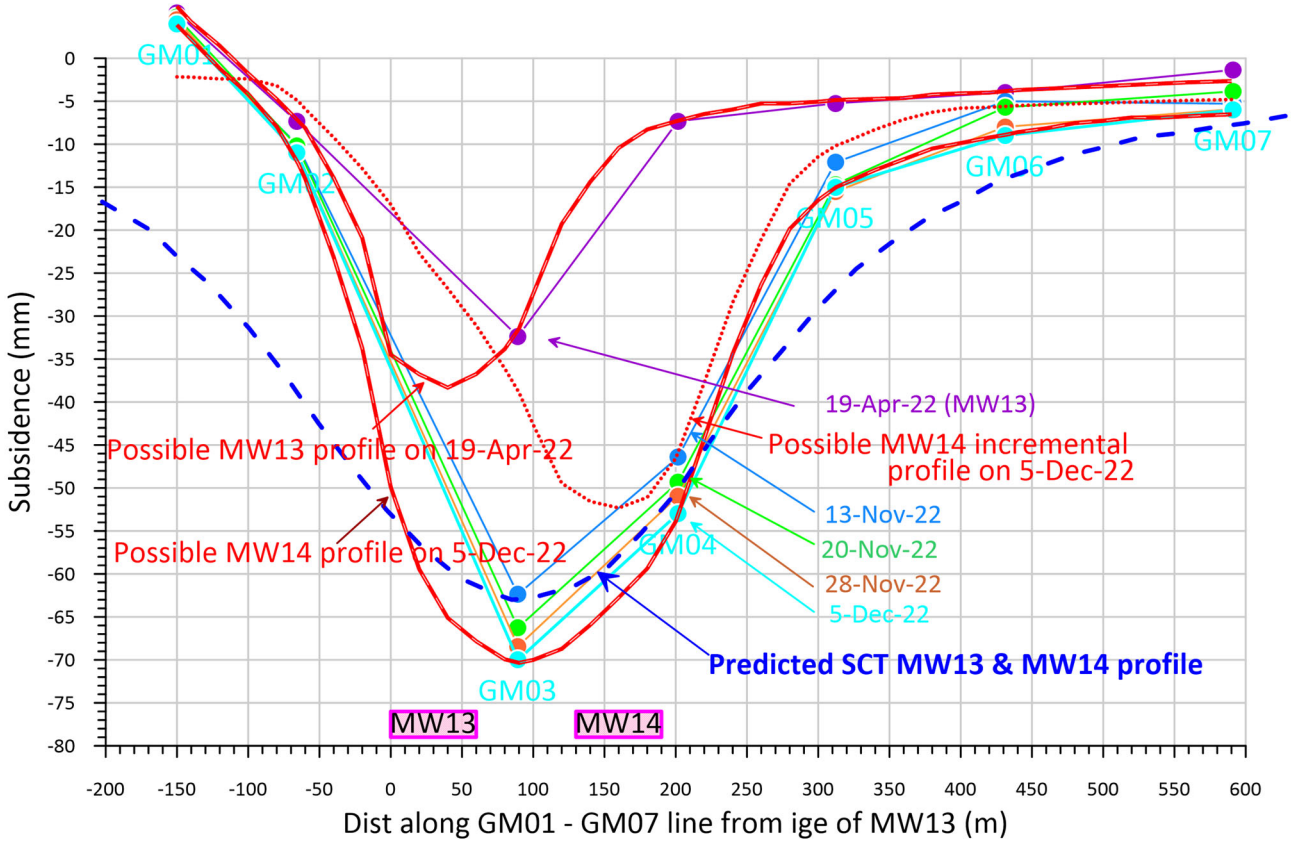


**Fig. 4.16 Recent observed subsidence profiles across MWs 13 and 14 at stations GM01 to GM07 and SCT Predictions (MSEC)**

Fig. 4.17 show the observed easting, northing, and subsidence movements on a daily basis at GNSS03. These observed subsidence & horizontal movement – time plots indicates that most of the subsidence over MW 14 was complete prior to the commencement of MW 15A.

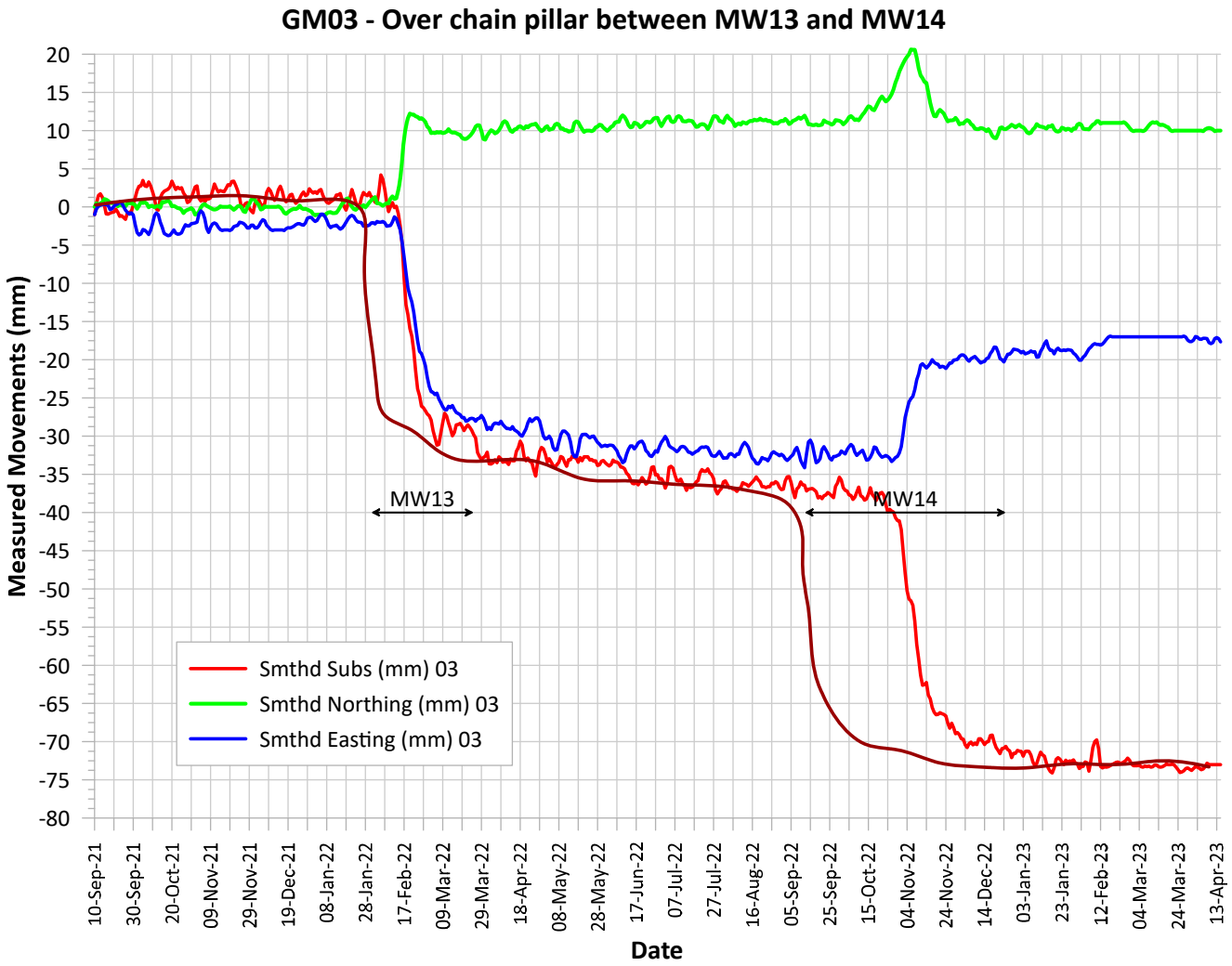


**Fig. 4.17 Observed horizontal movements and subsidence at GNSS station GM03 over MWs 13 to 14 on a daily basis (MSEC)**

It can also be noted that the observed subsidence over the initial goaf edge of MW13 and the advancing goaf edge of MW14 in Fig. 4.15 are less than the subsidence predicted in the FLAC model in Fig. 4.9. In this regard SCT explained that this model predicts the maximum subsidence value better than it predicts the subsidence around the edges of the mined panels. SCT recommended that CA use actual angle of draw data around the edges of the mined panel.

Based on the available subsidence monitoring, after MW13 was extracted under Point Hatteras under the Genowlan Mountain mesa, the maximum observed subsidence level was 38mm, which is similar to the levels measured when MW02 was extracted.

After MW14 was extracted under Point Hatteras, the maximum observed subsidence level was approx. 75 mm, which is less than the levels measured when MW03 was extracted, see Table 2.1.

Hence, based on the subsidence monitoring that has been undertaken to date, it can be concluded that the subsidence levels over the remainder of the mini wall panels under the Point Hatteras area of Genowlan Mountain will also be close to those levels of subsidence predicted by SCT with the FLAC modelling.

## 4.5. Comparison of subsidence monitoring results for MW15A against predictions

CA extracted MWs 15A during 2023. Daily subsidence monitoring has continued over the Point Hatteras area of Genowlan Mountain using the available 34 GNSS survey stations.

Fig. 4.18 shows the locations of the all the GNSS stations located over the Point Hatteras area of Genowlan Mountain. This plot also highlights that the GNSS stations were all established over the plateau areas of Point Hatteras with some pegs being located on the edge of the major external escarpments.

Fig. 4.19 also shows the locations of the all the GNSS stations located over the Point Hatteras area of Genowlan Mountain, and it shows the location of two monitoring cross lines, i.e., Monitoring Line 1 - GM01 to GM07, which is highlighted in yellow and Monitoring Line 2 - GM18 to GM28 which is highlighted in black.

This plot also shows the dates when the face started and finished extraction in each mini wall.

It can be deduced from the differing paths of these two cross lines, that Monitoring Line 1 was established with the aim of it being a cross line, whilst Monitoring Line 2 has been put together from the available GNSS stations across

MWs 13 to 16 where four panels are located side by side. It could be expected from Fig. 4.3 that the highest observed subsidence will be measured along Monitoring Line 1 would be at station GM03 after three panels have been extracted and the highest observed subsidence will be measured along Monitoring Line 2 at Stations GM32 or GM27 after four panels have been extracted.

GM01 to GM28 were installed prior to the start of MW13 in September 2021. Six new units, i.e., GM29 to GM34, were installed in March and April 2022 just after the extraction of MW13 and prior to the start of MW14. The new six GNSS units were installed at the request of the IEP during consultation for approval of the MW13 to MW16 Extraction Plan.

GNSS monitoring data gathered from the original 28 GNSS units were used to estimate the amount of vertical subsidence that each of the six new units were likely to have experienced during the extraction of MW13.

- Three of the new units, GM29, GM33 and GM34, were located remote from the edges of MW13 and, hence, they would have experienced negligible subsidence levels from the extraction of MW13;
- GM30 has been estimated to have experienced 10 mm subsidence due to the extraction of MW13;
- GM31 has been estimated to have experienced 12 mm subsidence due to the extraction of MW13; and
- GM32 has been estimated to have experienced 15 mm subsidence due to the extraction of MW13.

Fig. 4.20 shows the observed subsidence at each of the 34 GNSS units plotted against time. The maximum raw total subsidence measured after MW15A was extracted was 73 mm, which was recorded at station GM03. Measured raw total subsidence after MW15A at station GM32 was 71 mm, which equates to total subsidence of 86 mm when the estimated 15 mm of vertical due to the extraction of MW13 is added to the raw measurement. Based on the above, maximum measured vertical subsidence due to the extraction of MW13 to MW15A is 86 mm at station GM32.

Fig. 4.21 shows the observed horizontal movements of each of the 34 GNSS units plotted against time.

The maximum horizontal movement measured after MW15A was extracted was 60 mm which was recorded at station GM04.

Slightly higher measurements would have been recorded if there were more GNSS units located over the central zones between these MWs.

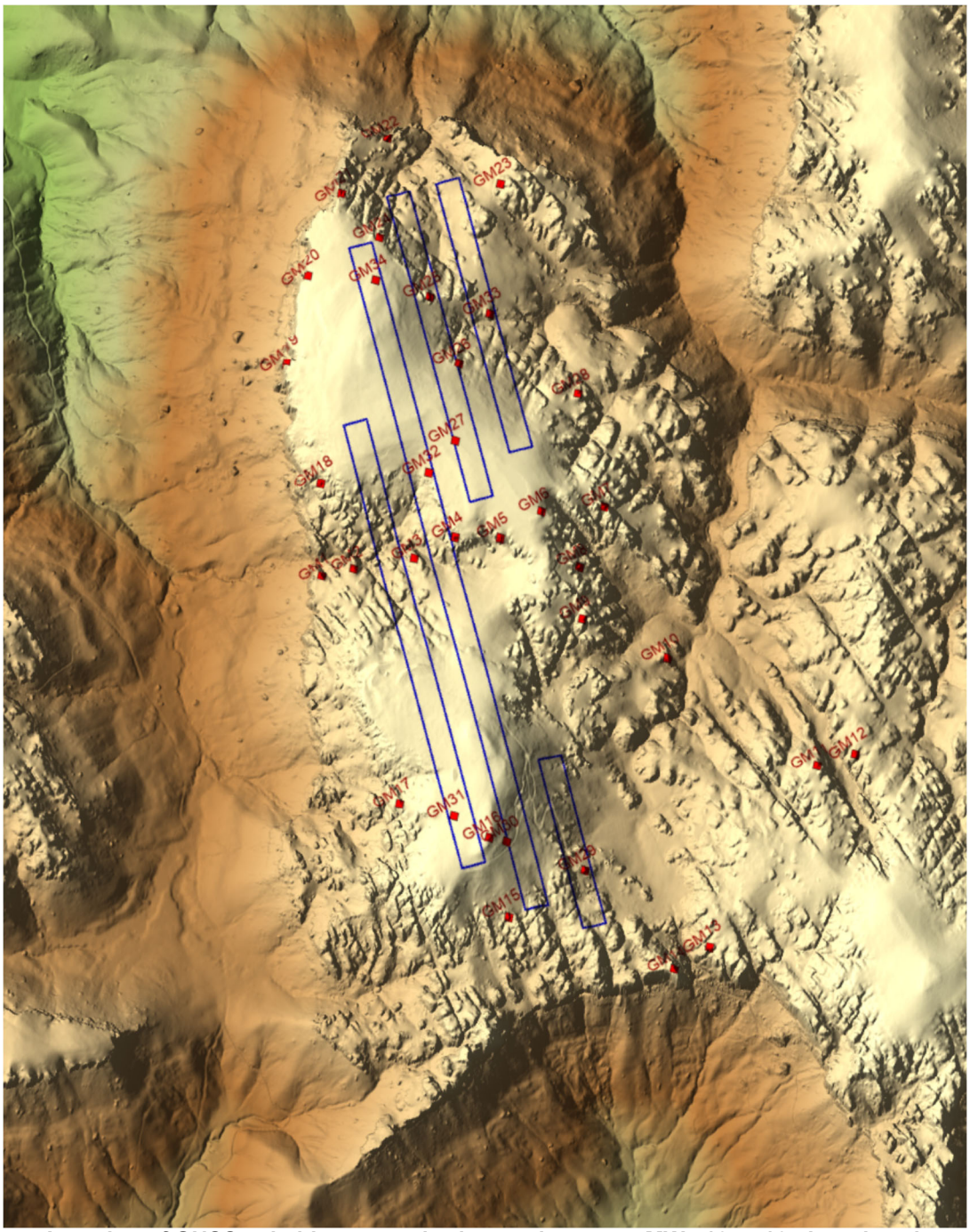


**Fig. 4.18 Location of GNSS subsidence monitoring stations over MWs 13 to 16 plotted against a surface terrain model of the Point Hatteras area of Genowlan Mountain (MSEC)**

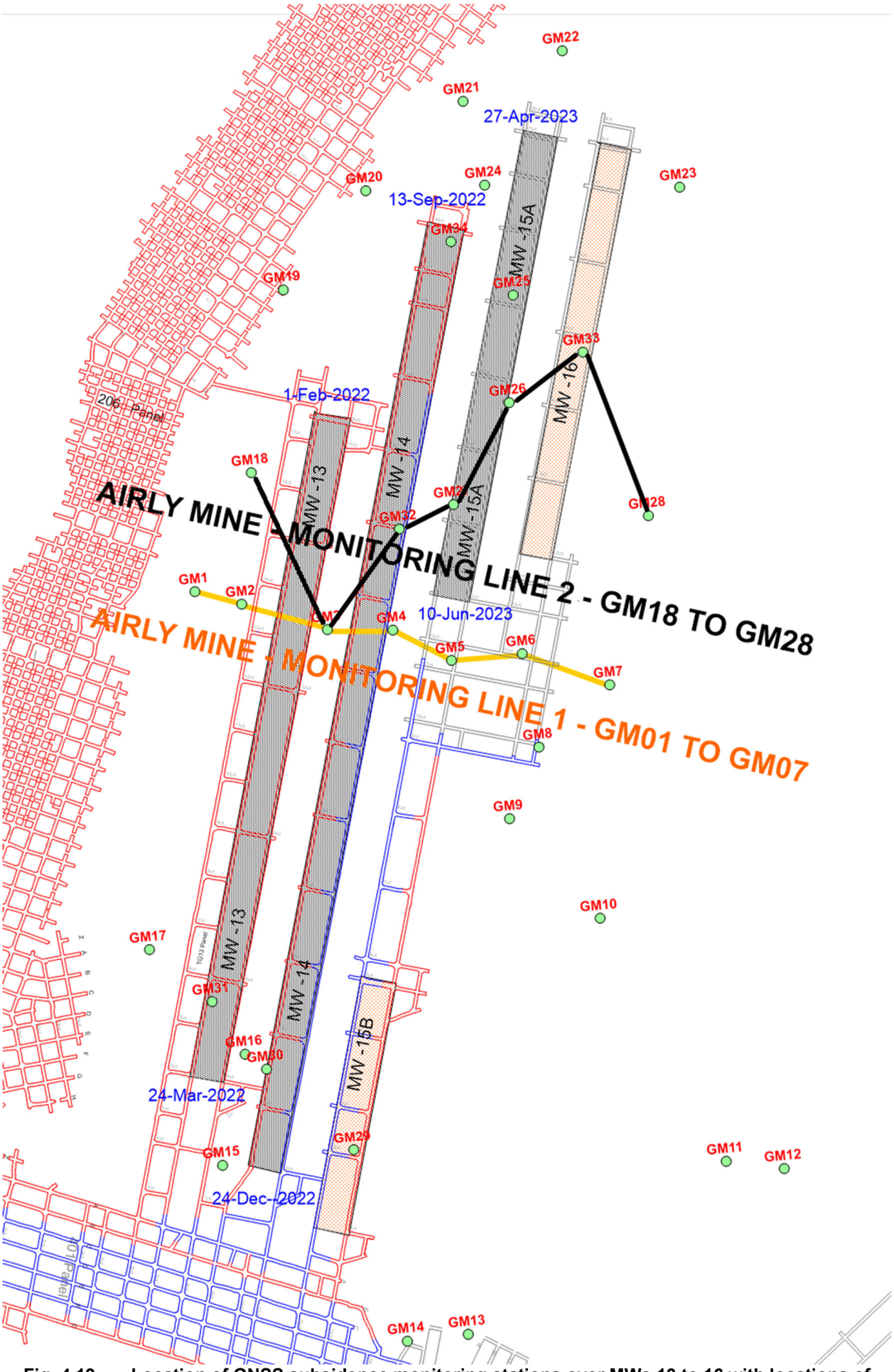


**Fig. 4.19 Location of GNSS subsidence monitoring stations over MWs 13 to 16 with locations of Monitoring Line 1 and Monitoring Line 2 (MSEC)**

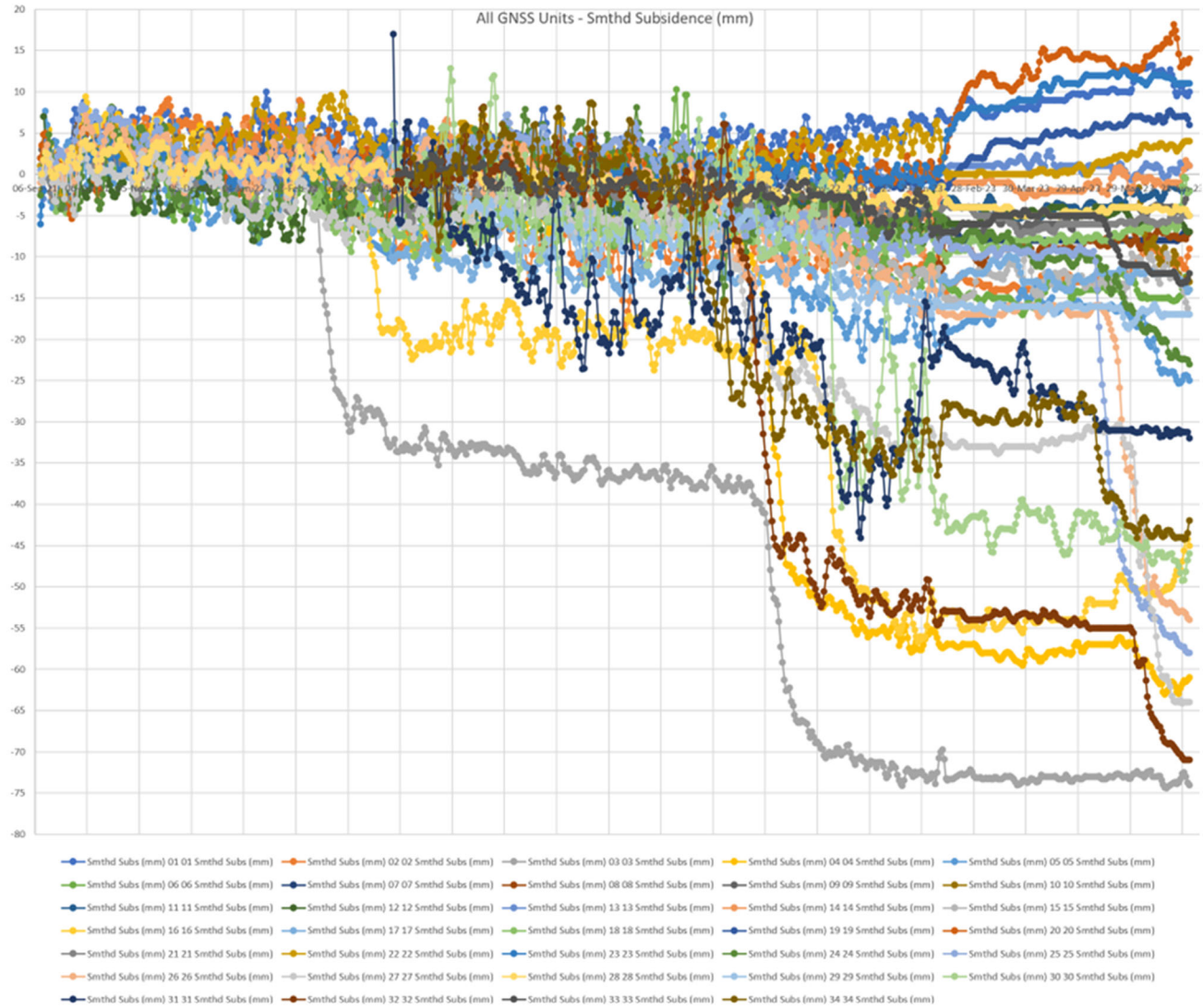


**Fig. 4.20 Observed raw subsidence of all GNSS Stations plotted against time during extraction of MWs 13 to 15A as at 2-Jul-23 (MSEC)**

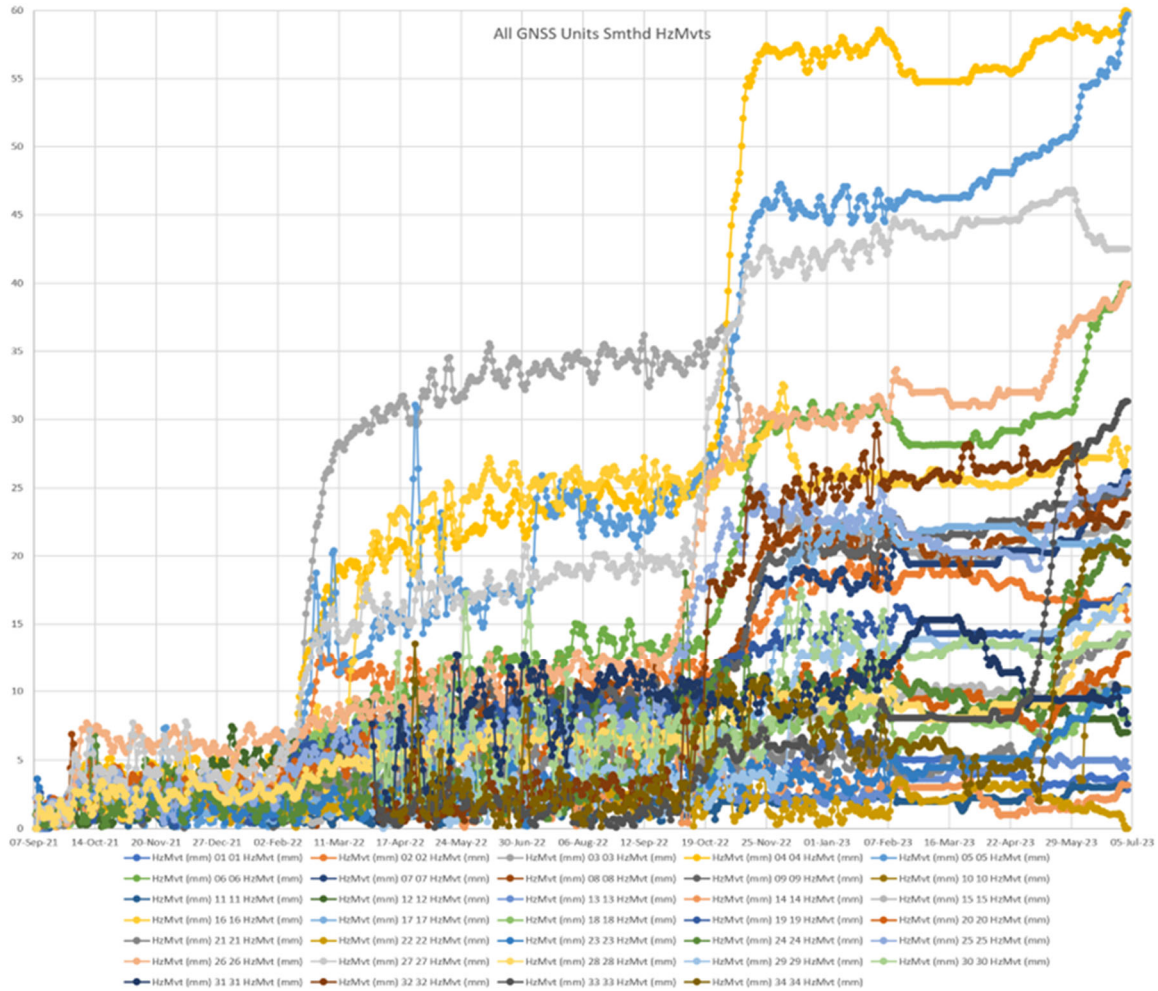


**Fig. 4.21 Observed horizontal movements of all GNSS Stations plotted against time during extraction of MWs 13 to 15A (MSEC)**

Fig. 4.22 to Fig. 4.28 show the observed easterly horizontal movement, northly horizontal movement and subsidence on each day at each of the GNSS stations along the Monitoring Line 1, i.e., at GM01 to GM07.

Fig. 4.30 to Fig. 4.34 show the observed easterly horizontal movement, northly horizontal movement and subsidence on each day at each of the GNSS stations along the Monitoring Line 2, i.e., at GM18 to GM28.

These plots also indicate the dates when the mini walls were extracted. It can also be noted that some of the GNSS units were not installed until before MW13 was extracted and in these cases very small subsidence values may have been recorded at these stations if they had been installed earlier.

It can be noted that the GNSS units provide daily subsidence and horizontal movement results varying subsidence results with an apparent accuracy up to 10 mm and MSEC has applied some low -level smoothing to reduce these variations and help show the overall trends.

Increased movements were recorded just after the face passed each GNSS station and depending on the location of the station with respect to the mini wall.

Many of these units would have moved more if the MW had travelled closer or past the station.

Further residual movements can be expected over the next month and up to when extraction in MW16 commences.

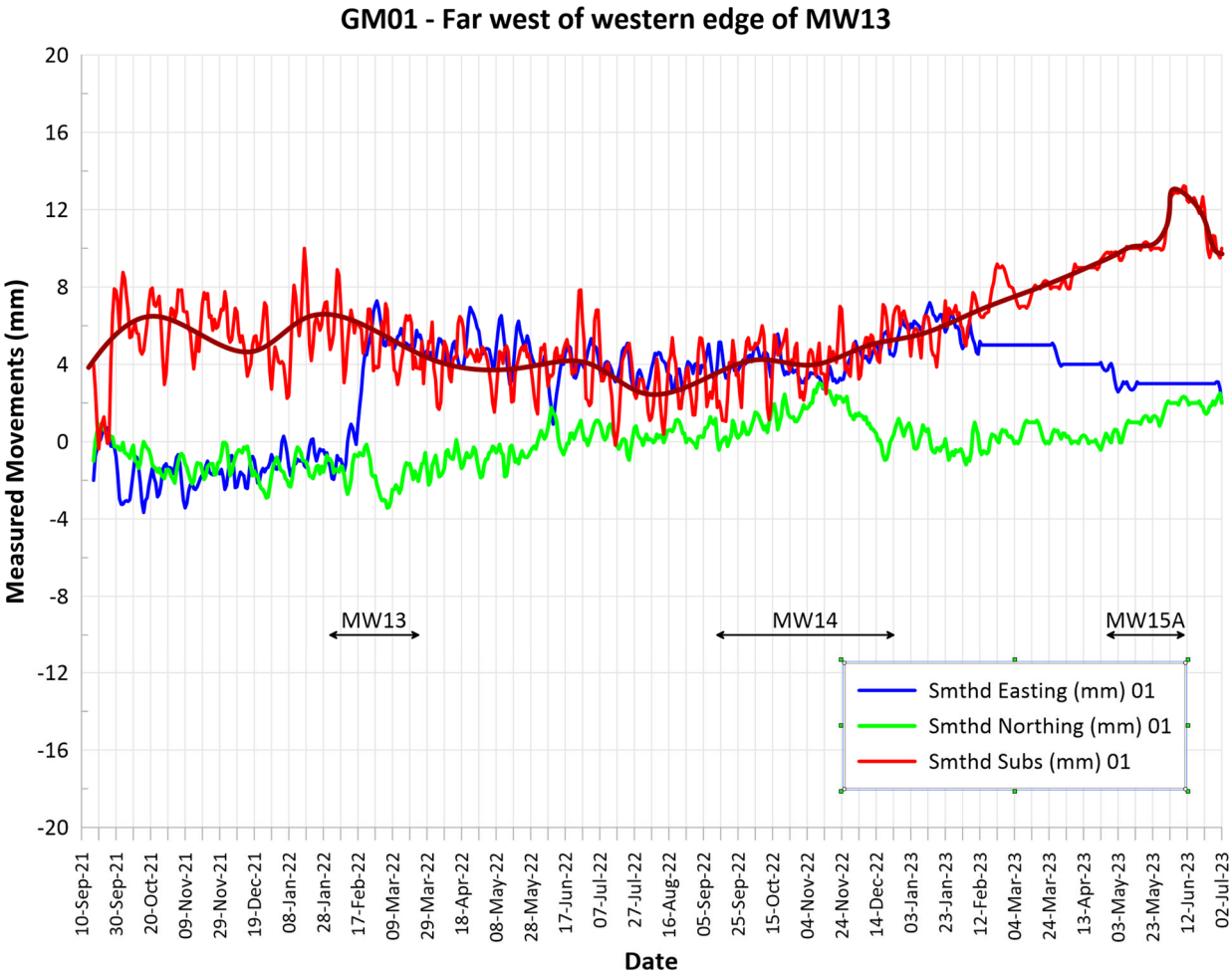


**Fig. 4.22 Eastwards and northward horizontal movements and subsidence of GNSS Station GM01 plotted against time during extraction of MWs 13 to 15A (MSEC)**

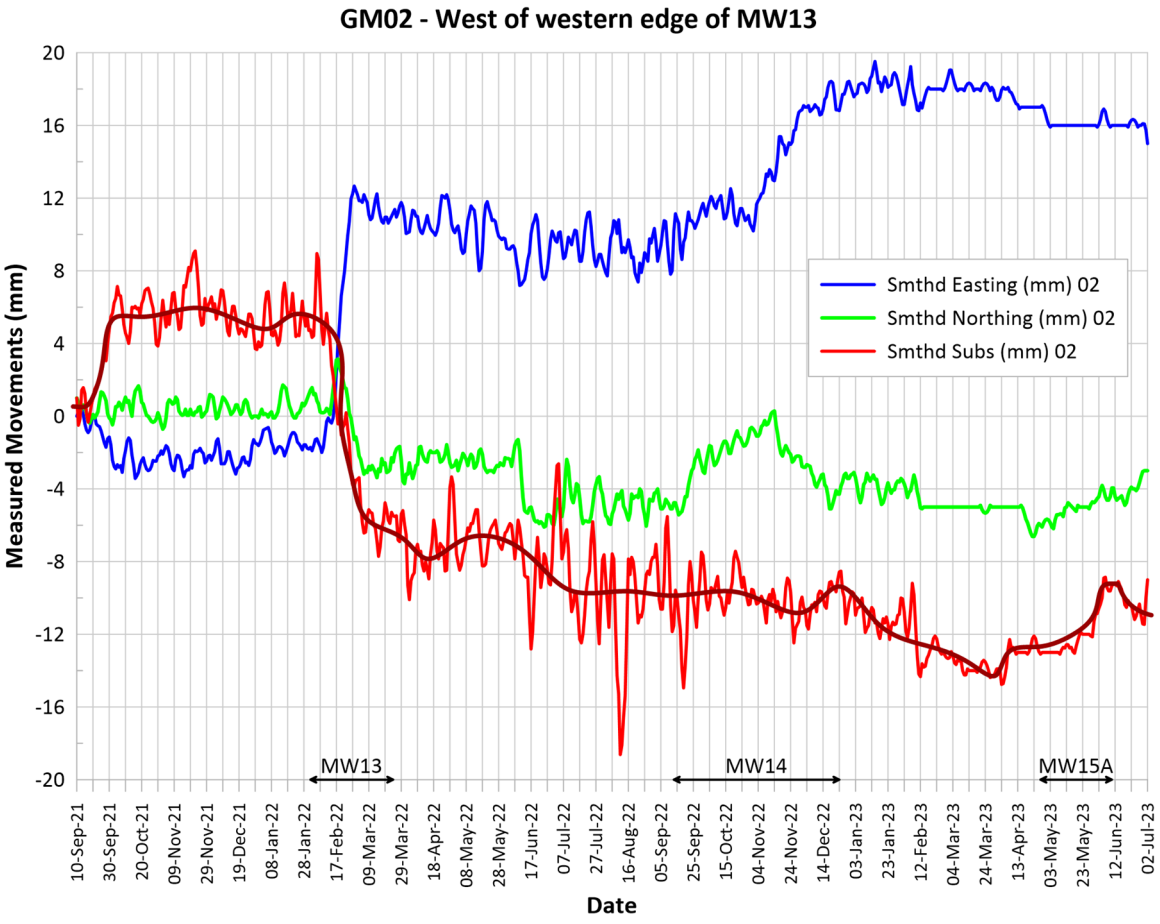

**Fig. 4.23 Eastwards and northward horizontal movements and subsidence of GNSS Station GM02 plotted against time during extraction of MWs 13 to 15A (MSEC)**

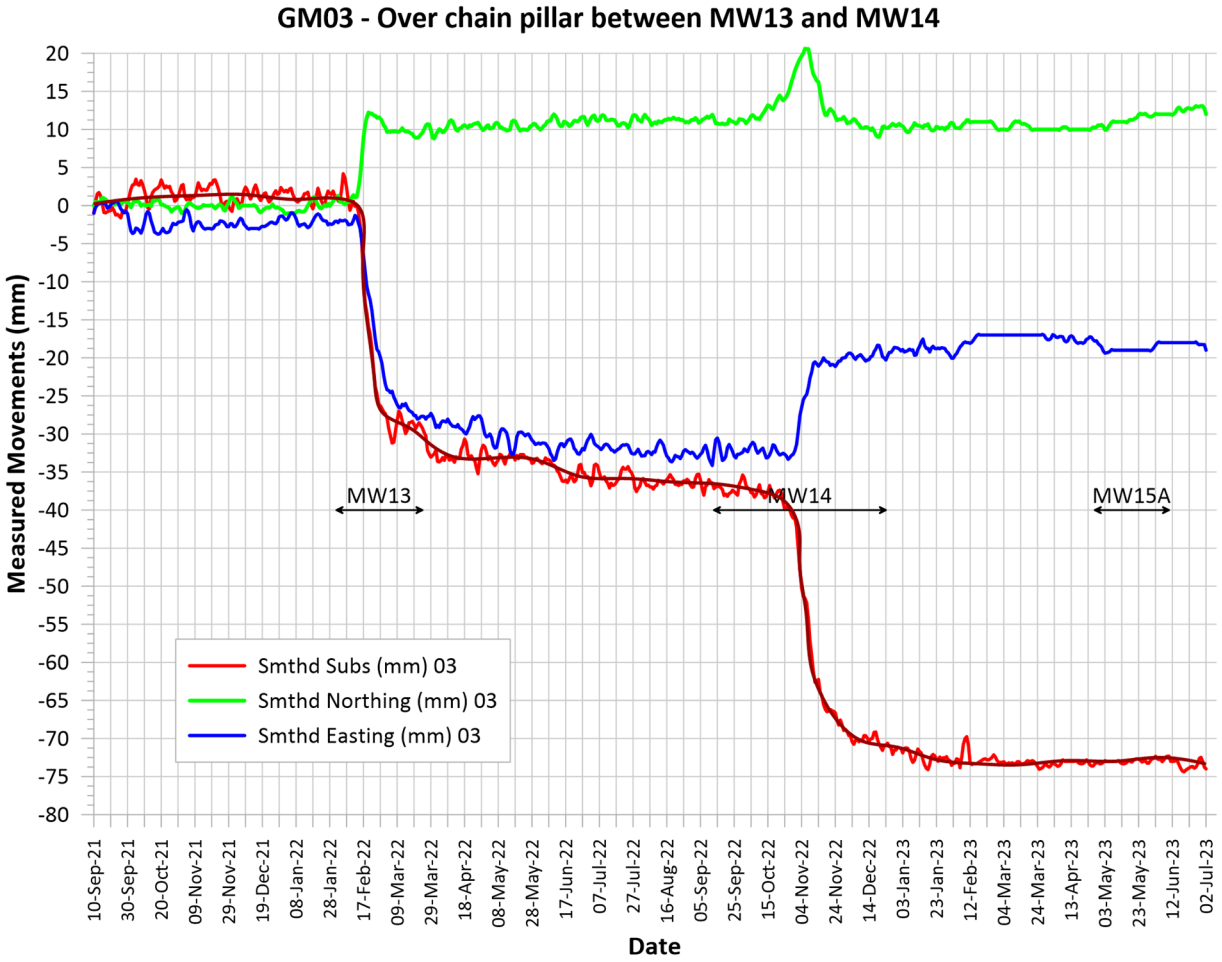


**Fig. 4.24 Eastwards and northward horizontal movements and subsidence of GNSS Station GM03 plotted against time during extraction of MWs 13 to 15A (MSEC)**

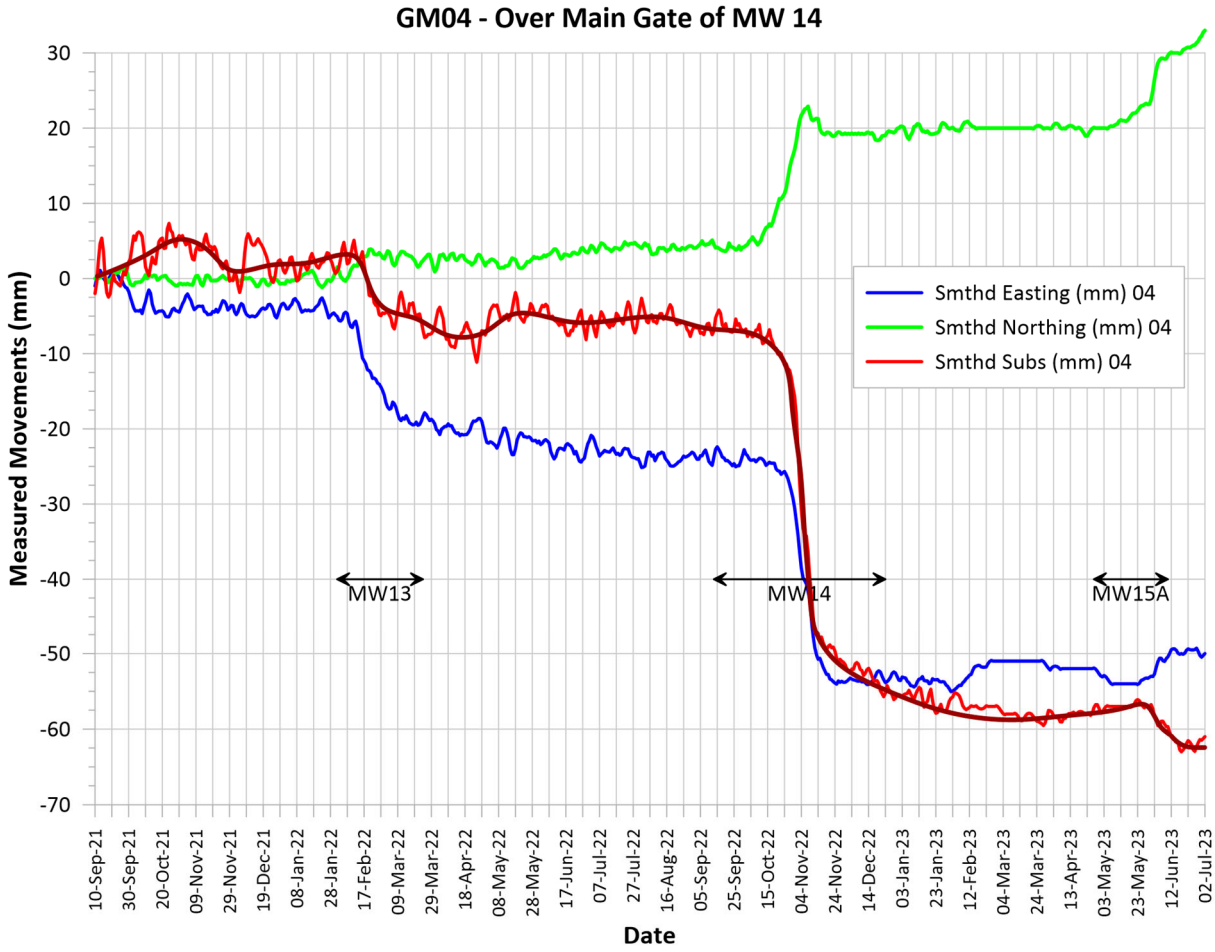


**Fig. 4.25** **Eastwards and northward horizontal movements and subsidence of GNSS Station GM04 plotted against time during extraction of MWs 13 to 15A (MSEC)**

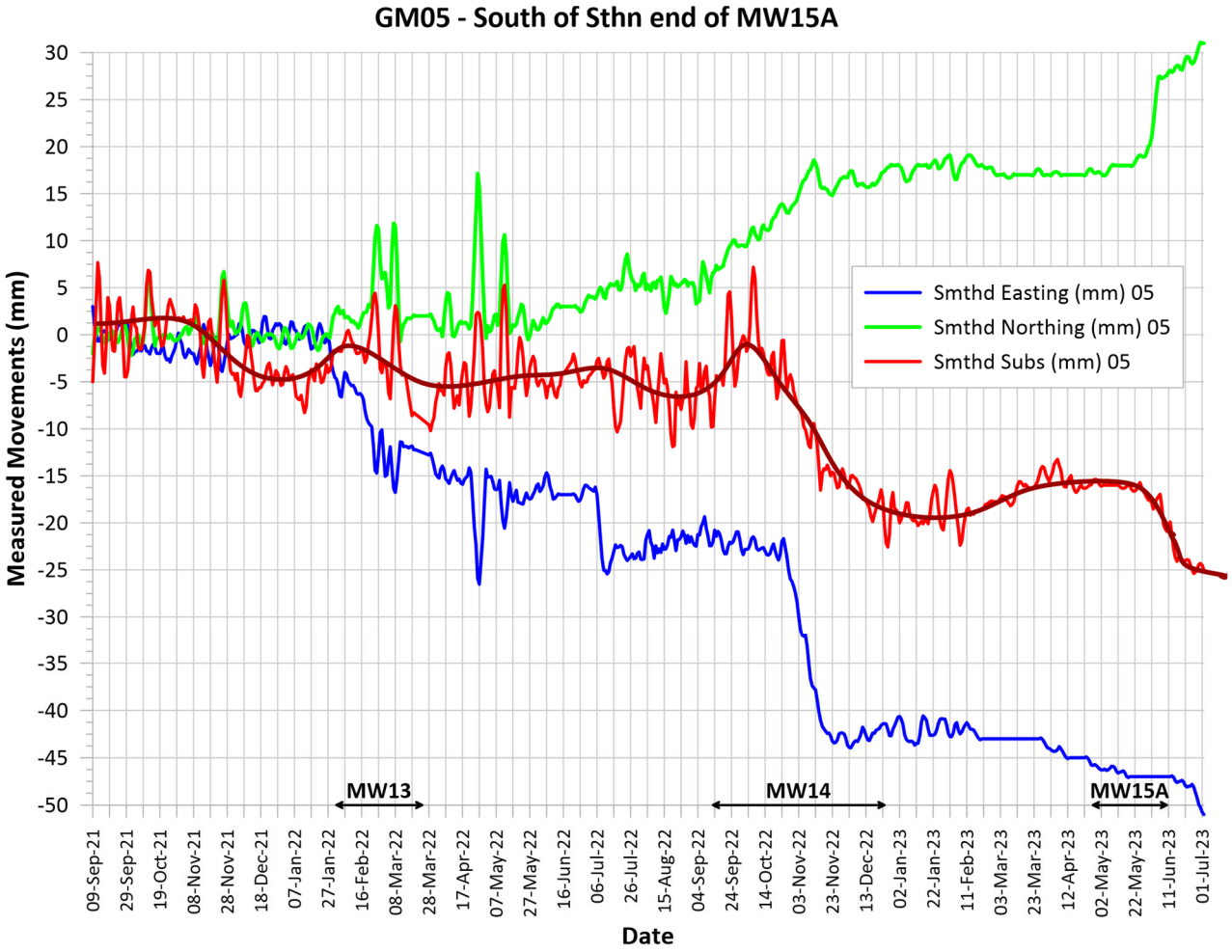

**Fig. 4.26 Eastwards and northward horizontal movements and subsidence of GNSS Station GM05 plotted against time during extraction of MWs 13 to 15A (MSEC)**

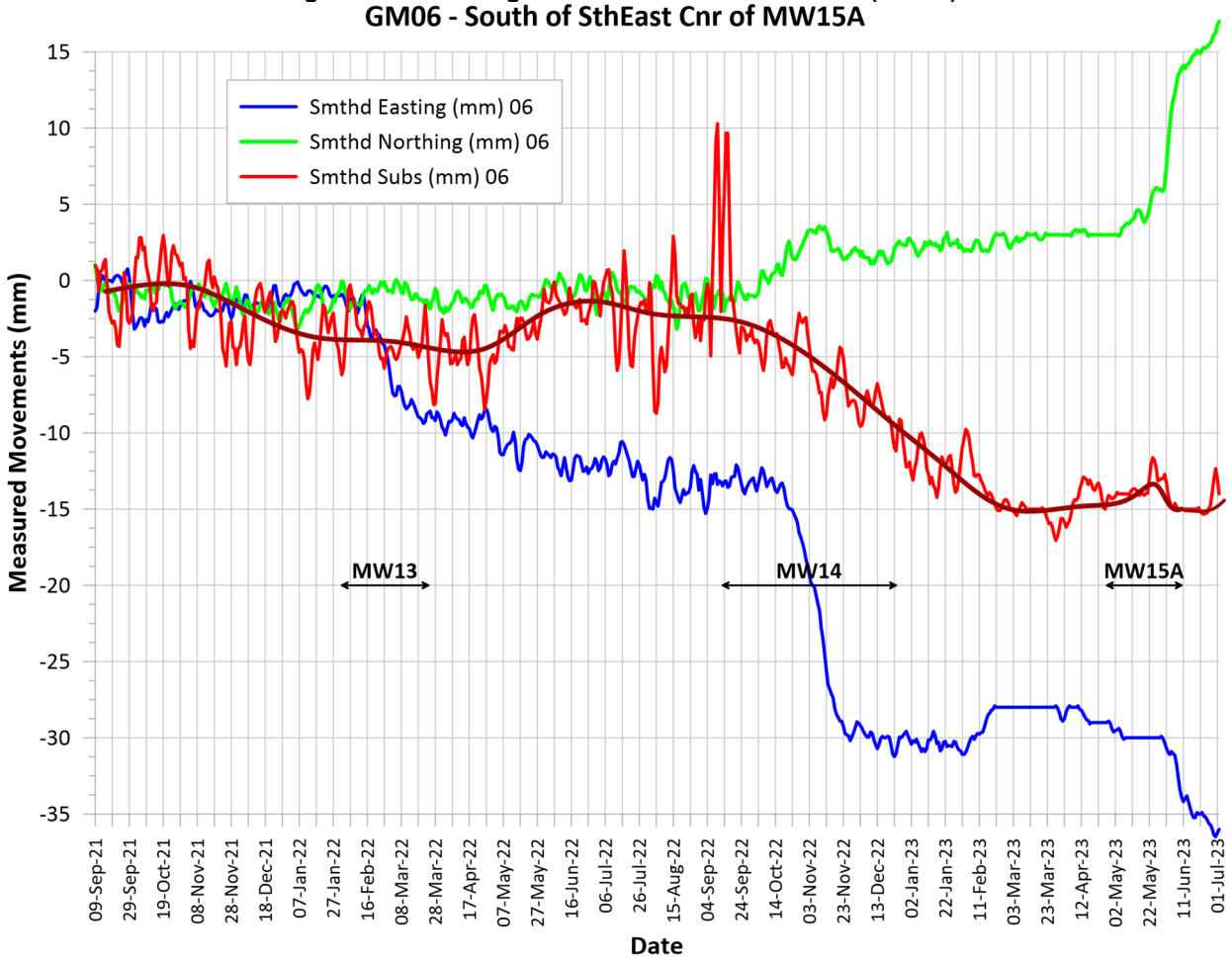


**Fig. 4.27 Eastwards and northward horizontal movements and subsidence of GNSS Station GM06 plotted against time during extraction of MWs 13 to 15A (MSEC)**

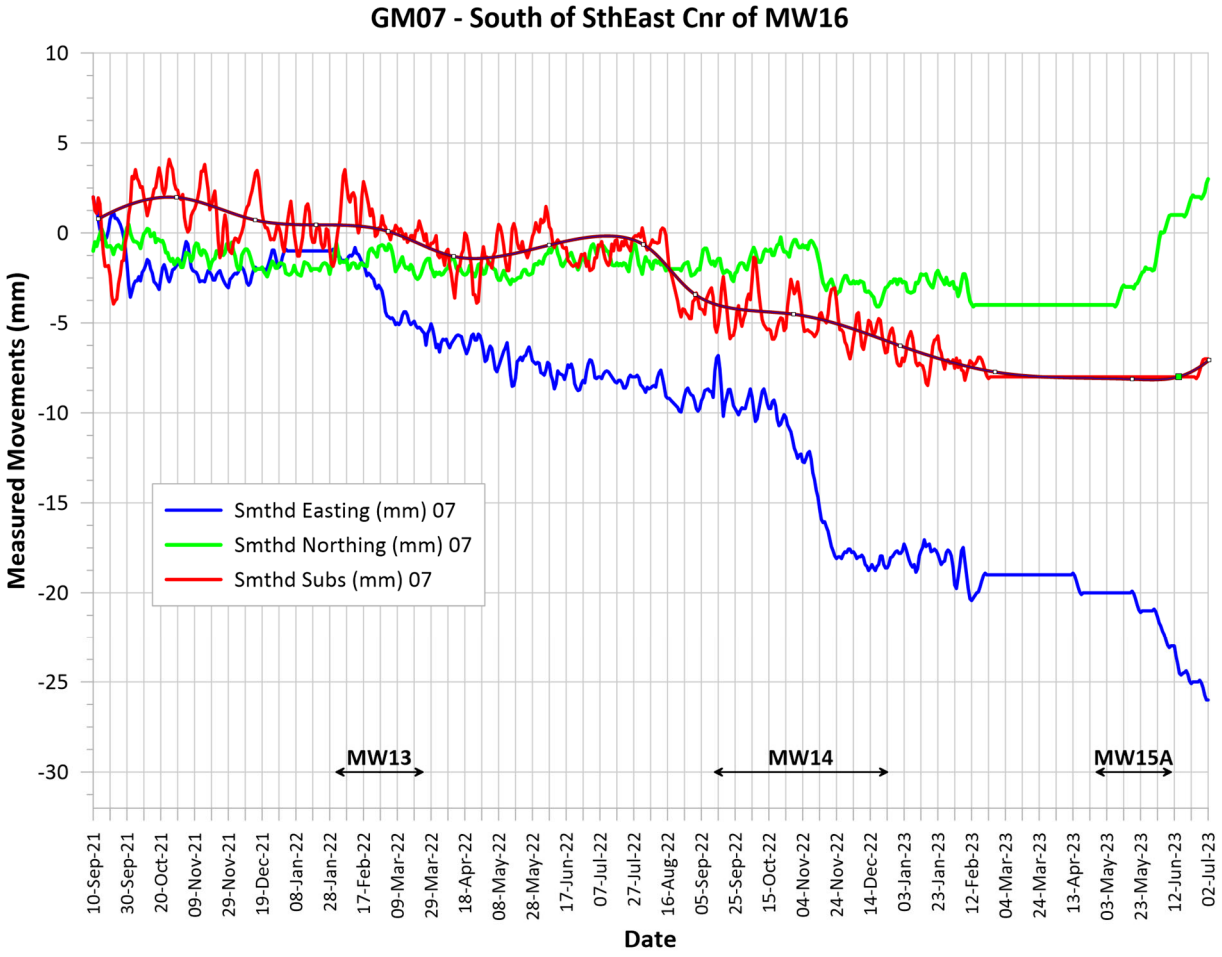


**Fig. 4.28** Eastwards and northward horizontal movements and subsidence of GNSS Station GM07 plotted against time during extraction of MWs 13 to 15A (MSEC)

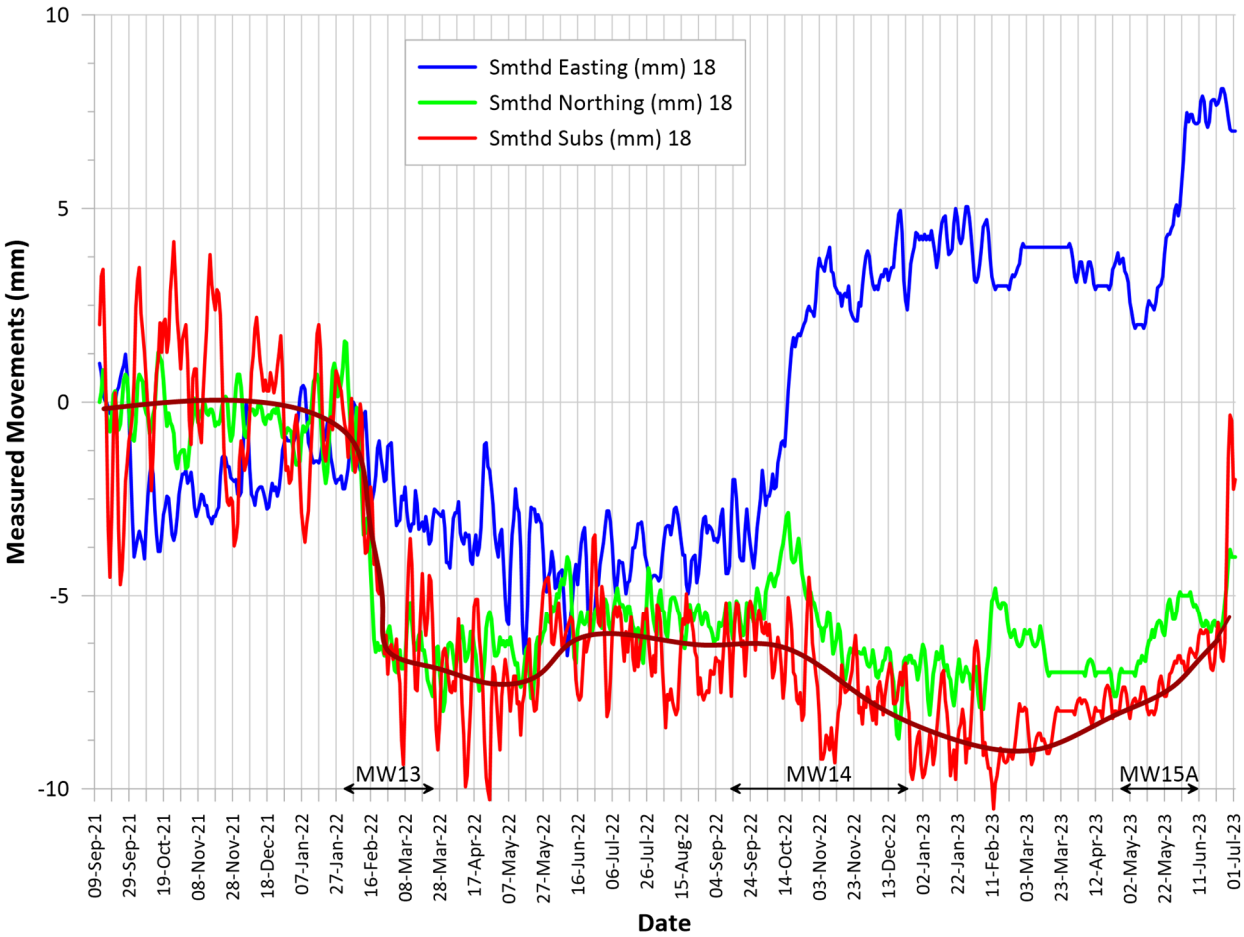


**Fig. 4.29** Eastwards and northward horizontal movements and subsidence of GNSS Station GM018 plotted against time during extraction of MWs 13 to 15A (MSEC)


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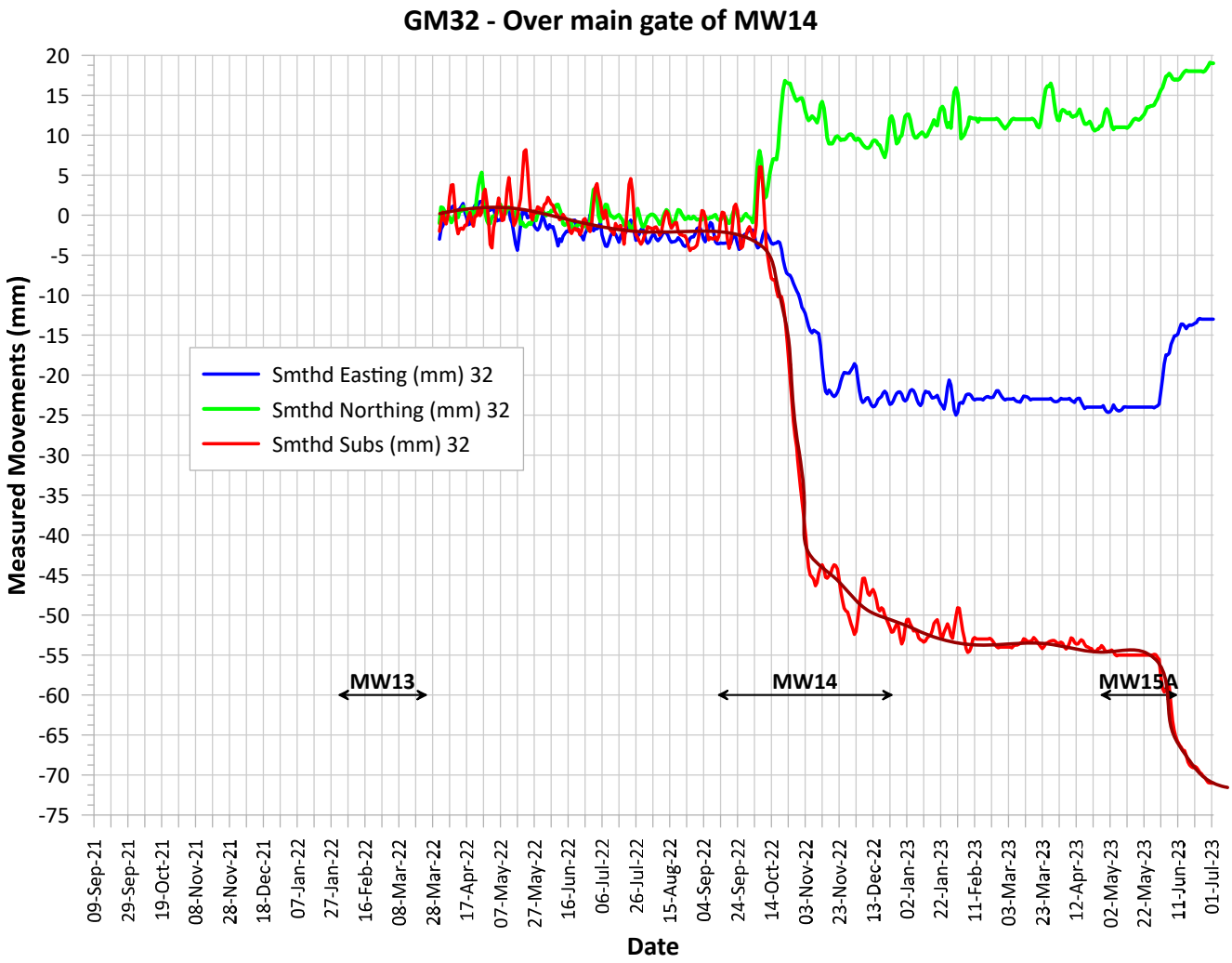



**Fig. 4.30** **Eastwards and northward horizontal movements and subsidence of GNSS Station GM32 plotted against time during extraction of MWs 14 to 15A (MSEC)**

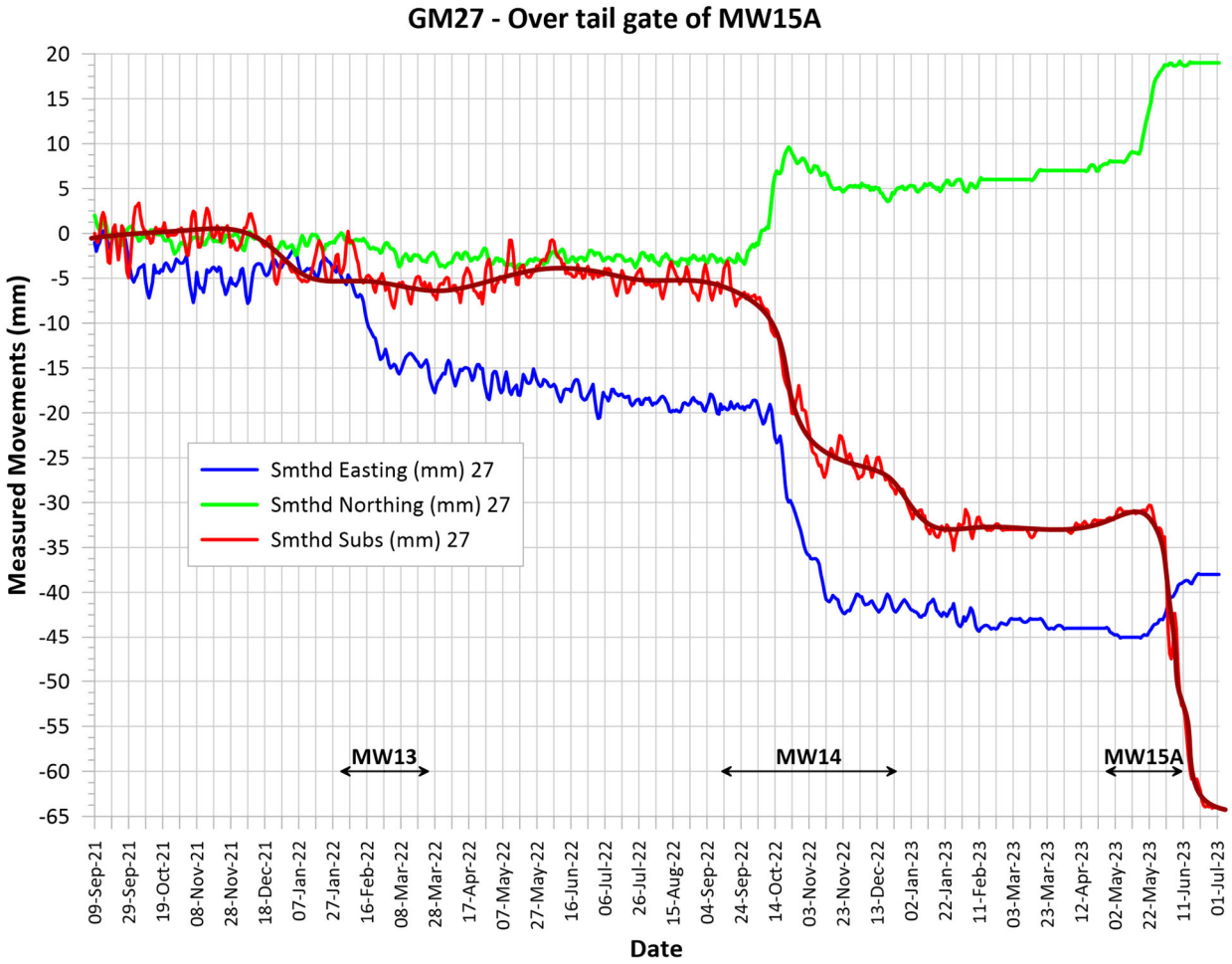



**Fig. 4.31** **Eastwards and northward horizontal movements and subsidence of GNSS Station GM27 plotted against time during extraction of MWs 13 to 15A (MSEC)**

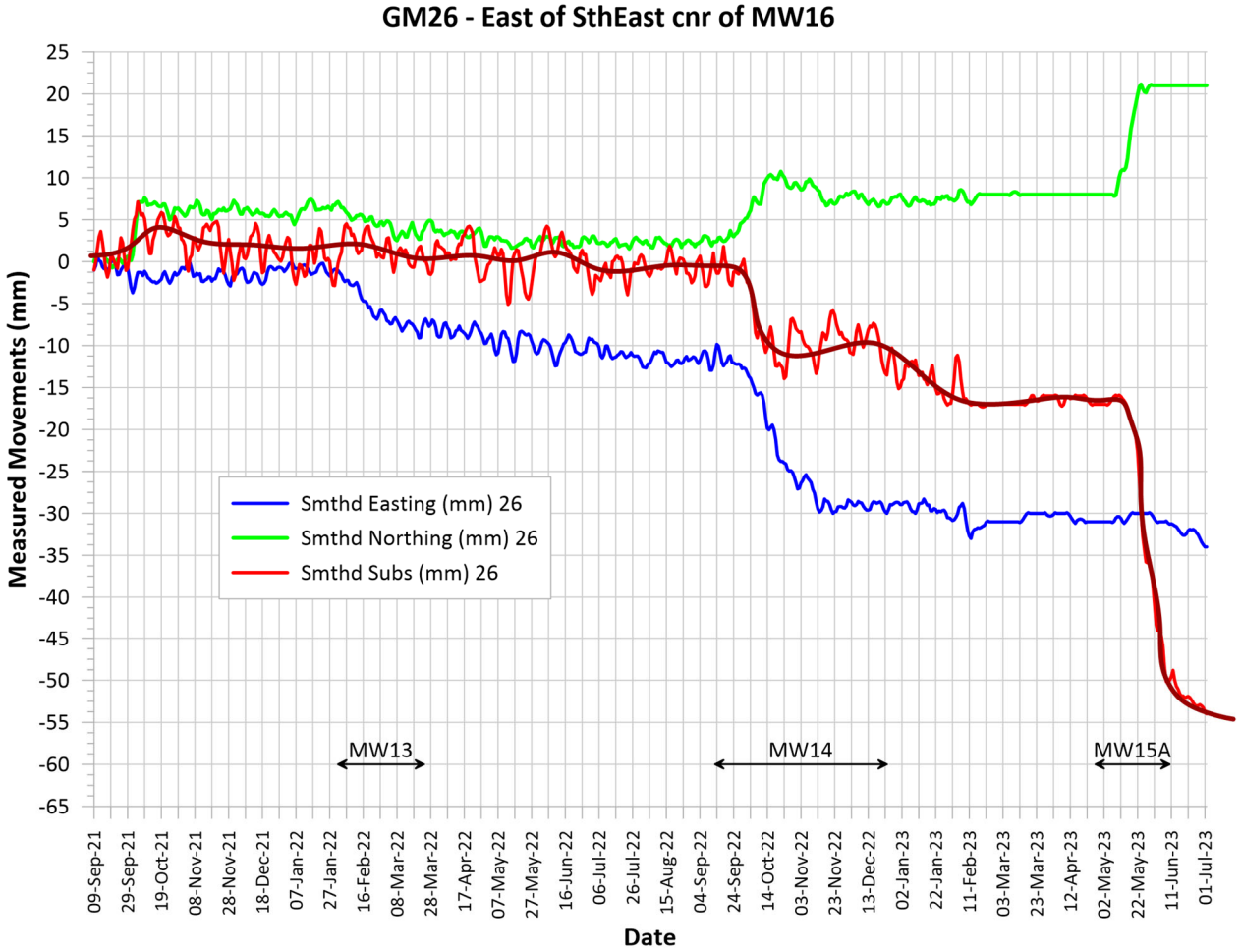


**Fig. 4.32 Eastwards and northward horizontal movements and subsidence of GNSS Station GM26 plotted against time during extraction of MWs 13 to 15A (MSEC)**

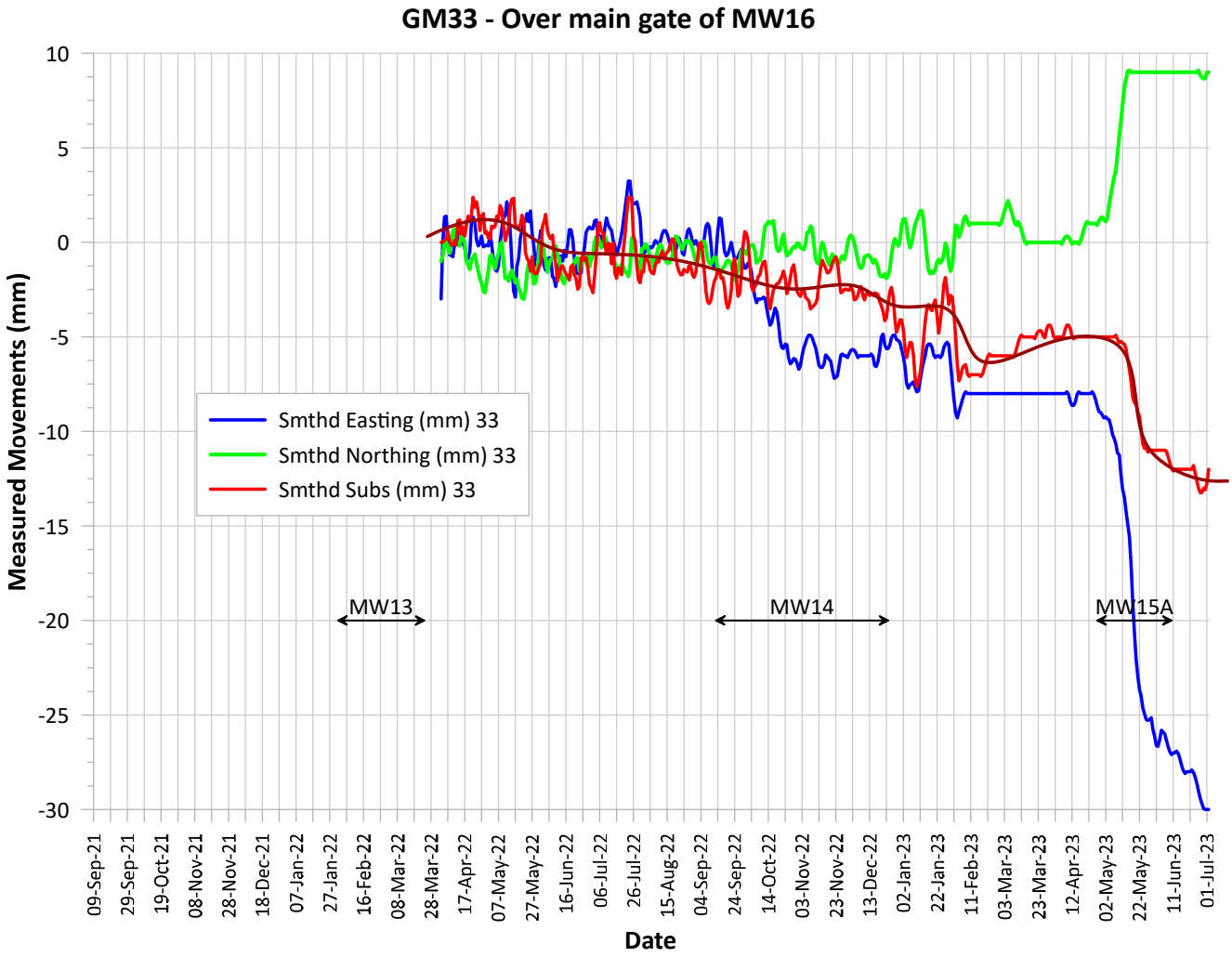



**Fig. 4.33 Eastwards and northward horizontal movements and subsidence of GNSS Station GM33 plotted against time during extraction of MWs 14 to 15A (MSEC)**

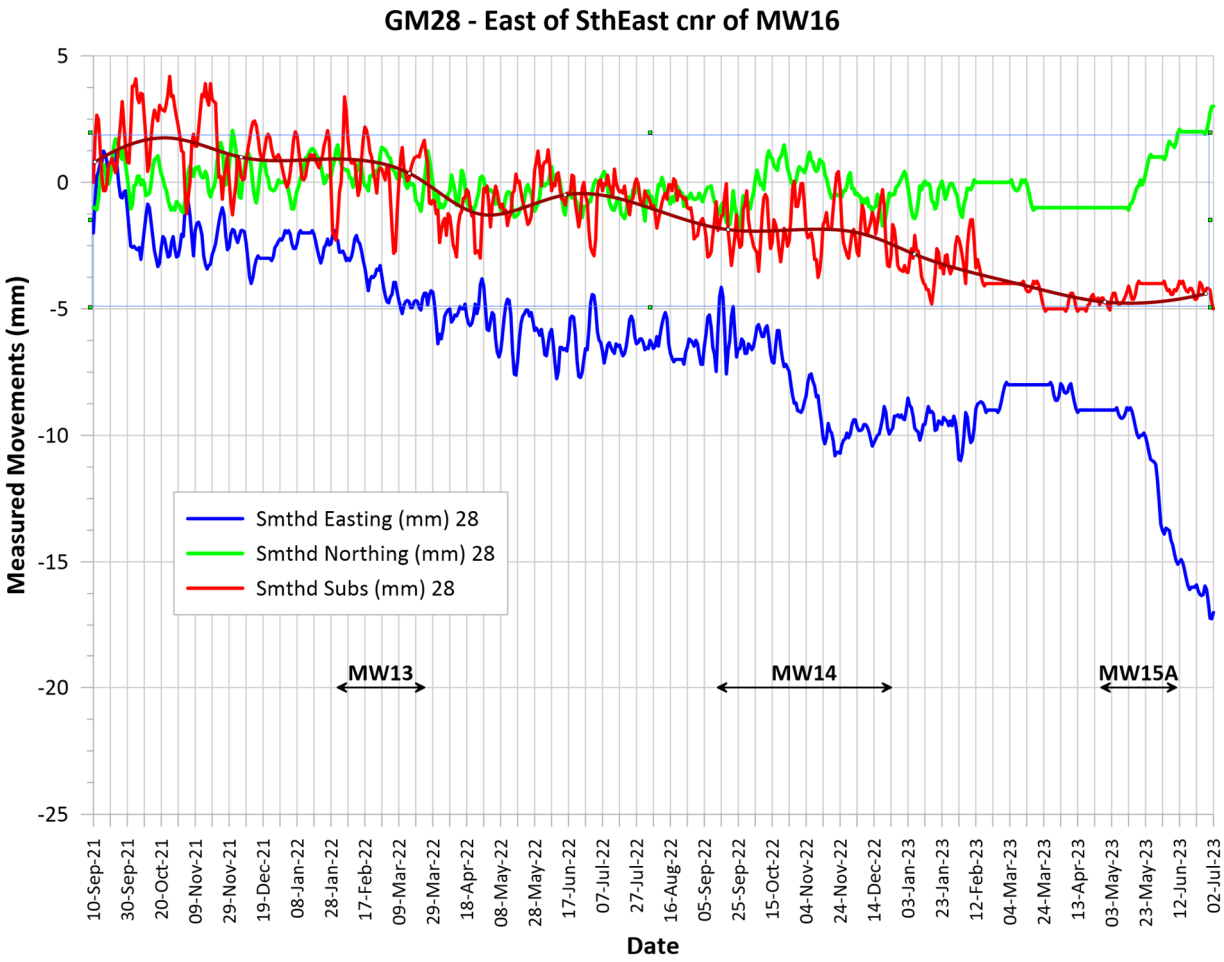



**Fig. 4.34 Eastwards and northward horizontal movements and subsidence of GNSS Station GM28 plotted against time during extraction of MWs 13 to 15A (MSEC)**

While extraction in MW15A finished on 10 June 2023, small levels of residual subsidence would be expected to still occur. At this time the maximum subsidence over MWs 13 to 15A is 86 mm. Fig. 4.35 shows observed subsidence along Monitoring Line 1 which mainly picks up the effects from the extraction of two panels, namely MW13 and MW14.

Fig. 4.35 shows the observed subsidence along Monitoring Line 1 between GNSS stations, GM01 to GM07 after the extraction of MWs 13 in **a dark red** colour, after the extraction of MW 14 in **blue,** and after the extraction of MW 15A in **green**.

The maximum subsidence along Monitoring Line 1 is 73 mm at GNSS station GM03. However, while all extraction in MW15A was finished in June 2023, small ongoing levels of residual subsidence would still be expected to occur for several months.

Fig. 4.35 also includes a **red** coloured possible subsidence profile after MW13 was extracted, which may have been monitored if more GNSS units could have been installed over this mesa.

Fig. 4.35 also includes a **purple**-coloured possible subsidence profile after MW14 was extracted, which may have been monitored if more GNSS units could have been installed over this mesa.

Fig. 4.35 also includes a **green**-coloured dashed possible subsidence profile after MW15A was extracted, which may have been monitored if more GNSS units could have been installed over this mesa.

It can be noted that only a small extra amount of subsidence was measured along this Monitoring Line 1 after the extraction of MW15A and this is predominantly because the MW14 and MW15A were stopped short of several internal cliffs to reduce the risk of rock falls.

It can be noted that the GNSS station GM01, which was located on the outer edge of the external escarpment was uplifted slightly.

Fig. 4.36 re plots the data from predicted subsidence profiles from Fig. 4.35 and it shows in blue dashed lines the SCT FLAC modelling subsidence predictions across one, two and three side by side panels.

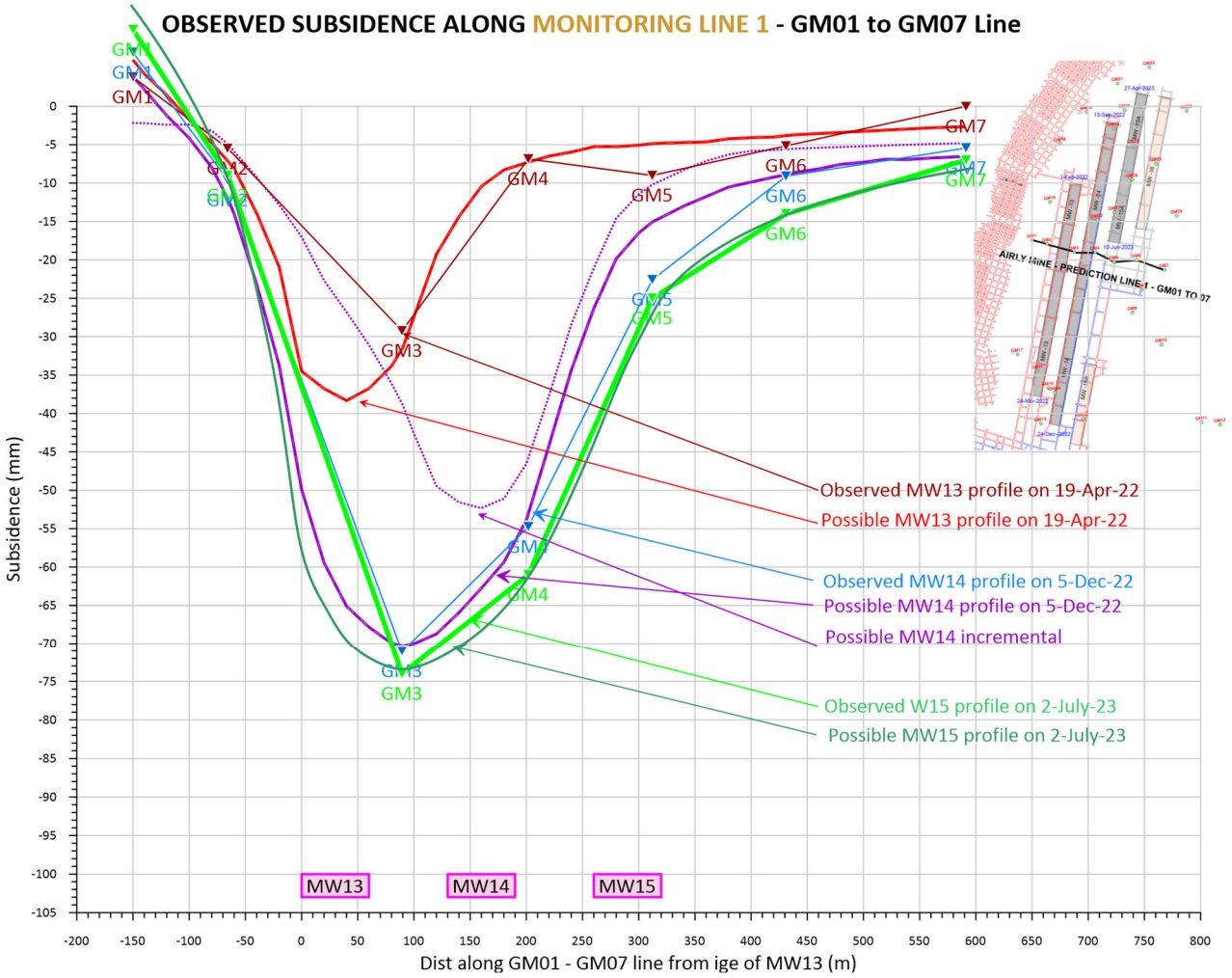



**Fig. 4.35 Observed Subsidence of GNSS units along Monitoring Line 1 plotted against time during extraction of MWs 13 to 15A (MSEC)**

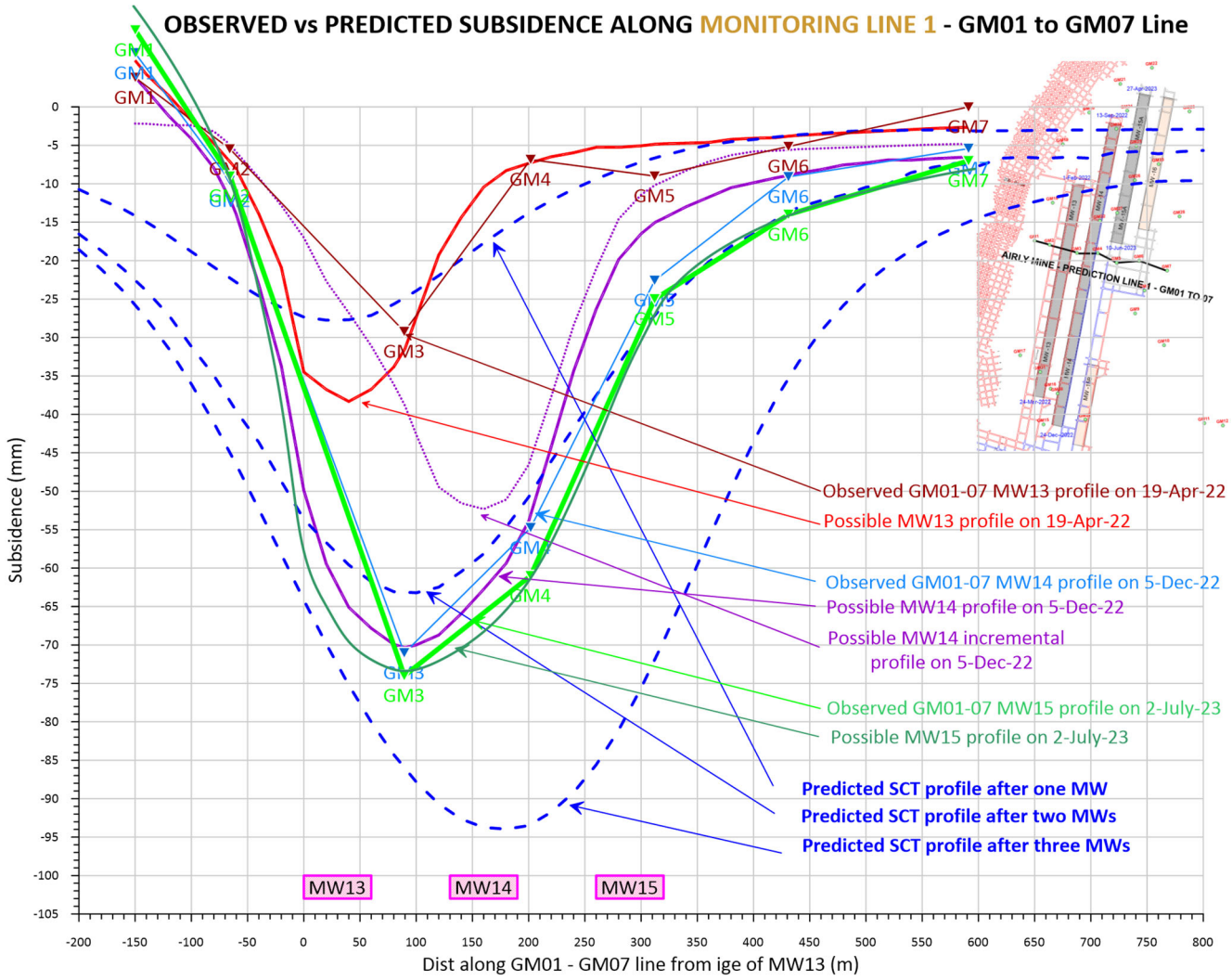



**Fig. 4.36 Observed Subsidence of GNSS units along Monitoring Line 1 plotted against time during extraction of MWs 13 to 15A versus predictions (MSEC)**

Fig. 4.37 shows the observed subsidence along Monitoring Line 2 between GNSS stations, GM18 to GM28 during the extraction of MWs 13 to 15A.

Fig. 4.37 shows the observed subsidence along Monitoring Line 2 between GNSS stations, GM18 to GM28 after the extraction of MW 13 in **a dark red** colour, after the extraction of MW 14 in **blue**, and after the extraction of MW 15A in **green**.

The maximum subsidence along Monitoring Line 2 is 86 mm at GNSS station GM32. However, while all extraction in MW15A was finished in June 2023, small ongoing levels of residual subsidence would still be expected to occur for several months.

Fig. 4.37 also includes a **red** coloured possible subsidence profile after MW13 was extracted, which may have been monitored if more GNSS units could have been installed over this mesa.

Fig. 4.37 also includes a **purple**-coloured possible subsidence profile after MW14 was extracted, which may have been monitored if more GNSS units could have been installed over this mesa.

Fig. 4.37 also includes a **green**-coloured dashed possible subsidence profile after MW15A was extracted, which may have been monitored if more GNSS units could have been installed over this mesa.

Lower levels of subsidence were measured along this Monitoring Line 2 after the extraction of MW15A and could have resulted from several causes, including;

- MW14 and MW15A were stopped short of several internal cliffs to reduce the risk of rock falls.
- Further ongoing residual subsidence can be expected, but this would only account a small amount, say an extra 10 mm, now that the extraction has stopped.
- Higher levels of subsidence may have been measured if more GNSS units had been installed.

Fig. 4.38 re plots the data from predicted subsidence profiles from Fig. 4.37 and it shows in blue dashed lines the SCT FLAC modelling subsidence predictions across one, two and three side by side panels.

In conclusion, based on the available subsidence monitoring, after MW15A was extracted under Point Hatteras, the maximum observed subsidence level was 86 mm, which is less than the predicted SCT levels of 94 mm for three panels over MWs 13 to 15A.

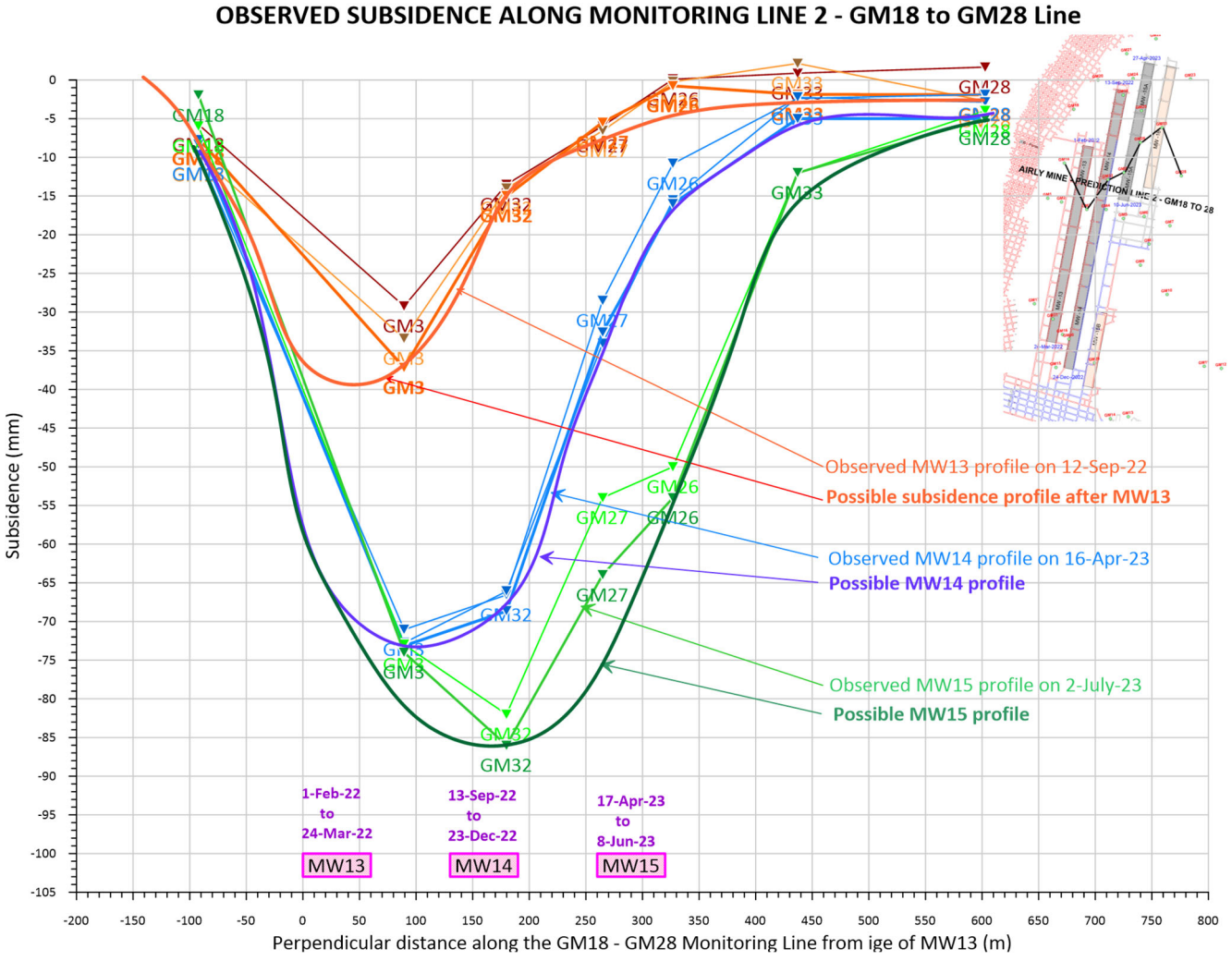



**Fig. 4.37 Observed Subsidence of GNSS units along Monitoring Line 2 plotted against time during extraction of MWs 13 to 15A (MSEC)**

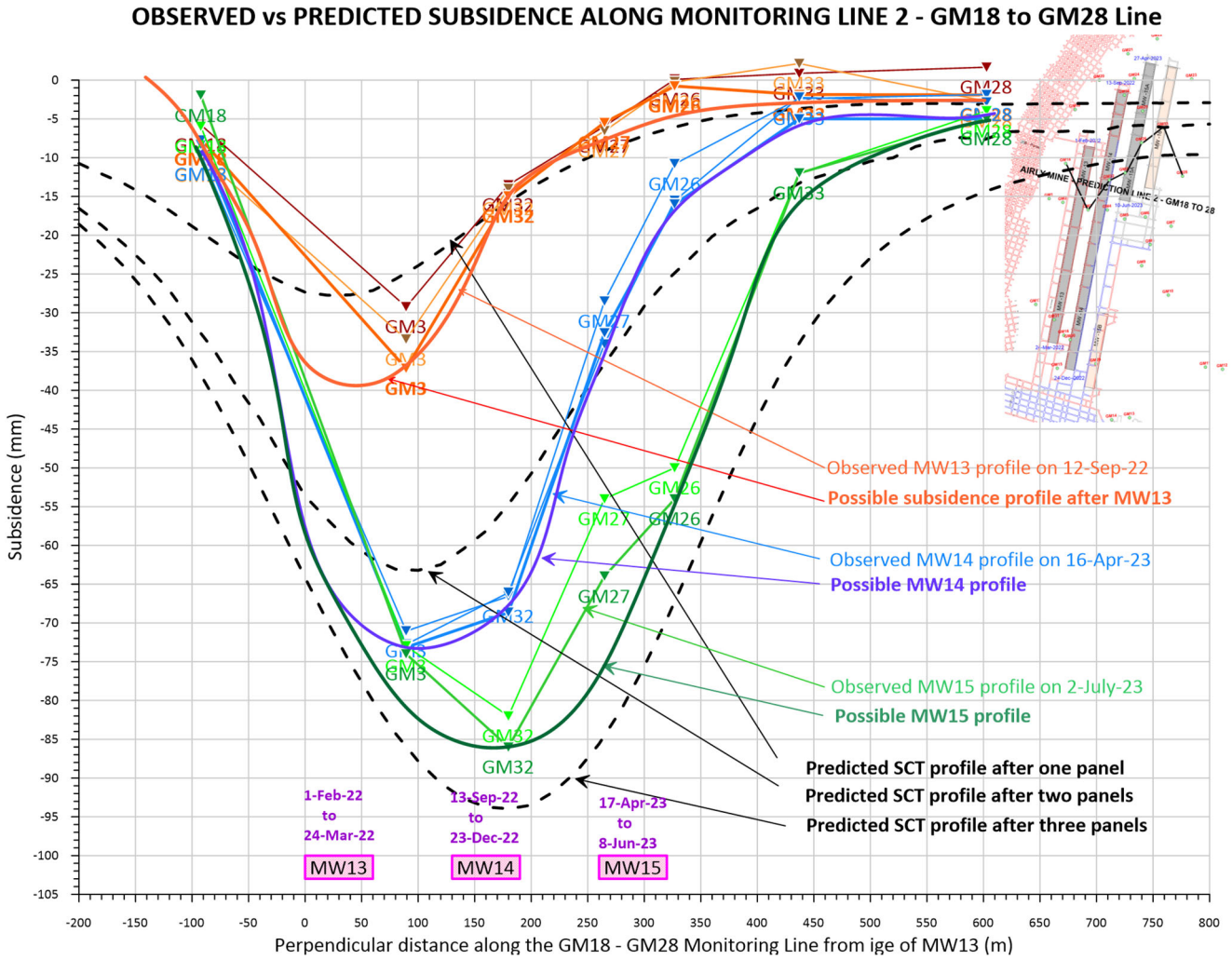



**Fig. 4.38 Observed Subsidence of GNSS units along Monitoring Line 2 plotted against time during extraction of MWs 13 to 15A versus predictions (MSEC)**

## 5.1. Definition of the Study Area

The Study Area for this subsidence assessment is defined as the surface area that could be affected by the extraction of the proposed MWs 17 & 18.

A Study Area based on a 26.5° AoD represents the minimum extent for impact assessments due to conventional ground movements (i.e., vertical subsidence and its associated effects). However, low-level conventional and non-conventional ground movements can, in most other projects, extend beyond the 26.5° AoD. Hence, for those cases, a Study Area based on the 600 m boundary is often used, as this boundary is regarded as the minimum extent of the assessments for the valley-related effects (refer Section 3.3.3). However, for this project where the coal seams outcrop around the talus slopes of the mesas and well above the valley floor, the surface areas that could be impacted by subsidence or valley related movements are limited to the top surface areas over the two mesas and the surrounding major escarpment cliff lines.

The extent of the Study Area has therefore been based on the predicted limit of vertical subsidence. However, as discussed in Section 4.0 , SCT advised that, while the numerical model, FLAC, predicts the vertical subsidence over the mined panels well, it overestimates the subsidence outside the panels, as can be seen in Section 4.4. Hence, SCT recommended that the predicted 20 mm limit of vertical subsidence could be based on the monitored subsidence around the early mini walls at Mount Airly. However, as discussed in Section 6.3, since the measured angles of draw (AoD) over these early panels were generally less than 17°, it was decided to conservatively adopt the 26.5° AoD line to predict the extent of the 20 mm subsidence contour line for South-eastern area of Genowlan Mountain.

The extent of the Study Area has therefore been based on the predicted 20 mm subsidence contour line which determined based on the 26.5° AoD (half the depth of cover) draw lines from the proposed panels.

## 5.2. Overview of the natural and built features within the Study Area

As shown in Fig. 5.1, almost all of the surface areas over MWs 17 & 18 and Genowlan Mountain are undeveloped, and it is included in the MMSCA that has significant natural and cultural heritage values. There are few built features over Genowlan Mountain with the most prominent natural feature being the major escarpment cliff lines that surround these two mesas. A summary of the natural and built features within the Study Area is provided in Table 5.1.

The locations of these natural and built features plus the descriptions, subsidence ground movement predictions and impact assessments for each of the natural and built features are provided in Chapters 7 and 8.

**Fig. 5.1 Proposed Airly Mine panel boundaries for MWs 17 & 18 overlain over an aerial photograph of Genowlan Mountain (MSEC)**

## Table 5.1 Natural and built features within the Study Area

| Item | Within Study Area | Section Number |
|---|---|---|
| **NATURAL FEATURES** | | |
| Drinking Water Catchment Areas or Declared Special Areas | × | |
| Streams | ✓ | 7.2 |
| Aquifers or Known Groundwater Resources | × | |
| Springs or Groundwater Seeps | ✓ | 7.3 |
| Sea or Lake | × | |
| Shorelines | × | |
| Natural Dams | × | |
| Cliffs or Pagodas | ✓ | 7.4 |
| Steep Slopes | ✓ | 5.5 |
| Escarpments | ✓ | 5.4 |
| Land Prone to Flooding or Inundation | × | |
| Swamps or Wetlands | × | |
| Water Related Ecosystems | × | |
| Threatened or Protected Species | ✓ | 5.6 |
| Lands Defined as Critical Habitat | × | |
| National Parks | × | |
| State Forests | × | |
| State Recreation or Conservation Areas | ✓ | 5.7 |
| Natural Vegetation | ✓ | 5.8 |
| Areas of Significant Geological Interest | × | |
| Any Other Natural Features Considered Significant | × | |
| | | |
| **PUBLIC UTILITIES** | | |
| Railways | × | |
| Roads (All Types) | ✓ | 8.1 |
| Bridges | × | |
| Tunnels | × | |
| Culverts | × | |
| Water, Gas or Sewerage Infrastructure | × | |
| Liquid Fuel Pipelines | × | |
| Electricity Transmission Lines or Associated Plants | × | |
| Telecommunication Lines or Associated Plants | ✓ | 6.2 |
| Water Tanks, Water or Sewage Treatment Works | × | |
| Dams, Reservoirs or Associated Works | × | |
| Air Strips | × | |
| Any Other Public Utilities | × | |
| | | |
| **PUBLIC AMENITIES** | | |
| Hospitals | × | |
| Places of Worship | × | |
| Schools | × | |
| Shopping Centres | × | |
| Community Centres | × | |
| Office Buildings | × | |
| Swimming Pools | × | |
| Bowling Greens | × | |
| Ovals or Cricket Grounds | × | |
| Race Courses | × | |
| Golf Courses | × | |
| Tennis Courts | × | |
| Any Other Public Amenities | × | |

| Item | Within Study Area | Section Number |
|---|---|---|
| **FARM LAND AND FACILITIES** | | |
| Agricultural Utilisation or Agricultural Suitability of Farm Land | × | |
| Farm Buildings or Sheds | × | |
| Tanks | × | |
| Gas or Fuel Storages | × | |
| Poultry Sheds | × | |
| Glass Houses | × | |
| Hydroponic Systems | × | |
| Irrigation Systems | × | |
| Fences | × | |
| Farm Dams | × | |
| Wells or Bores | × | |
| Any Other Farm Features | × | |
| | | |
| **INDUSTRIAL, COMMERCIAL AND BUSINESS ESTABLISHMENTS** | | |
| Factories | × | |
| Workshops | × | |
| Business or Commercial Establishments or Improvements | × | |
| Gas or Fuel Storages or Associated Plants | × | |
| Waste Storages or Associated Plants | × | |
| Buildings, Equipment or Operations that are Sensitive to Surface Movements | × | |
| Surface Mining (Open Cut) Voids or Rehabilitated Areas | × | |
| Mine Related Infrastructure Including Exploration Bores and Gas Wells | × | |
| Any Other Industrial, Commercial or Business Features | × | |
| | | |
| **AREAS OF ARCHAEOLOGICAL SIGNIFICANCE** | ✓ | 6.3 |
| | | |
| **AREAS OF HISTORICAL SIGNIFICANCE** | ✓ | 6.4 |
| | | |
| **ITEMS OF ARCHITECTURAL SIGNIFICANCE** | × | |
| | | |
| **PERMANENT SURVEY CONTROL MARKS** | ✓ | 6.5 |
| | | |
| **RESIDENTIAL ESTABLISHMENTS** | | |
| Houses | × | |
| Flats or Units | × | |
| Caravan Parks | × | |
| Retirement or Aged Care Villages | × | |
| Associated Structures such as Workshops, Garages, On-Site Waste Water Systems, Water or Gas Tanks, Swimming Pools or Tennis Courts | × | |
| Any Other Residential Features | × | |
| | | |
| **ANY OTHER ITEM OF SIGNIFICANCE** | × | |
| | | |
| **ANY KNOWN FUTURE DEVELOPMENTS** | × | |

The 2014 Airly EIS was based primarily on empirical modelling by Strata Engineering in 2010 to 2012, Golder Associates in 2013 and 2014 and later by Strata[2] in 2019. This work was backed up or supplemented by some numerical modelling with using the "LaMODEL" numerical model.

The empirical modelling noted that the sag subsidence component of the likely total strata movements would be very small and most of the measured subsidence was likely to be caused by the squashing or compression of the strata layers in the chain pillars and the strata layers above and below the seam. This modelling was predominantly based on the successful modelling that was undertaken for similar mine layouts, similar depths of cover and similar maximum subsidence targets under similar cliff lines at the Centennial Clarence Mine, which is located approximately 50 kms to the south from Airly. The 2014 EIS acknowledged that the seam mined at Clarence, the top Katoomba Seam, is not the target seam at Airly, but appropriate mining methods had been planned to suit its geotechnical environment.

The empirical methodology utilised a database of subsidence results over panels with low span (W) to depth (H) ratios, focussing largely on Western Coalfield experiences. Strata[2] (2020) advised later, i.e., after the increased levels of subsidence were recorded that the predictive curves used had relied heavily on the Clarence subsidence data set. Unfortunately, however, the overburden geology at Airly is not similar as Clarence mined the Katoomba seam while Airly mined was the Lithgow seam. Strata[2] (2020) also advised that factors affecting the difference in subsidence between the two Western Coalfield seams were;

- The thickness of the Permian overburden is 50% greater than the in the case of the Lithgow Seam at Airly, as opposed to the Katoomba Seam at Clarence (i.e., around 90m versus 60m). Also, the immediate and near roof of the Katoomba Seam is stiffer and more competent; factors that would be expected to result in less subsidence.
- the Katoomba Seam is one of the strongest Australian coals, whereas the Lithgow Seam is of effectively average strength. The stronger the seam, the less potential for rib softening at the margins of the extracted area.

As discussed in Section 4.1, further mathematical modelling was undertaken in 2020 by Chengguo Zhang of UNSW using UDEC and by Yvette Heritage of SCT in 2021 using FLAC. This new modelling indicated that the increased subsidence that was measured over MWs 2 to 10, resulted from failures within the weaker than expected overburden strata layers that overlie the chain pillars.

The modelling that was undertaken by SCT in 2021, using the FLAC 2D programme, (refer to SCT Report AIRLY5240, dated 20 January 2021 and SCT Report AIRLY5265, August 2021), was first aimed at calibrating the FLAC model against the observed subsidence measured over MWs 2 to 7 and, then this model was used to predict the likely subsidence over MWs 11 and 12 under Mount Airly and then MWs 13 to 16 under Point Hatteras areas of Genowlan Mountain. (Refer to Fig. 1.3 for these locations). SCT advised that the key control mechanism that can be used to reduce surface subsidence for these panels was to widen the chain pillar widths in order to result in an elastic response for the pillar loading and to minimise the fracturing and rock mass damage of the strata overlying the pillars.

SCT advised that, with the mini wall panel widths of 61 m (rib to rib) and much wider proposed chain pillar widths of 70 m (solid), the predicted subsidence, after four side by side mini walls are extracted, i.e., for MWs 13 to 16, , (*where the DoC ranged up to 305 m*), would be 115 mm, which was less than the EIS maximum subsidence prediction of 125 mm.

CA has now extracted MW 13 to MW15A under the Point Hatteras region of the Genowlan Mountain. As discussed in Section 4.5, based on the available subsidence monitoring, after MW15A was extracted under Point Hatteras, the maximum observed subsidence level was 86 mm, which is less than the predicted SCT levels of 94 mm for three panels over MWs 13 to 15A.

## 6.1. Subsidence Predictions for Airly MWs17 to 19

SCT was engaged by CA in 2022 to advise on a modification of the panel and pillar design to fit three panels within the available resource under the south-eastern side of Genowlan Mountain that would limit the maximum predicted subsidence over MWs 17 to 19 to less than the maximum subsidence limit of 125 mm.

SCT's report titled "*South East Genowlan (MW17 & 18) Pillar and Panel Width Numerical Modelling Assessment*", SCT Report AIRLY5521 Rev 1, dated 19th December 2022, advised that the maximum predicted subsidence estimate for the newly proposed mine layout of 3*56 m voids and 2 * 50 m pillars, (*where the DoC ranged from 240 m to 280 m*), was 118 mm.

Fig. 6.1 shows predicted subsidence profiles over three mini wall panels, i.e., MWs 17 to 19, based on the SCT modelling (SCT Report AIRLY5521, Oct 2022). That is, compared to the EIS design, the panel void widths proposed for MWs 17 to 19 are to be reduced from 61 to 56 m and the chain pillar widths are increased from 29.5 to 50 m.

In this report SCT also advised:

- The risk of increased subsidence was slightly heightened with the onset of shear failure above the second pillar, causing softening of the strata,
- A subsidence tolerance/natural variability of ± 20 mm should be applied to the modelled subsidence, and
- The potential for additional subsidence from any first workings or pillar extraction adjacent to these panels should be considered.

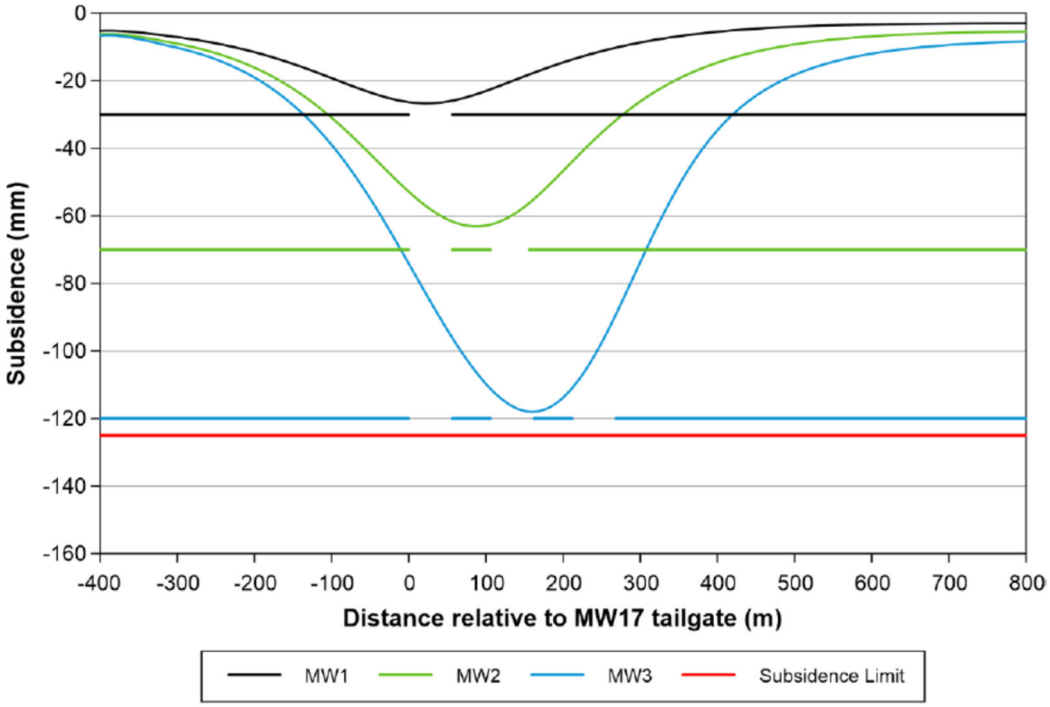
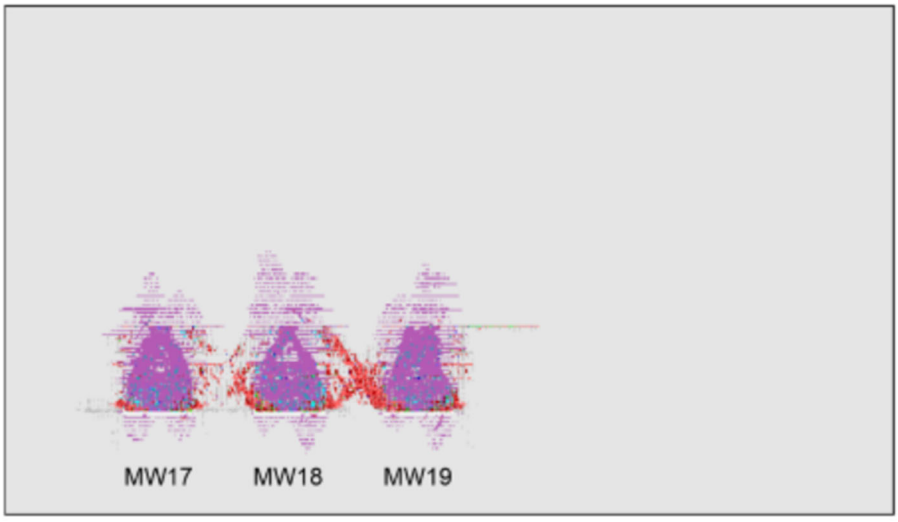



**Fig. 6.1 FLAC modelling results of 3*56 m mini wall panels with 2*50m chain pillars (SCT, 2022)**

Fig. 6.2 shows the FLAC model predicted more extensive failure over the pillar between MW18 and 19 than the pillar over MW17 and 18. This has led to increased subsidence over MWs 18 and 19 and an asymmetrical subsidence profile over MWs 17 to 19.




**c) MW17, MW 18 and MW19.**

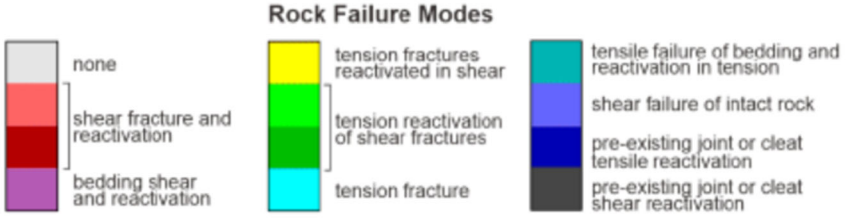



**Fig. 6.2 FLAC modelling results showing modes of failure (SCT, 2022)**

Fig. 6.3 shows the same SCT profiles with a symmetrical subsidence profile with 26.5-degree AoDs.

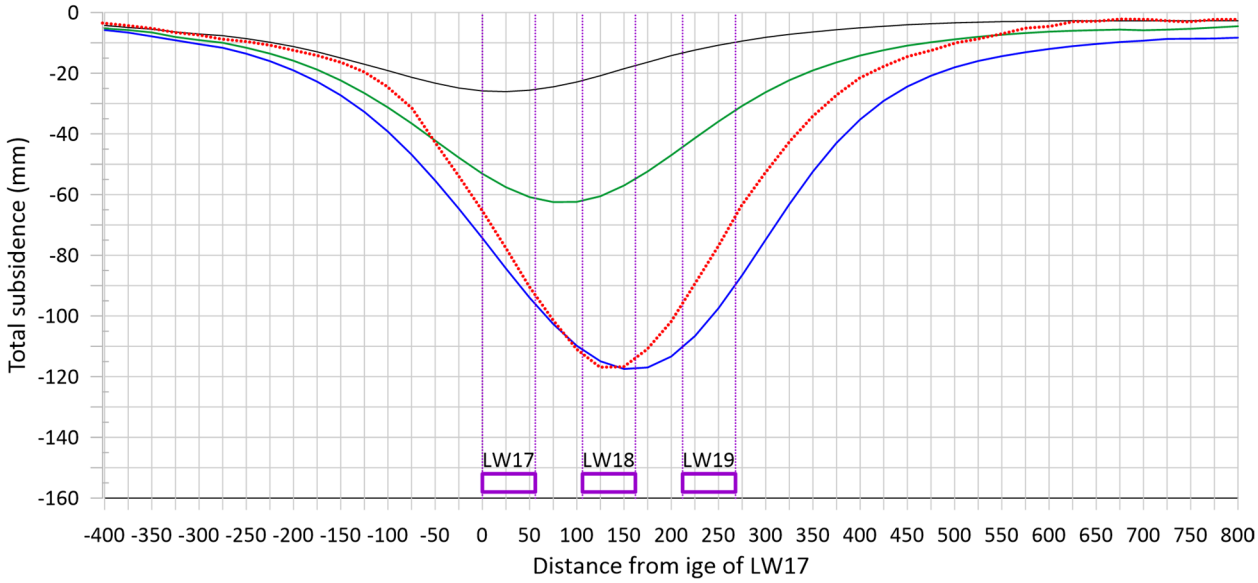



**Fig. 6.3 FLAC modelling (2022) results with relative positions of MWs 17 & 18 and a symmetrical profile with 26.5-degree AoD (MSEC and SCT, 2022)**

## 6.2. Subsidence Predictions for Airly MWs17 & 18

SCT was then engaged by CA in 2023 to advise on a modification of the panel and pillar design to fit two panels within the available resource under the south-eastern side of Genowlan Mountain that would limit the maximum measured subsidence over MWs 17 &18 to less than the maximum subsidence limit of 125 mm.

SCT's report titled "*MW17-18 Pillar and Panel Optimisation Assessment: Increasing from56m Panels and 50m Pillars to 70.5 Panels and 70m Pillars*", SCT Report AIRLY5612, dated 8th June 2023, advised that the maximum predicted subsidence estimate for the newly proposed mine layout of 2*70.5 m voids and 1 * 70 m pillar, (*where the DoC ranged from 240 m to 280 m*), was 88 mm.

Fig. 6.4 shows predicted subsidence profiles over two mini wall panels, i.e., MWs 17 & 18, based on the SCT modelling (SCT Report AIRLY5612, Jun23). That is, compared to the EIS design, the panel void widths proposed for MWs 17 & 18 are to be increased from 60 to 70.5 m and the chain pillar widths are increased from 29.5 to 70 m and the seam extraction height has increased from 2.8 to 3.0m.

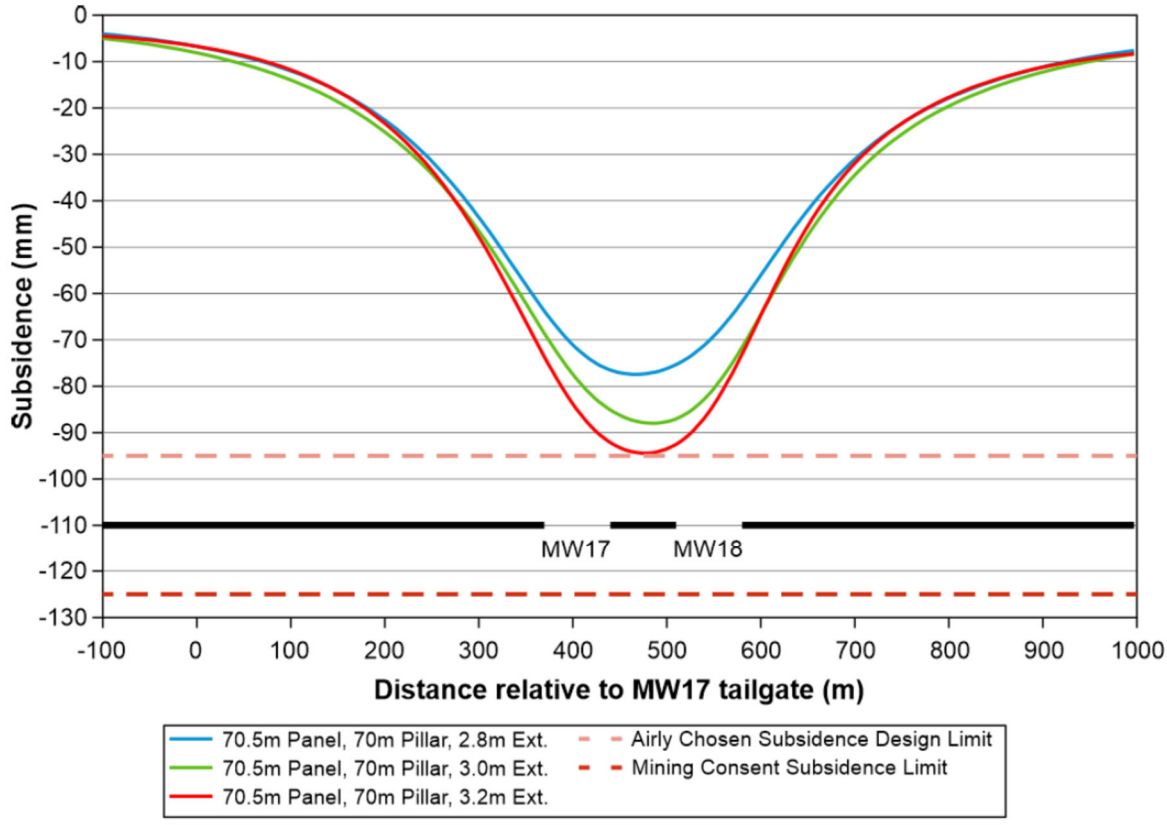



**Fig. 6.4 FLAC modelling results showing predicted subsidence over MWs 17 & 18 (SCT, 2023)**

**Fig. 6.5** shows the FLAC model predicted little rock failure in the strata over the pillar between MW17 and MW18. This has led to reduced subsidence over MWs 17 and 18.

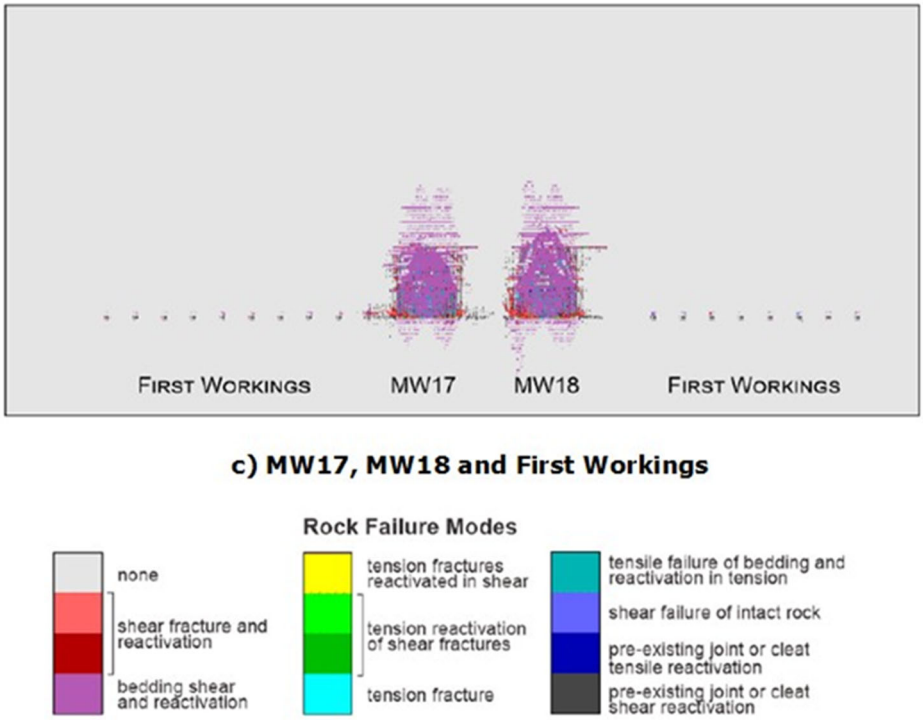



**Fig. 6.5 FLAC modelling results showing modes of failure (SCT, 2023)**

In this report SCT also advised:

- A subsidence tolerance/natural variability of ± 20 mm should be applied to the modelled subsidence, and
- The potential for additional subsidence from any first workings or pillar extraction adjacent to these panels should be considered.

## 6.3. Predicted Angles of Draw to 20 mm and Predicted Subsidence Contour Lines

In Section 6.1, (page 20), of the SCT subsidence prediction report (AIRLY5265, Aug2021), SCT recommended that empirical datasets from the comparable panels could be used for setting the AoD estimates and subsidence predictions around and near the panel edges.

Reviews of the measured AoDs over MWs 2 to 10 found the measured AoDs ranged between -1.4 and 32.8° and the averaged AoD was 17°. The higher AoDs were associated with the higher depths of cover (DoC) and these higher AoDs were associated with where the strong overlying Burra-Moko Head Sandstone was able to span over the first three mini walls causing the greatest loading and compression over the initial tail gate and the main gate areas of these three mini walls.

Similarly, reviews of measured AoDs over Clarence, also found the measured AoDs, i.e., to where 20 mm of subsidence was observed around or over the mined panel could sometimes be negative. The highest recorded AoD associated with the partial extraction panels at Clarence was 5.9°, (Final Report of the Airly Mine Independent Review Panel, 2016).

If a lower than 26.5° AoD was adopted to predict where the predicted 20 mm subsidence contour line, then the edges of the mined panels, could be positioned closer to the top of the cliffs. Nevertheless, despite this suggestion by SCT to use the observed angles of draw from the early Mount Airly panels, CA chose to locate the nearest edge of the proposed mini wall panels for MWs 17 & 18 outside the CLZ, based on a 26.5° AoD from the top of the cliffs down to the panel edge using the depths of cover identified at the cliffs as is shown in Fig. 1.2 and Fig. 6.6.

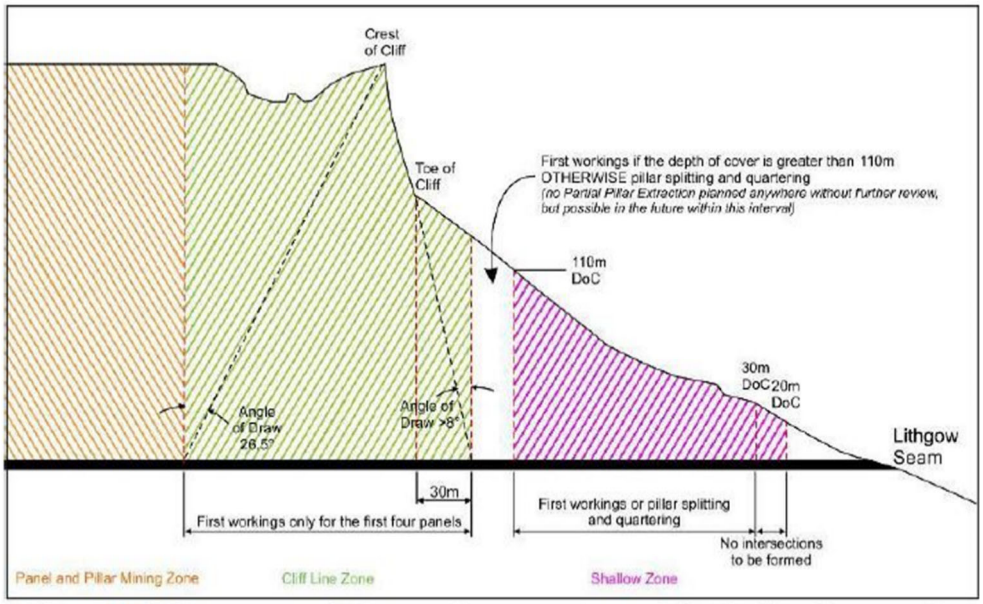



**Figure C: IRP recommendations and current proposal for the first four panels**

**Fig. 6.6 Proposed Panel and Pillar Zone (PPMZ) and Cliff Line Zone (CLZ) from the top of the external major cliffs (CA)**

With the DoC at the crest of some of these external cliffs being 270 m this results in a protective CLZ barrier behind the cliffs of up to 135 m, which is more conservative than the 30m barrier (equivalent to an 8° AoD) that was proposed in the EIS (2014) as shown in Fig. 6.7.

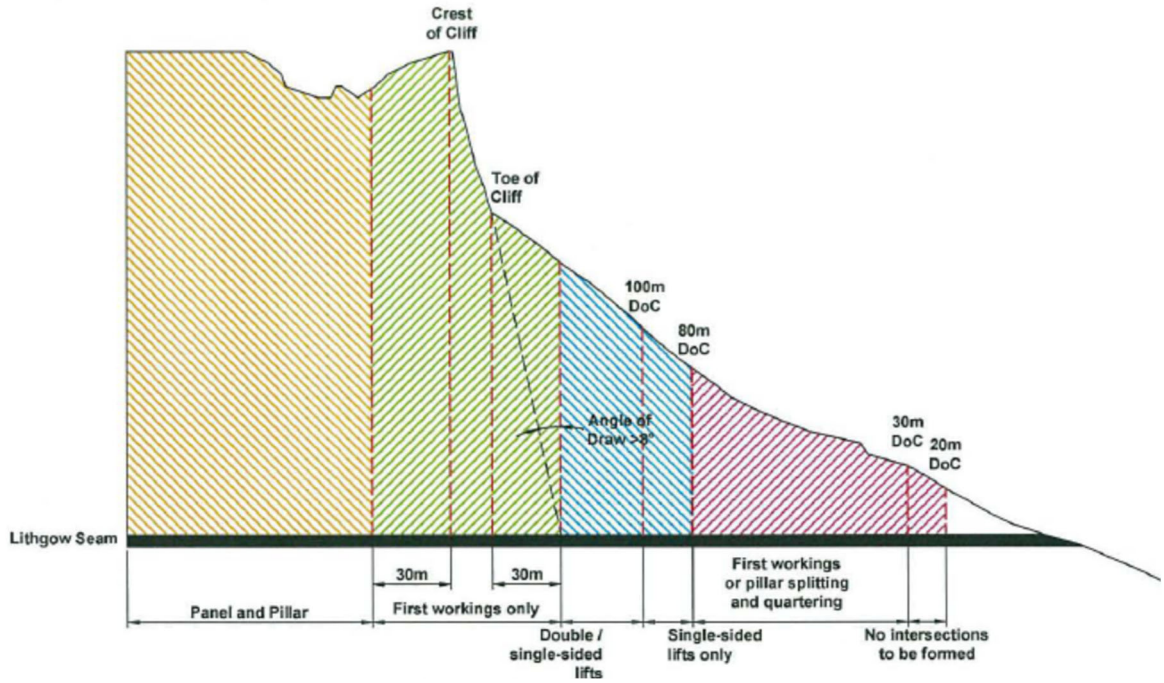



**Fig. 6.7 Panel and Pillar Zone (PPMZ) and Cliff Line Zone (CLZ) as proposed in the 2014 EIS (CA)**

Hence, the predicted 20 mm subsidence contour line around MWs 17 & 18 has now been located based on 26.5° AoD from the edges of the mined panels, as shown in **red** in Fig. 6.8. The predicted 20mm, 50 mm and 88 mm subsidence contours lines were then prepared as is shown in Fig. 6.8.

These contours were located based on; this predicted 20 mm contour line, the SCT predicted maximum subsidence values - depending on the changing DoCs over the panels as was shown in Fig. 2.6.

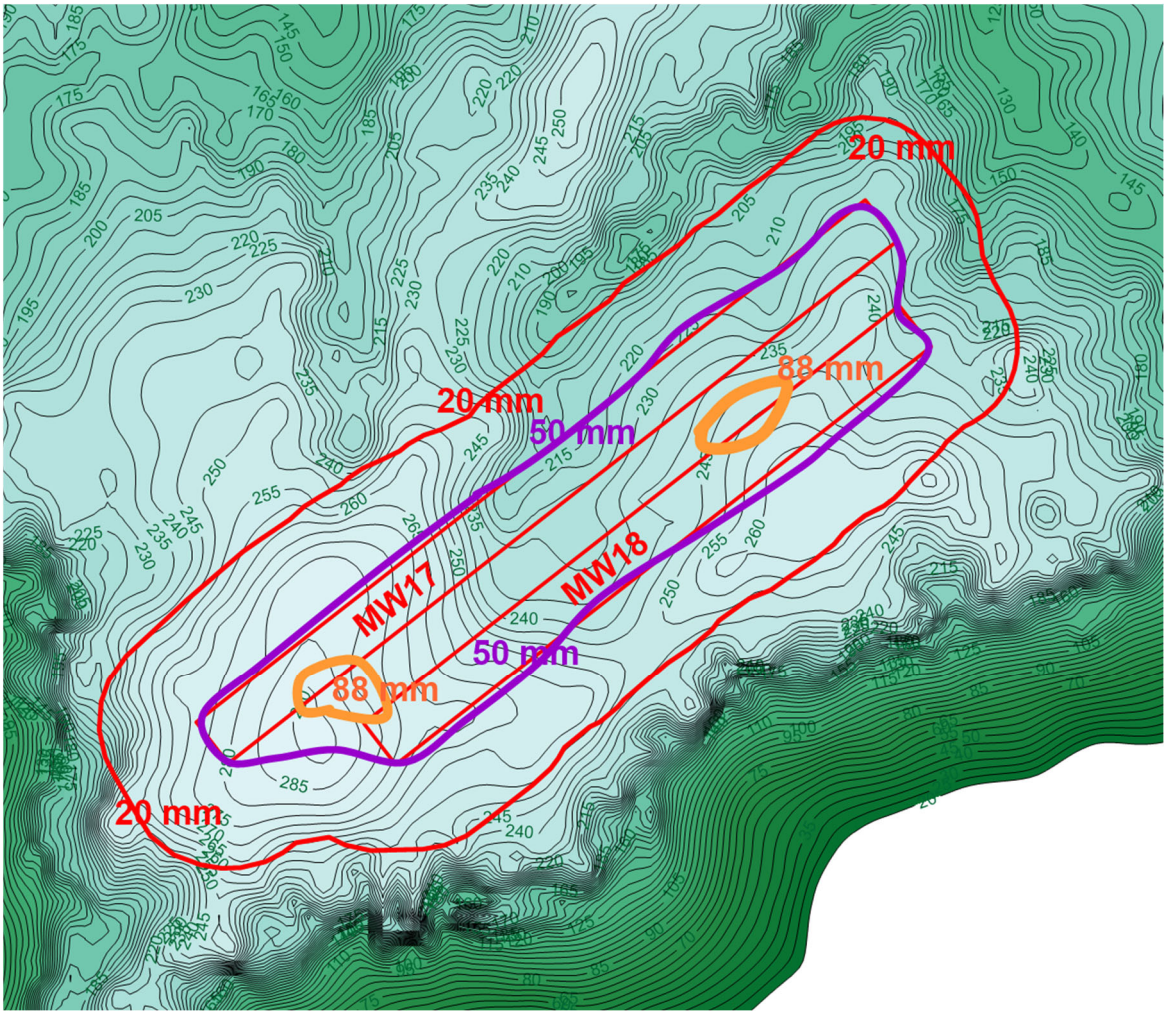



**Fig. 6.8 Predicted subsidence contour levels (using 26.5° AoD) overlain over DoC contours and panel boundaries for MWs 17 & 18 (MSEC after SCT, 2023)**

## 6.4. Predicted tilts, strains and curvatures over the MWs 17 & 18 Study Area

Fig. 6.9 shows the observed subsidence along the Combined B-A Line over Mount Airly on 31 January 2020 when most of MW4 had been extracted and when a maximum subsidence of was 185 mm observed at peg B16 over MW3, i.e., when the measured subsidence was first noticed to exceed the EIS predicted value of 125 mm. Fig. 6.10 also shows the subsidence at each peg as circles on the A, B, C and D Lines over Mount Airly on 31 January 2020 when most of MW4 had been extracted and when a maximum subsidence of was 185 mm.

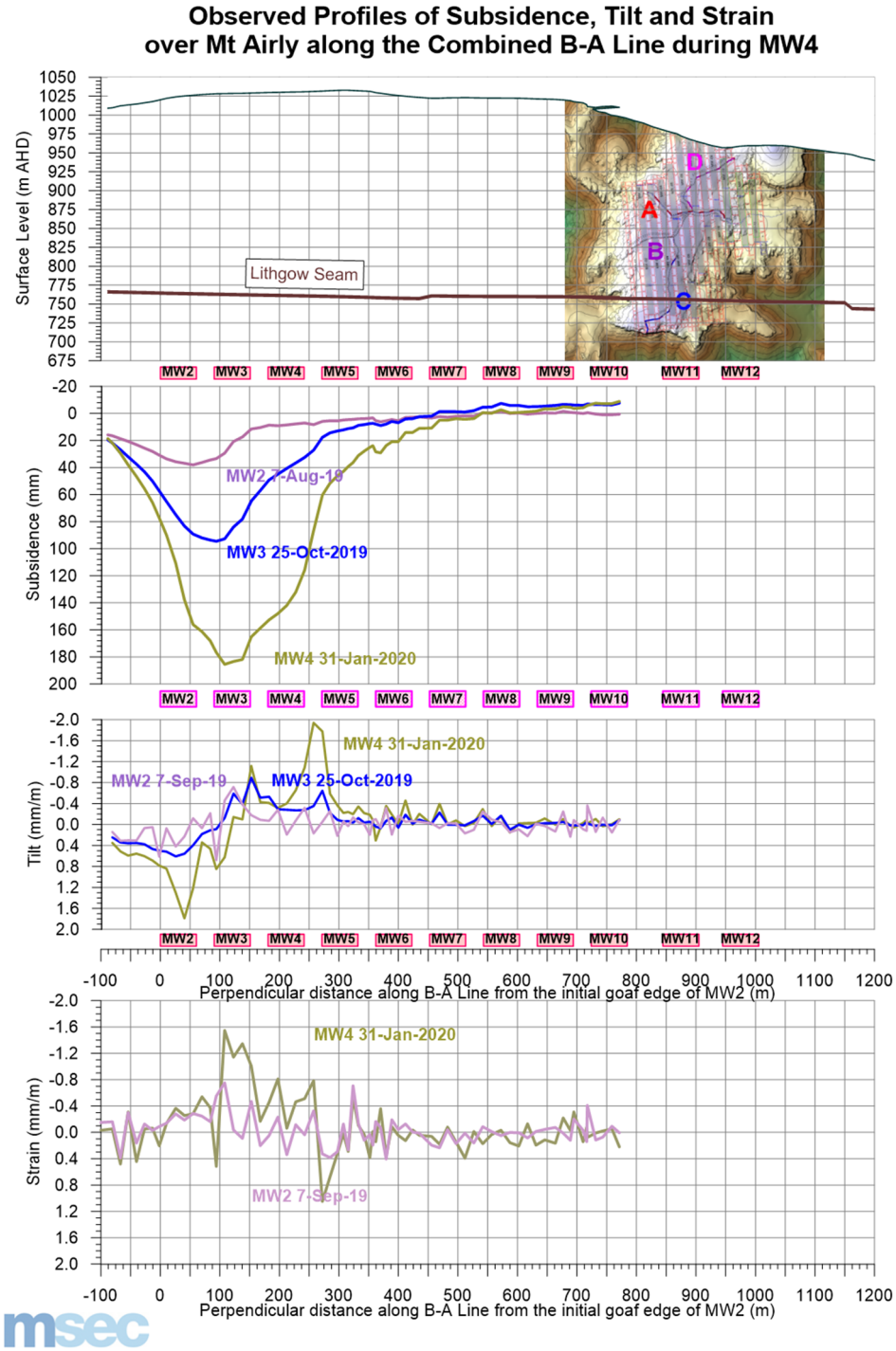



**Fig. 6.9 Observed total subsidence profiles on 31 Jan 2020 during MWs 04 (MSEC)**

Fig. 6.10 shows the measured subsidence, tilt and strain profiles along the B-Line on 31 January 2020. It can be noted that, at this time when the maximum subsidence was 185 mm, the maximum observed tilt was 1.77 mm/m between pegs B10 and B11, the maximum observed compressive strain was 1.55 mm/m between pegs B15 and B16, and the maximum observed tensile strain was 1.05 mm/m between pegs B26 and B27.

Fig. 6.11 shows the observed horizontal movements over MWs 2 to 4 on 31 January 2020, i.e., when the maximum observed horizontal movement was 83 mm, measured along the A-Line at peg A19. The highest horizontal movement along the B-Line at this time was 80 mm at peg B26.

Hence, these measured tilt and strain values over the early Mount Airly mini walls all support the predictions that if the measured subsidence is less than 125 mm, the tilts should be less than 2.5 mm/m and strains should be less than 2 mm/m.

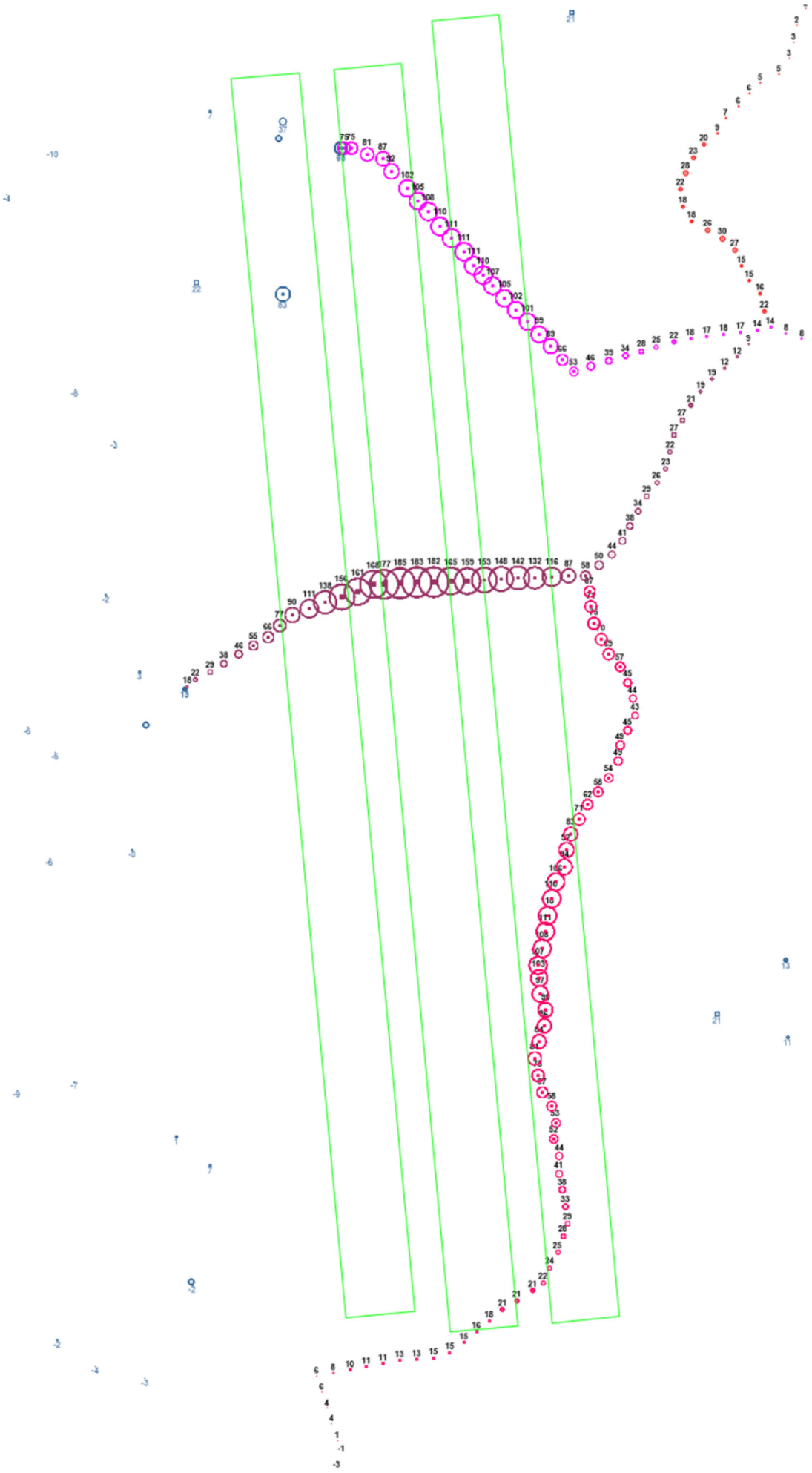


**Fig. 6.10 Observed vertical subsidence after MWs 2 to 4 (MSEC)**

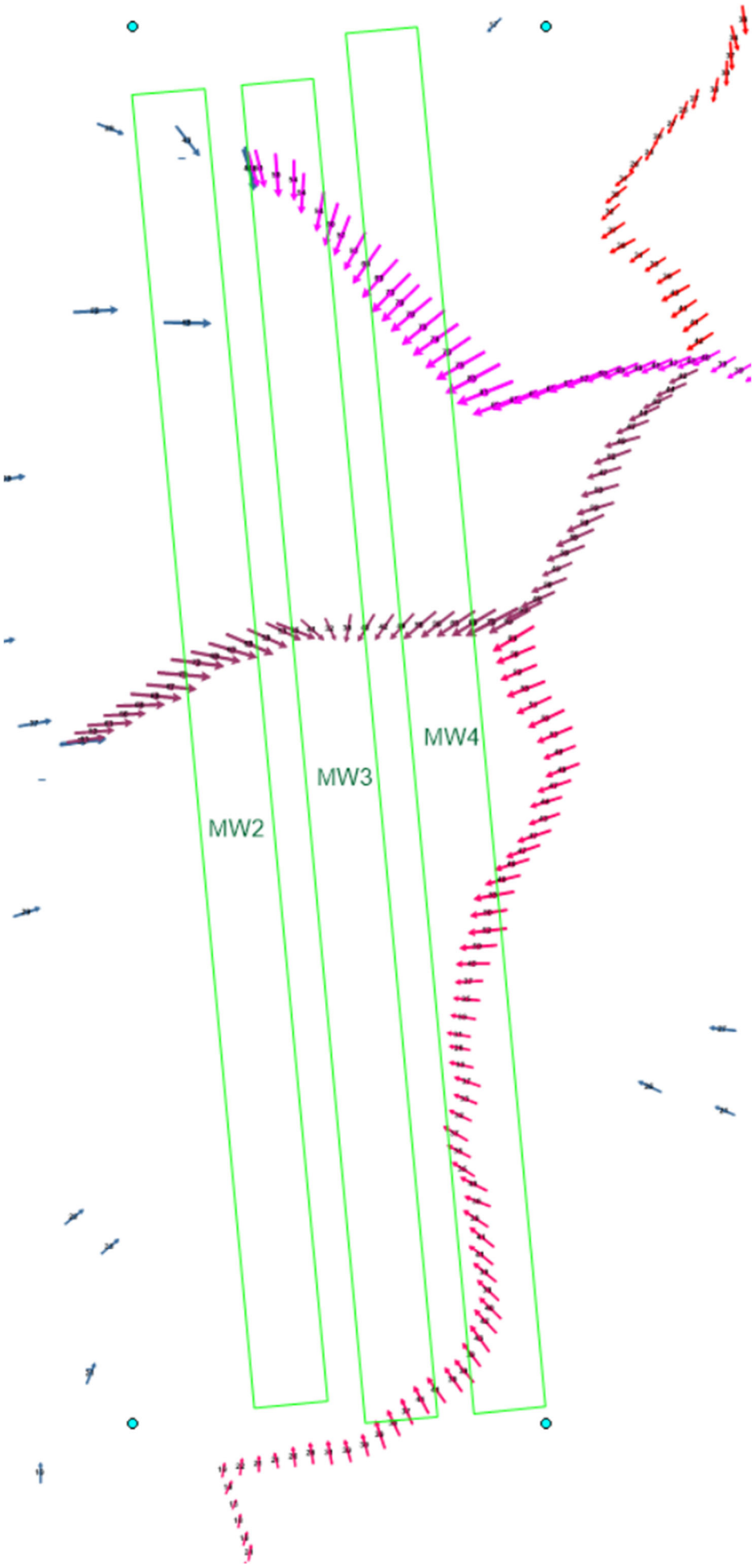



**Fig. 6.11 Observed vectors of horizontal movement after MWs 2 to 4 (MSEC)**

## 7.1. Introduction

There are some significant natural features that are located outside the Study Area, which may be subjected to very small conventional subsidence movements, valley-related or far-field horizontal movements and may be sensitive to these effects, such as the major cliff escarpments and hence they have also been included as part of these assessments. There are some other significant natural features that are located outside the Study Area, which will not be subjected to conventional subsidence movements, valley-related or far-field horizontal movements and hence they have not been included as part of these assessments.

The following sections provide the descriptions, predictions and impact assessments for the natural features identified within the Study Area, as summarised in Table 2.1 in Chapter 2.

## 7.2. Streams

### 7.2.1. Description of the streams

There are small ephemeral streams that flow across the mesa. They are first and second order tributaries. These tributaries have shallow incisions into the natural surface soils. Some sections of the tributaries have sandstone outcropping that forms a series of steps or drop downs in the steeper sections. There are also debris accumulations that include loose rocks and tree branches.

The tributaries are ephemeral, although there are some groundwater seeps from the perched aquifers. The natural gradients of the drainage lines above the proposed mining area typically vary between 50 mm/m (i.e., 5 %, or 1 in 20) and 400 mm/m (i.e., 40 %, or 1 in 2.5).

Further descriptions of the streams are provided by the specialist surface water consultant on the project, see Airly Water Management Plan, GHD August 2021.

### 7.2.2. Predictions for the streams

The streams are located across the Study Area and, therefore, they could experience subsidence effects up to the maximum predicted values summarised in Chapter 6, which are relatively small movements.

### 7.2.3. Comparison of the predictions for the streams with those provided in the EIS Application

The predicted levels of subsidence over the south eastern side of the Genowlan mesa of the MMSCA are similar to those provided in the 2014 EIS.

### 7.2.4. Impact assessments for streams

The impact assessments for the streams are provided in the following sections. The assessments provided in this report should be read in conjunction with the assessments provided by the other specialist consultants on the project.

Mining can potentially result in increased levels of ponding in locations where the mining-induced tilts oppose and are greater than the natural stream gradients that exist before mining. Mining can also potentially result in an increased likelihood of scouring of the stream beds in the locations where the mining-induced tilts considerably increase the natural stream gradients that exist before mining.

However, for this project at Airly, the maximum predicted total tilt is far less than the existing natural grades along these three streams. It is not expected, therefore, that there would be adverse changes in ponding or scouring along the streams resulting from the mining-induced tilt.

Further discussions on the potential changes in ponding and flooding along the streams are provided by the specialist surface water consultant on the project, see Airly Water Management Plan, GHD August 2021.

Fracturing in bedrock is not expected at the low predicted subsidence, tilts and strains.

Mining-induced compression due to valley closure effects and fracturing in bedrock is not expected at the low predicted subsidence, tilts and strains.

Surface water flow diversions are not expected to occur along the sections of the streams even those that are located directly above the proposed mini walls.

These comments on assessed impacts on the streams from the revised mine layout are similar to the impacts assessed in the 2014 EIS reports.

Further discussions on the potential impacts on the streams are provided by the other specialist surface water and groundwater consultants on the project, project, see Airly Water Management Plan, GHD August 2021.

## 7.3. Springs and groundwater seeps

There are natural springs and groundwater seeps just outside the Study Area, which are described by the reports by the specialist groundwater consultants. Further discussions on the potential impacts from the extraction of the proposed MWs 17 & 18 on these groundwater sources, seeps and springs are provided by the other specialist groundwater consultant reports on the project, project, see Airly Water Management Plan, GHD August 2021.

## 7.4. Escarpments, cliffs, minor cliffs and pagodas

The surface areas over Airly include steep and rugged topography with large areas of escarpments, cliffs and significant rock outcrops. The topography is dominated by Mount Airly and Genowlan Mountain which are two large mesas that sit broadly within the landscape of the Capertee Valley, which measures over 30 km from north to south and east to west. This valley is surrounded by sandstone escarpments, cliffs and steep talus slopes similar to those found on Mount Airly and Genowlan Mountain.

Both Mount Airly and Genowlan Mountain are clearly visible for tens of kilometres in all directions from within the valley and from vantage points that are located at various edges of the valley. The surface topography within the two mesas varies from gently undulating to steep sided valleys, major cliff lines, pagodas and gorges.

The potential impact of subsidence on these cliffs was seen as the most important issue facing CA in its Airly mine design. As part of the Airly Mine Extension Project EIS in 2014, CA developed a conservative approach to the mine design and decided on using different mining methods in different areas, referred to as 'mining zones', each targeted to suit each specific area. The key objective of the zoned approach was to minimize risk of surface impacts through appropriate mine design to minimise subsidence.

The EIS report was predominantly based on the premise that low levels of subsidence within each of the mining zones would result in low levels of tilt, strain and curvature and avoid surface cracking and minimise risks of impacts to cliff lines, pagodas, and other natural features, as had been successfully undertaken for twenty years at the Centennial Clarence Mine.

Several mine design steps were adopted in the 2014 EIS by CA to protect the cliffs at Airly.

1. It was decided to identify and, then protect the major external escarpments and cliffs that surround the two mesas at Airly by not extracting second workings under these major "external" cliffs. (See Appendix A for a more detailed discussion on this cliff identification process);
2. It was decided to only extract narrow panels within the "internal" panel and pillar areas of Airly and the resulting chain pillars would be designed to be long-term stable. This step was based on the success of designing for the low subsidence limits at Clarence Mine. Hence, a similar conservative maximum subsidence limit of 100 $\pm$ 25 mm tolerance was adopted for the Airly panel and pillar zone mine-design.
3. The sensitive high cliffs and escarpments that surround the external parts of the Mount Airly and Genowlan Mountain mesas were to be protected by an 8° AoD barrier called the CLZ set back from the identified top of the external cliffs, (these external cliffs were not expected to be impacted by the proposed partial extraction within the PPMZ, see Section 6.3 and Fig. 6.7).
4. However, as shown in Fig. 6.6, after the 2014 EIS approval process was completed and, after further consultation with the IRP, Airly agreed to provide further protection to the external major cliffs over Mount Airly by not extracting panels within a more conservative 26.5° AoD from the back of the major external cliffs in the CLZ until a closer AoD was proven appropriate. It was stated that after four panels and monitoring had proved that the mine design had achieved the targeted subsidence limits and no rock falls had occurred, then, panel and pillar extraction may be applied closer to the external cliffs.

That is, the 2014 EIS report predicted the maximum subsidence over the PPMZ areas of the mine, with 61 m wide panel widths and 29.5 m wide chain pillars, would be less than 125 mm, tilts less than 2.5 mm/m and strains of less than 2 mm/m. The 2014 EIS assessed that, at these low subsidence values, no surface cracking, rock falls or cliff impacts would be expected. However, because the strata layers above the coal pillars compressed more than was expected, up to 727 mm of subsidence was monitored over MW05, and surface cracking and a small rock fall were observed over and near MW02. It can also be noted that many of the "internal" cliffs, that are located over the MWs 2 to 10 have experienced subsidence of approximately 300 mm with some surface cracking, but, thankfully to date, there has been only one small rock fall observed over MW02.

That is, despite the increased levels of subsidence that have been monitored over MWs 2 to 10, and despite the occurrence of surface cracking over these areas and a small rock fall at an internal cliff near MW02, no cliff falls have been reported over the external major escarpments and cliff lines as these cliffs are still being protected by an AoD of 26.5° from the top of the external major escarpments and cliff lines.

To limit/restrict the observed subsidence over the future mini walls and achieve no surface cracking over the future panels, CA significantly widened the chain pillars between the mini walls for MWs 11 to 16 from 29.5 m to up to 70 m, and this has successfully restricted the observed subsidence over these areas to less than 125 mm. Importantly, no surface cracking or rock falls have been observed over the areas where Airly formed the wider pillars to limit subsidence to less than 125 mm. Hence, CA are still planning to protect the major external and internal cliffs over the south eastern areas of Genowlan Mountain with a revised mine plan for MWs 17 & 18 that is seen to be more cautious and conservative than the mine plan that was proposed in the EIS.

CA have proposed an early high-quality daily subsidence monitoring programme over the MWs 17 & 18 to confirm that the maximum subsidence will be limited below 125 mm.

The following sections detail the extensive cliff identification process that has been undertaken at Airly by CA.

### 7.4.1. Airly external cliff identification studies

The initial cliff identification and location mapping for cliffs and pagodas at Airly was undertaken for CA by Golder Associates in 2013. Cliff lines were initially identified from aerial photographs and surface topography contours were generated from a LiDAR survey that was provided by CA. Because there was about 40 kms of cliff lines to define, which was extremely difficult to access on foot, the cliff line survey took the form of ground inspections and a helicopter survey using a GPS linked photography system to generate a pictorial record of the cliff line area as a whole.

Cliffs were initially defined as being greater than 20m in height with > 2 in 1 slope from the horizontal (>63.4°). The most significant cliff lines over Airly, i.e., the external cliffs with heights of up to 80-100 m in height, were found to be located within the CLZ, although many cliffs were also identified within the PPMZ.

However, during the 2014 EIS approval processes, new approaches to defining cliff lines as greater than 10m in height were adopted. Rock features were given the following new definitions a:

- "**cliff**" was defined as a continuous rock face, including overhangs, having a minimum length of 20 m, a minimum height of 10 m and a minimum slope of 2 to 1 (>63.4°).
- "**minor cliff**" was defined as a continuous rock face, including overhangs, having a minimum length of 20 m, a minimum height between 5 m and 10 m, and a minimum slope of 2 to 1 (>63°).
- "**pagoda**" was defined as a conical or sub conical rock formation, whether smooth, platy, stepped or terraced, generally between 5 m and 20 m in height and that are not cliffs or minor cliffs.
- "**steep slope**" was defined as an area of land having a gradient between 1 in 3 (33% or 18.3°) and 2 in 1 (200% or 63.4°).

The 2016 Development Consent adopted those definitions and set the following conditions for the above definitions;

| | |
|---|---|
| Cliffs within a 26.5 degree angle of draw of the Airly underground mine workings | No greater subsidence impacts or environmental consequences than predicted in the EIS *(ie occasional rock falls, displacement or dislodgment of boulders or slabs of less than 30 $m^3$, or fracturing, that do not impact Aboriginal heritage, EECs or public safety)*, that in total do not impact more than 2% of the total area of such cliffs |
| Pagodas within a 26.5 degree angle of draw of the Airly underground mine workings (other than pagodas affected by the New Hartley interaction zone) | No greater subsidence impacts or environmental consequences than predicted in the EIS *(ie occasional rock falls, displacement or dislodgment of boulders or slabs of less than 30 $m^3$, or fracturing, that do not impact Aboriginal heritage, EECs or public safety)*, that in total do not impact more than 2% of the total area of such pagodas |
| Pagodas within a 26.5 degree angle of draw of the New Hartley interaction zone | No greater subsidence impacts or environmental consequences than predicted in the EIS |
| Minor cliffs | No greater subsidence impacts or environmental consequences than predicted in the EIS |
| Steep slopes | No greater subsidence impacts or environmental consequences than predicted in the EIS |

Because of these approval conditions CA engaged, in 2017, RPS Australia East (RPS) to undertake further detailed analysis and mapping in accordance with the revised definitions of the new development consent conditions.

RPS analysed the specific geology within the study area using existing LiDAR survey data acquired by CA in May 2016. RPS (2018) advised that the LiDAR was acquired using Trimble Harrier 68i LiDAR system, capturing a minimum of 2 points per square metre with a flying height of 700 m, ensuring 15-centimetre vertical accuracy. The data was captured and processed on a plane co-ordinate system, referenced to Map Grid Australia Zone 56 (MGA56) coordinates and the Australian Height Datum (AHD).

For example, the 2017 RPS report on the PPMZ advised that there was a total of 1,236 m of potential cliff lines and 2561 m of potential minor cliff lines within the studied area, which included the PPMZ of Mount Airly and a portion of Genowlan Mountain. After checking and deleting smaller features, RPS advised that, within this area of Mount Airly and a portion of Genowlan Mountain, a total of 25 rock features were identified to meet the criteria of a cliff, 58 rock features meet the criteria of minor cliff, and 275 rock features meet the criteria of a pagoda.

In 2019 CA then engaged Aerometrex to undertake a further, even more detailed analysis to refine the external cliff identification and mapping of the cliffs over Mount Airly and the Genowlan Mountain mesas. Aerometrex used a more detailed LiDAR point cloud of 4 points per square m. with classified ground points to improve the accuracy of the process.

Further detail on this cliff identification process is detailed in Appendix A. Fig. 7.1 shows the external polygons that were provided by Aerometrex overlain over an aerial photograph of the south-eastern portion of Genowlan Mountain. This figure also shows a magenta-coloured line that has been drawn to separate the CLZ and the PPMZ, i.e., at half the depth of cover or 26.5o from the top of the identified external cliffs. Based on this, work by Aerometrex, CA then prepared the mine layout plan for the proposed MWs 17 & 18, as was shown in Fig. 1.4 that fits within the PPMZ over this south-eastern portion of Genowlan Mountain.

The final process in the cliff identification process, that was undertaken by CA staff and MSEC staff for MWs 13 to 16 and by MNC for MWs 17 & 18, was to “ground truth” the cliffs identified by Aerometrex by walking over the mesas near all the cliffs and site inspecting the larger cliffs to check that there are no large overhangs at these cliffs and to confirm that the desktop mapping and identification process did not miss sensitive rock formations / features that could be susceptible to small mining induced subsidence ground movements.

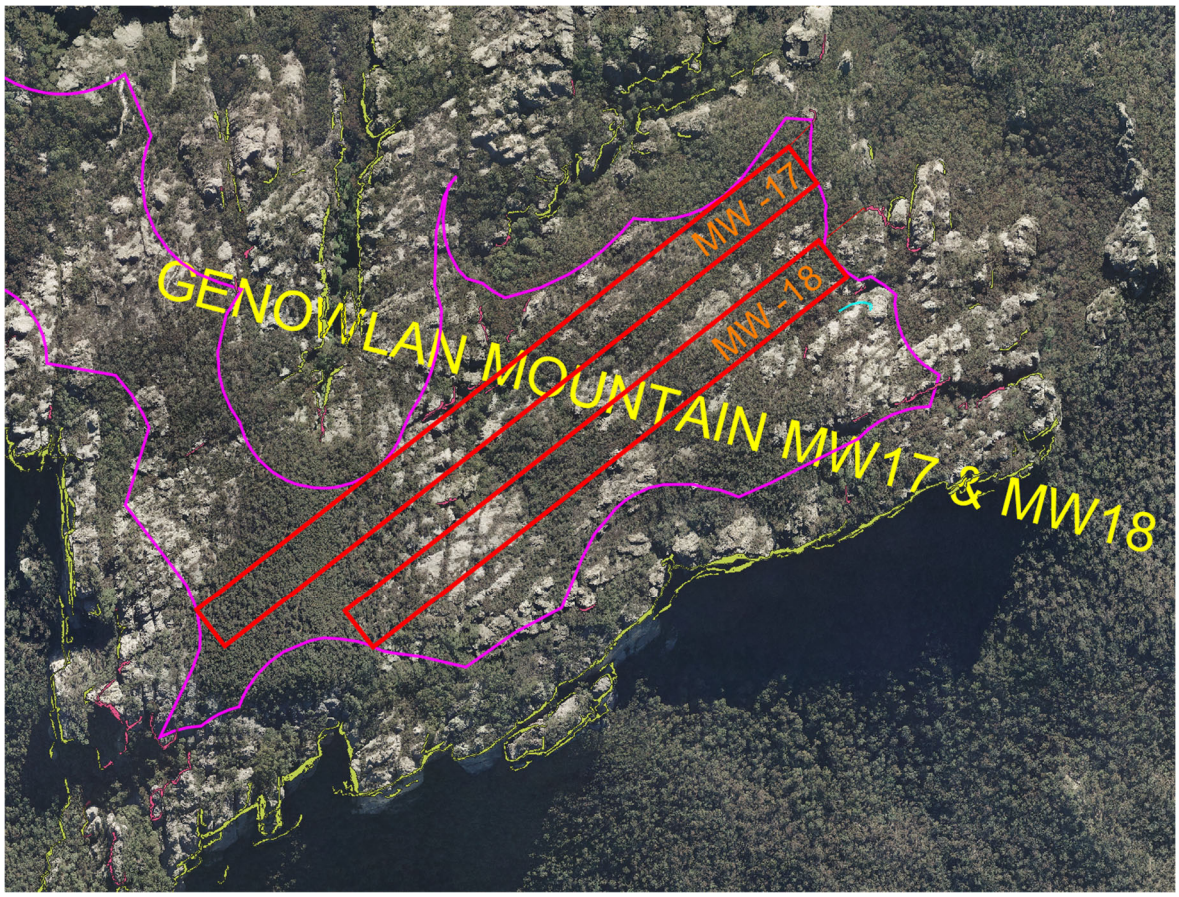



**Fig. 7.1 Identified cliffs, boundary of CLZ & PPMZ and proposed panel boundaries for MWs 17 & 18 overlain over an aerial photograph of Genowlan Mountain (CA, MSEC)**

Fig. 7.2 shows the same polygons that were provided by Aerometrex of the identified positions of the CLZ external major cliff lines (in yellow/green) near MWs 17 & 18. This figure shows the labels that have been assigned to each of these identified cliffs.

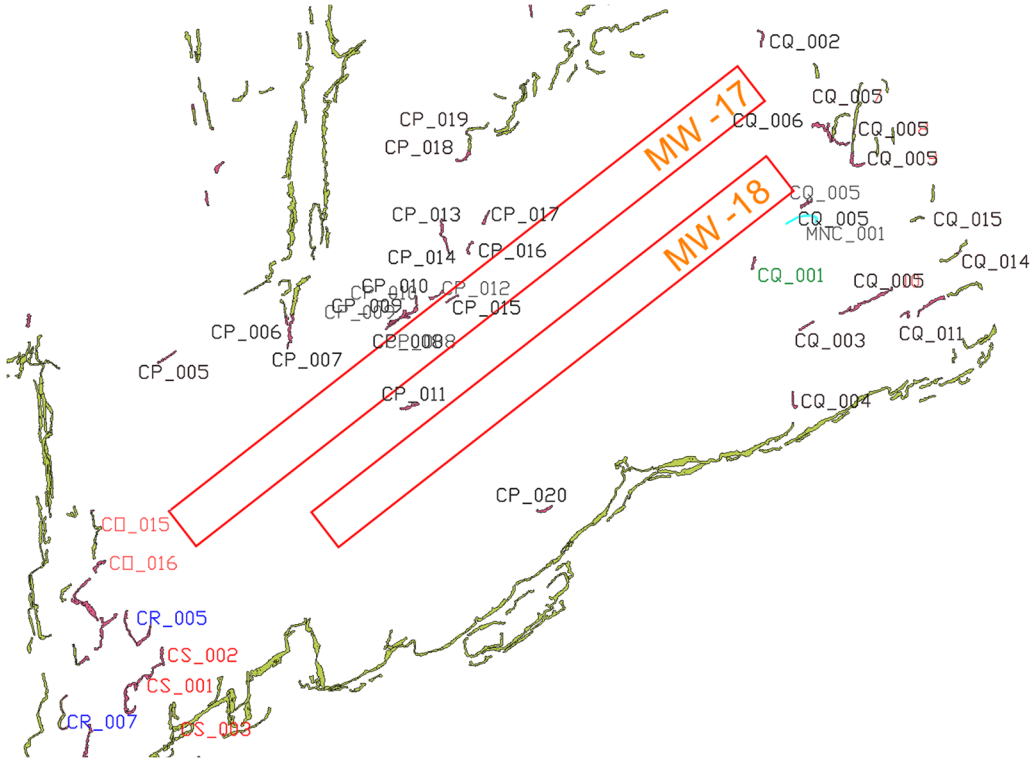



**Fig. 7.2 Identified external and internal (green and red) cliffs, proposed MWs 17 & 18 (CA, MSEC)**

Fig. 7.3 shows these cliff locations and the predicted subsidence contours overlain over the aerial photograph of Genowlan Mountain. It can be noted that the only identified cliff location, where greater than 70 mm of subsidence has been predicted, is the small identified internal cliff over MW 18 that is labelled CP_011. Fig. 7.3 also shows that the red-coloured predicted 20 mm line is located at the top of and the back of the major external cliff lines.

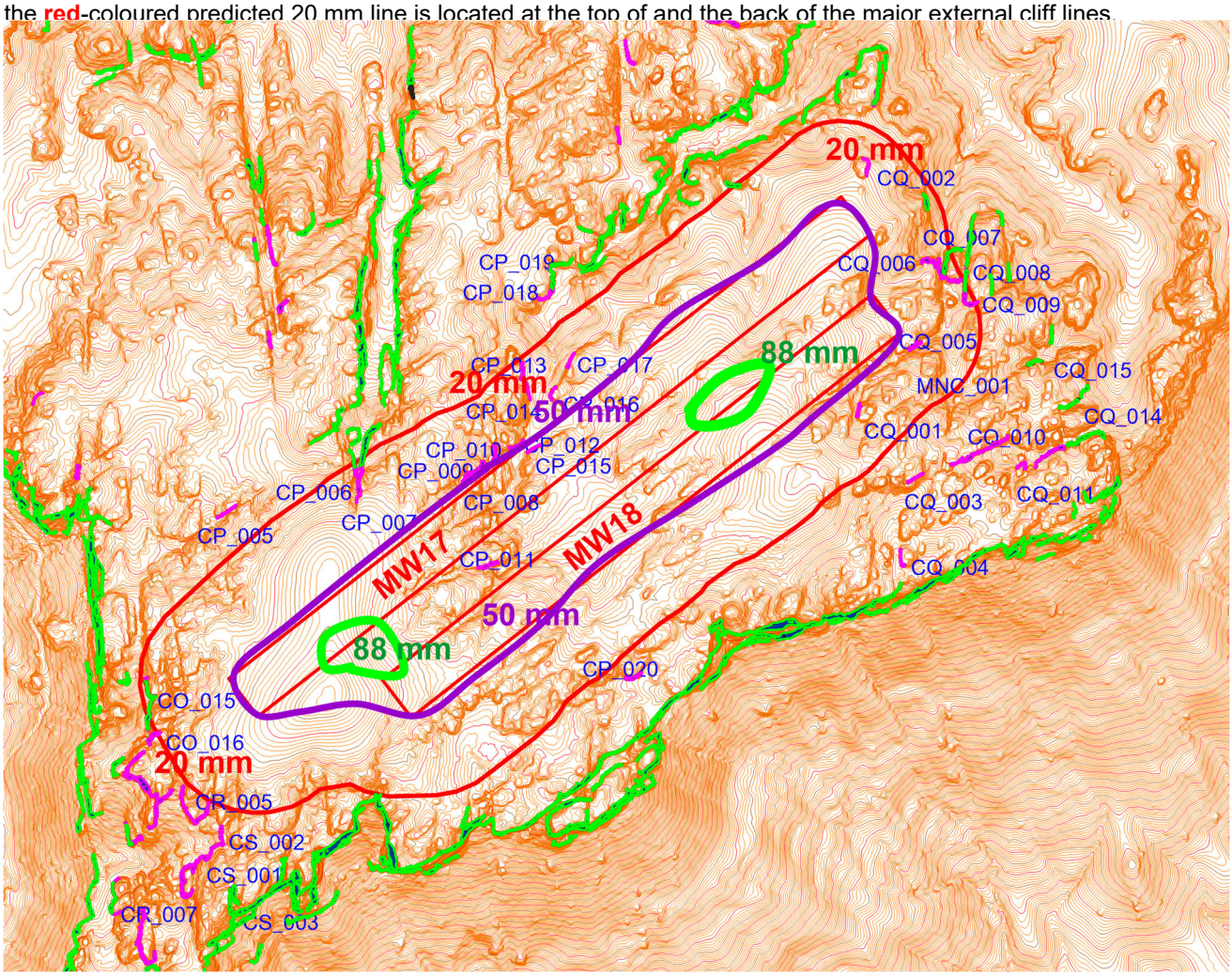



**Fig. 7.3 Identified cliffs and proposed panel boundaries for MWs 17 & 18 plus the predicted 20 mm, 50 mm and 88 mm predicted subsidence contour overlain over a detailed surface terrain model of Genowlan Mountain (CA, MSEC)**

These figures also show that there are many other rock features over the Genowlan Mountain that are located outside the Study Area that are not expected to be impacted by the proposed extraction of MWs 17 & 18.

It can also be noted that where the highest subsidence values are being predicted is where there are no cliffs.

### 7.4.2. Airly internal cliff identification studies

As discussed in Section 7.4.1, Aerometrex was initially engaged by CA to identify the external major cliffs over Mount Airly and a part of Genowlan Mountain as a Phase 1 study. So then CA asked Aerometrex to undertake a second phase, i.e., to identify all the rock features that could be identified as an "internal cliff", i.e., they are located on the mesa behind the top external cliffs that surround the mesas, have a slope >2 in 1, it has to have a continuous rock face, have a minimum length of 20m, and have a minimum height of 10 metres.

Aerometrex identified these internal phase 2 cliffs that meet the specified definitions of "cliffs and are located near the proposed south-eastern area of Genowlan Mountain and near the proposed MWs 17 & 18, and these can also be seen shown coloured in red in Fig. 7.2. There may be other rock features within this internal zone, but they are not continuous rock features, or they are not high enough, or long enough to meet the definitions of "cliff" as per the development consent conditions.

Some of these "internal" cliffs were then found to be located outside a 26.5° AoD from of the edge of the proposed MWs 17 & 18 and, hence, they too were excluded from a list of cliffs requiring the internal cliff impact assessments. Those internal cliffs that were identified by Aerometrex as meeting the criteria for a "cliff" and are located within a 26.5° AoD of the edge of the proposed MWs 17 & 18 are detailed in Table 5.1.

The ground truthing for verification and checking of the cliff mapping and cliff identification desktop studies of the internal identified cliffs was then undertaken by MNC by visual site inspections over the surface areas of MWs 17 & 18 in June 2022 see MNC (2022). The purpose of the site inspection was also to photograph and inspect for sensitive features or identified/mapped cliffs over or near MWs 17 & 18. This ground truthing also reviewed the cliff heights and cliff lengths that were provided by Aerometrex (2020) against the criteria of either a cliff or minor cliff as

per the definitions in the development consent for the Project (SSD_5581) and checked the suitability of the setbacks to secondary extraction from cliffs in the CLZ.

The site inspections revealed that the terrain around these PPMZ cliffs and pagodas would be described as extremely rough and difficult to pass through. This visual inspection covered the extents of south-eastern region of Genowlan Mountain. However, in many locations it was impossible to pass as it was too dangerous to continue climbing over the many steep and slippery rock features. Accordingly, those impossible to access areas were site inspected by MNC by flying drones that took many photos. Where inspected, MNC found many small undercuts, but no large overhang features or cave structures that would be sensitive to the predicted subsidence movements.

The visual inspections did identify a few rock features that could be considered sensitive to subsidence ground movements and, hence, they were considered worth identifying and discussing in this impact assessment and these features have been included in Table 5.2.

CA and Catalyst then provided the detailed cliff heights, cliff lengths and depth of cover information based on the Aerometrex study as is prepared and detailed in Table 5.1 and shown in Fig. 7.4.

As shown in Fig. 7.4, to assist in this determination, a 26.5$^{o}$ AoD circle (using the local DoC) was drawn by Catalyst, around each of the identified cliffs. Where it was found that these 26.5 $^{o}$ AoD circles from the cliffs overlapped with the edges of the proposed mini walls, then those cliffs were within the 20 mm subsidence contour, and it was included in Table 5.1. That is, when a cliff satisfied the definitions of a cliff (from the Aerometrex study), and it was located within the 26.5$^{0}$ AoD from the edges of the proposed mini walls, then it was shown in Fig. 7.4 and included in Table 5.1.

Photographs of these cliffs are provided in the MNC site inspection report (2022).

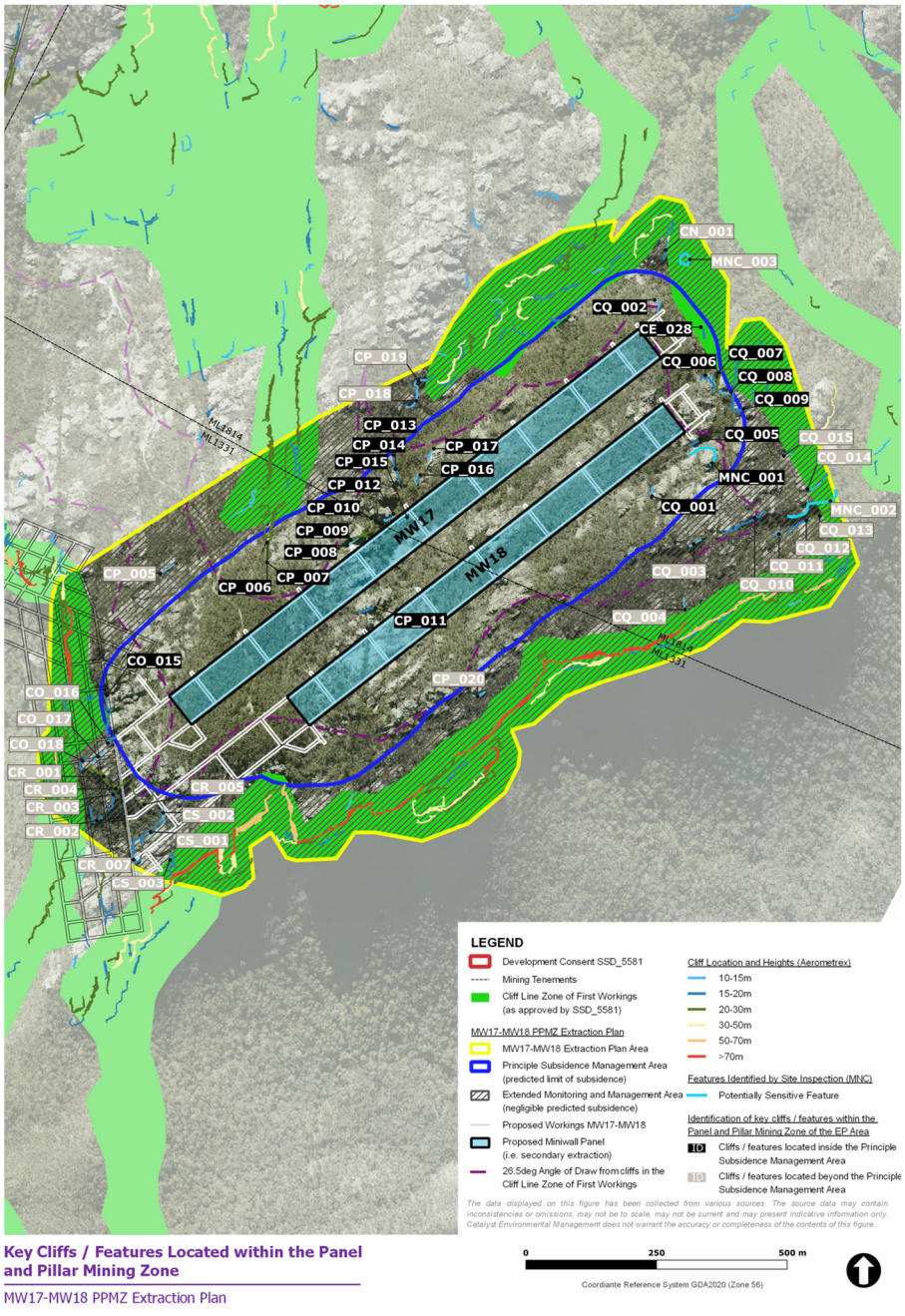



**Fig. 7.4 Identified cliffs and features in the CLZ & PPMZ as shown in Fig. 1.4 (Catalyst)**

**Table 5.1: Identification of Key Cliffs and Features MWs 17 & 18 (Fig. 7.4) (Source: CA and Catalyst)**

| Cliff / Feature ID | Cliff Height (m) | DoC @back of cliff (m) | Dist. to MW17-MW18 (m) | General Location of Cliff / Feature |
|---|---|---|---|---|
| **Within the Principal Subsidence Management Area** | | | | |
| CO_015 | 15-20m | 220 | 111 | West of finishing end of MW17 |
| CP_006 | 20-30m | 260 | 116 | North of centre of MW17 |
| CP_007 | 20-30m | 270 | 87 | North of centre of MW17 |
| CP_008 | 10-15m | 250 | 14 | North of centre of MW17 |
| CP_009 | 20-30m | 250 | 18 | North of centre of MW17 |
| CP_010 | 20-30m | 240 | 6 | North of centre of MW17 |
| CP_011 | 15-20m | 250 | Over MW17-18 pillar | Centre and over pillar between MW17 and MW18 |
| CP_012 | 10-15m | 230 | 5 | North of centre of MW17 |
| CP_013 | 15-20m | 220 | 78 | North of centre of MW17 |
| CP_014 | 15-20m | 230 | 47 | North of centre of MW17 |
| CP_015 | 10-15m | 220 | Over MW17 | Centre and over MW17 |
| CP_016 | 10-15m | 210 | 27 | North of centre of MW17 |
| CP_017 | 10-15m | 210 | 50 | North of centre of MW17 |
| CQ_001 | 10-15m | 250 | 42 | South of commencing end of MW18 |
| CQ_002 | 10-15m | 220 | 45 | Northeast of commencing end of MW17 |
| CQ_005 | 15-20m | 240 | 24 | South of commencing end of MW18 |
| CQ_006 | 15-20m | 200 | 83 | East of commencing end of MW18 |
| CQ_007 | 20-30m | 200 | 96 | East of commencing end of MW18 |
| CQ_008 | 10-15m | 200 | 101 | East of commencing end of MW18 |
| CQ_009 | 15-20m | 210 | 99 | East of commencing end of MW18 |
| CE_028 | 15-20m | 180 | 88 | East of commencing end of MW17 |
| MNC_001 | 15-20m | 240 | 40 | South of commencing end of MW18 |
| **Beyond the Principal Subsidence Management Area** | | | | |
| CO_016 | 15-20m | | Outside 26.5deg | West of finishing end of MW17 |
| CO_017 | 10-15m | | Outside 26.5deg | West of finishing end of MW17 |
| CO_018 | 15-20m | | Outside 26.5deg | West of finishing end of MW17 |
| CR_001 | 20-30m | | Outside 26.5deg | West of finishing end of MW17-MW18 |
| CR_002 | 15-20m | | Outside 26.5deg | West of finishing end of MW17-MW18 |
| CR_003 | 15-20m | | Outside 26.5deg | West of finishing end of MW17-MW18 |
| CR_004 | 20-30m | | Outside 26.5deg | West of finishing end of MW17 |
| CR_005 | 20-30m | | Outside 26.5deg | West of finishing end of MW18 |
| CR_007 | 15-20m | | Outside 26.5deg | West of finishing end of MW18 |
| CS_001 | 15-20m | | Outside 26.5deg | West of finishing end of MW18 |
| CS_002 | 10-15m | | Outside 26.5deg | West of finishing end of MW18 |
| CS_003 | 15-20m | | Outside 26.5deg | West of finishing end of MW18 |
| CP_005 | 10-15m | | Outside 26.5deg | North of finishing end of MW17 |
| CP_018 | 10-15m | | Outside 26.5deg | North of centre of MW17 |
| CP_019 | 10-15m | | Outside 26.5deg | North of centre of MW17 |
| CP_020 | 10-15m | | Outside 26.5deg | South of centre of MW18 |
| CN_001 | 15-20m | | Outside 26.5deg | Northeast of commencing end of MW17 |
| MNC_002 | 20-30m | | Outside 26.5deg | Southeast of commencing end of MW18 |
| MNC_003 | 35m | | Outside 26.5deg | Northeast of commencing end of MW17 (in the CLZ) |
| CQ_003 | 10-15m | | Outside 26.5deg | South of commencing end of MW18 |
| CQ_010 | 15-20m | | Outside 26.5deg | South of commencing end of MW18 |
| CQ_011 | 10-15m | | Outside 26.5deg | South of commencing end of MW18 |
| CQ_012 | 15-20m | | Outside 26.5deg | South of commencing end of MW18 |
| CQ_013 | 20-30m | | Outside 26.5deg | Southeast of commencing end of MW18 |
| CQ_014 | 10-15m | | Outside 26.5deg | Southeast of commencing end of MW18 |
| CQ_015 | 10-15m | | Outside 26.5deg | Southeast of commencing end of MW18 |
| CQ_004 | 10-15m | | Outside 26.5deg | South of commencing end of MW18 |

### 7.4.3. Predictions and Assessments for the internal cliffs

This cliff impact assessment has been prepared by MSEC taking into consideration the:

- low predicted levels of subsidence at these cliffs based on the subsidence prediction work provided by SCT (2022), (that is, whilst the maximum predicted subsidence over MWs 17 & 18 is 88 mm and the maximum predicted subsidence at the identified cliff sites over or near MWs 17 & 18 is less than 80 mm, see Table 5.2);
- very low predicted levels of tilts (< 2.5 mm/m) and predicted strains (< 2 mm/m) over MWs 17 & 18;
- predictions of no surface cracking over the mesa and at the cliffs;
- extensive review of the observed cliff fall data base and cliff impact monitoring data and the low monitored cliff impact results over Airly Mine to date, i.e., despite increased subsidence levels of up to 680 mm;
- knowledge of the various factors that have caused mining induced cliff falls in the past;
- location and orientation of the cliffs with respect to the proposed mined panels;
- the height range and length range of each cliff feature that has been identified by the analysis by Aerometrex (2020) and CA and listed in Table 5.1; and
- results of the site inspections at the identified cliffs over or near MWs 17 & 18 by MNC that have revealed that there are no large cave features or large overhangs at any of these identified cliff features in Table 5.1.

The cliff impact assessments at each cliff are detailed in the following Table 5.2.

The relevant cliff ID numbers in Table 5.1 and Table 5.2 can be located in Fig. 7.4 that were prepared by Catalyst.

**Table 5.2: Cliff Impact Assessment of Key Cliffs and Features within the Principal Subsidence Management Area (Fig. 7.4) (Source: CA and Catalyst)**

| Cliff / Feature ID | Avg, Height Range | Avg. Length (m) | Max. Predicted Subsidence (after MW18 (mm) | Cliff Impact Assessment |
|---|---|---|---|---|
| CO_015 | 15-20m | 85 | 15-20 | falls are unlikely |
| CP_006 | 20-30m | 42 | 15-25 | falls are unlikely |
| CP_007 | 20-30m | 79 | 20-30 | falls are unlikely |
| CP_008 | 10-15m | 26 | 40-60 | falls are unlikely |
| CP_009 | 20-30m | 37 | 40-60 | falls are unlikely |
| CP_010 | 20-30m | 51 | 40-60 | falls are unlikely |
| CP_011 | 15-20m | 31 | 60-80 | falls are unlikely |
| CP_012 | 10-15m | 25 | 40-65 | falls are unlikely |
| CP_013 | 15-20m | 27 | 20-40 | falls are unlikely |
| CP_014 | 15-20m | 29 | 30-40 | falls are unlikely |
| CP_015 | 10-15m | 22 | 50-60 | falls are unlikely |
| CP_016 | 10-15m | 22 | 25-45 | falls are unlikely |
| CP_017 | 10-15m | 24 | 20-40 | falls are unlikely |
| CQ_001 | 10-15m | 21 | 30-50 | falls are unlikely |
| CQ_002 | 10-15m | 32 | 10-30 | falls are unlikely |
| CQ_005 | 15-20m | 21 | 20-40 | falls are unlikely |
| CQ_006 | 15-20m | 47 | 15-30 | falls are unlikely |
| CQ_007 | 20-30m | 31 | 15-30 | falls are unlikely |
| CQ_008 | 10-15m | 23 | 15-30 | falls are unlikely |
| CQ_009 | 15-20m | 115 | 15-30 | falls are unlikely |
| CE_028 | 15-20m | 26 | 15-30 | falls are unlikely |
| MNC_001 | 15-20m | 70 | 20-40 | falls are unlikely |

Table 5.1 provided detail on some other rock features or “internal” cliffs that are coloured red in Fig. 7.2, Fig. 7.1, Fig. 7.3 and Fig. 7.4 but are located inside and just outside a 26.5° AoD from the edge of the proposed MWs 17 & 18.

Table 5.2 provides detail on the predicted subsidence and the cliff impact assessment at each cliff inside principal subsidence Management Area, i.e., inside the 26.5 deg AoD of MWs 17 & 18.

### 7.4.4. Conclusion of cliffs impact assessments at identified cliffs over MWs 17 & 18

This cliff and pagoda impact assessment report has noted that:

- Statistical reviews have been undertaken, based on the available monitoring data at cliffs or near cliffs when falls occurred, to determine which of the various potential factors causing mining-induced cliff falls has the greatest influence on these rock falls occurring (See Appendix B). The main factors found to be influencing the likelihood of cliff falls are:
  - **Increased levels of subsidence ground movements;**
  - **Presence of mining induced surface cracking at or near the cliff face;** and
  - **Shape of cliffs, heights of cliffs and extent of the cliff line.**
- Reviews of coal mining-induced cliff impact assessment studies have also confirmed that, where low levels of subsidence movements of less than 100 mm were experienced over the mined panels and at the cliffs, then, little to no cliff damage was observed; especially when these low levels of subsidence caused no surface cracks near the cliff lines; (*That is, far less rock falls have been observed from cliff lines above narrow panels or mini walls with stable pillars and with no mining induced surface cracks than have been observed above wide longwall panels or mini wall panels*);
- No cliff falls were observed at Clarence Mine where extensive areas of first and second workings have been successfully undertaken over decades with predicted levels of subsidence over the panels and at the cliffs of up to 100 mm (with 25 mm survey tolerance) and measured levels of subsidence over the panels and at the cliffs up to 98 mm;
- Surface cracking and only one small rock fall has been observed over MWs 02 to 10 where the maximum monitored subsidence exceeded the design levels with up to 727 mm of subsidence being monitored over MW05, tilts exceeding 15 mm/m and strains exceeding 5 mm/m. Although one small rock fall was observed over MW02, no rock falls were observed at many of the “internal” cliffs that were located over MWs 02 to 10 with monitored subsidence levels were up to 300 mm.
- No rock falls or cliffs have been observed around the major external escarpments and cliff lines around over MWs 02 to 10 that were protected by AoD of 26.5 degrees.
- Almost all of the mining-induced cliff falls found in literature reviews have resulted from longwall extraction or total extraction panels that caused high levels of subsidence, tilt and strains over the mined panels, (i.e., where the typical maximum subsidence levels over the mined panels were greater than 1,000 mm and high levels of subsidence occur at the impacted cliffs);
- Cliff falls occur naturally as weathering and erosion occurs. Studies at Airly indicate that cliff falls have been occurring around the major external cliffs of the two mesas at Mount Airly and Genowlan Mountain. Obviously the higher the cliffs then the greater the chance or risk of rock falls occurring. By not extracting mini walls within 26.5° of the top of the major external cliffs then no mining induced impacts are expected at these major external cliff lines.
- Mining is proposed within the PPMZ near and under some smaller internal cliffs that have been identified to meet the height and length criteria specified in the development consent. However, these internal cliffs are generally smaller and the predicted levels of subsidence at these cliffs is much lower than the maximum predicted levels of subsidence over the centre of the extracted mini walls. Only one cliff, CP_015, is located over the proposed MWs 17 & 18 panels (MW17) and CP_011 is located between MW17 & 18.
- During major cliff fall monitoring studies, it was noted that 96 % of the monitored cliff falls recorded within the cliff fall data base occurred over the mined panels and only 4 % of the recorded falls fell over solid unmined coal areas around the mined panels, i.e., beyond the edges of the mined panels;
- Based on the above plus, noting that the low levels of subsidence being predicted over MWs 17 & 18 should not exceed 88 mm and the greatest subsidence being predicted at a rock feature listed in Tables 5.1, Table 5.2, Tables 5.3 or Table 5.4 is less than 80 mm, it can be concluded that:
  - ❖ where very low levels of subsidence movements of less than 125 mm have been experienced, it is expected that low levels of tilts, strains, horizontal movements and no surface cracks are expected to occur, and, where no surface cracking is likely to be observed, then, no cliff impacts are expected. *(That is, no cliff impacts or rock falls have been observed from cliff lines over narrow panels or mini walls with stable pillars, with subsidence of less than 125 mm and with no mining induced surface cracks compared to the many impacts observed above wide longwall panels*);
  - ❖ there is a very low chance of rock falls occurring to those cliffs that are positioned over solid unmined coal areas;
  - ❖ considering the very low levels of subsidence being predicted over Airly MWs 17 & 18 and noting that these internal rock features are relatively small, i.e., with subsidence of up to 88 mm over the mined panel, there is only an extremely low probability that cliff instabilities and rock falls may occur at the identified cliffs;
  - ❖ hence, this report assesses that these low levels of subsidence should not cause significant rock fall impacts at the overlying and nearby cliffs, minor cliffs and pagoda features in this MWs 17 & 18 area; and
  - ❖ Due to this assessment of low cliff impacts no additional mitigation measures are considered necessary to manage the potential impacts from mining MWs 17 & 18.

Further detail on past mining induced cliff falls and monitoring around cliffs as longwall panels were extracted and rock falls occurred are presented in previous MSEC cliff impact assessment reports and Appendix B to support this report.

This report concludes that, there should be little chance of exceedance of the conditions of approval for the cliffs that have been identified over the proposed MWs 17 & 18.

Nevertheless, there is a still a remote and very small chance that small rock falls may occur at one or more of these cliff features, perhaps due to natural weathering and erosion process that are ongoing and, based on past satellite images, have occurred on average every 3 to 4 years over Genowlan Mountain.

Nevertheless, based on the available data, if this happens, we assess that the size of these rock falls would be less than the consent condition that the fall size should be less than 2 % by area of cliff lines.

#### 7.4.5. Comparison of cliff impact predictions and assessments at identified cliffs over MWs 17 & 18 compared to assessments in the 2014 EIS

The predicted levels of subsidence over Genowlan Mountain are similar to those provided in the 2014 EIS and the assessed levels of potential impact for the cliffs, based on the proposed Extraction Plan Layout for MWs 17 & 18, are similar to those based on the EIS Layout.

#### 7.4.6. Recommendations for managing impacts at identified cliffs over MWs 17 & 18

The assessments and recommended management strategies for the cliffs, therefore, are the similar to those in the EIS Application and those previously discussed and agreed to with the IRP.

High quality early subsidence monitoring is recommended over MWs 17 & 18 to collect data that can be used as a basis for future adjustments to the very cautious and conservative mine design. It is understood that a subsidence monitoring plan has been prepared by CA.

### 7.5. Steep slopes and rock outcrops

#### 7.5.1. Descriptions of the steep slopes and rock outcrops

The surface areas over Airly are characterised by a steep and rugged topography with large areas of escarpments, cliffs, steep slopes and significant rock outcrops. The surface topography within the two mesas varies from gently undulating to steeply sloped valley sides, major cliff lines, pagodas and gorges. The steep slopes and rock outcrops within the Study Area are typical of the Genowlan Mountain mesa.

#### 7.5.2. Predictions for the steep slopes and rock outcrops

Potential impacts on these features generally result from increased horizontal movements in the downslope direction, potentially resulting in tension cracks appearing at the tops and on the sides of the steep slopes and outcrops, compression ridges forming at the bottoms of the steep slopes, and buckling of the bedrock at the bottoms of the rock outcrops.

However, given that the predicted levels of subsidence and tilt over these steep slopes and rock outcrops are very low and not greater than 125 mm and 2 mm/m, respectively the change in tilt or the steepness of these existing steep slopes and outcrops will not be noticeable. The predicted strains are less than 2 mm/m. While fracturing of the bedrock could occur, it is not expected that visual cracking would be observed at the surface,

#### 7.5.3. Comparison of the predictions for the steep slopes and rock outcrops with those provided in the EIS Application

The predicted levels of subsidence, tilts and strains over the steep slopes and rock outcrop areas due to the proposed Extraction Plan Layout for MWs 17 & 18 are very low similar to those provided in the 2014 EIS.

#### 7.5.4. Impact assessments for the steep slopes and rock outcrops

Given that the predicted levels of subsidence and tilts over these steep slopes and rock outcrop areas are very low and, noting that the steepness of the existing slopes will not be noticeable, it is unlikely that the steep slopes and rock outcrop areas will be impacted by the proposed mini wall extraction.

#### 7.5.5. Recommendations for the steep slopes and rock outcrops

The assessments and recommended management strategies for the steep slopes and rock outcrops, therefore, are the similar to those in the EIS Application and those previously discussed and agreed to with the IRP.

### 7.6. Threatened or Protected Species

See the discussion in Section 7.7 regarding threatened ecological communities that have been identified outside the south-eastern area of Genowlan Mountain.

## 7.7. State Recreation or Conservation Areas

Most of the surface areas over the south-eastern areas of Genowlan Mountain are located within the MMSCA that has significant natural and cultural heritage values and contains significant mineral resources. The MMSCA was gazetted in 2011 to protect environmental and cultural heritage values while permitting mining and exploration. As shown in Fig. 7.5, it covers an area of 3650ha.

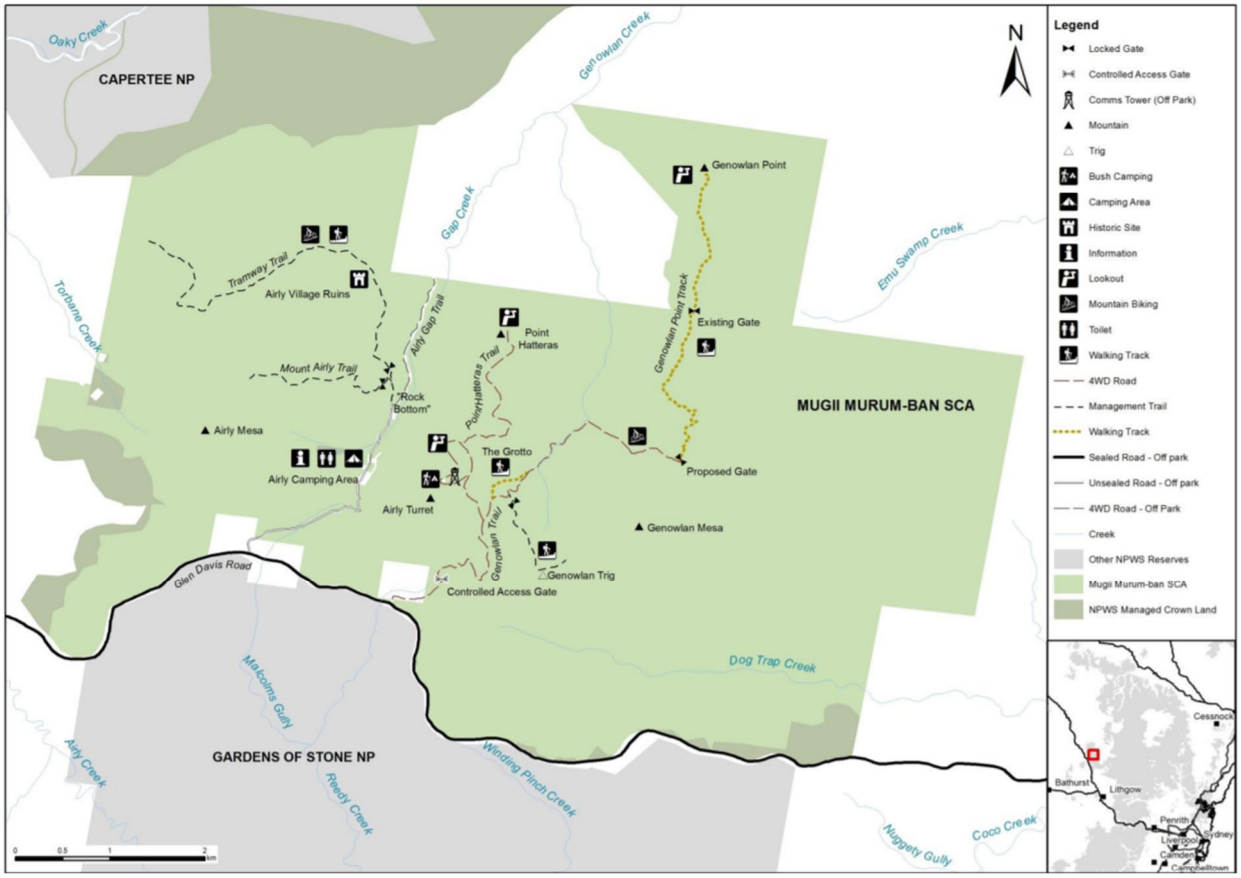



**Fig. 7.5 Mugii Murrum-ban State Conservation Area**

The MMSCA is managed through the Mugii Murrum-ban State Conservation Area Draft Plan of Management, dated September 2015 that was prepared by the NSW National Parks and Wildlife Service and the NSW Office of Environment & Heritage.

The MMSCA is bordered to the north by the Capertee National Park and to the south by the Gardens of Stone National Park.

This Draft Plan of Management for the MMSCA advises the area;

- is described as having the greatest range and concentration of pagodas within the greater Blue Mountains and is known by some as the 'three hundred sisters' in reference to the number and diversity of pagodas.
- contains a great diversity of ecosystems, supporting several threatened plants and animals and two threatened ecological communities on Genowlan Point which is near Point Hatteras.
- is of particular significance to the Wiradjuri Aboriginal People and also contains numerous significant historic heritage sites.
- also contains important mineral deposits and is recognised in particular as having economically significant deposits of coal.

The natural vegetation in MMSCA was mapped in 1991 (Lembit 1991). Since then, the Colo Committee and the Royal Botanic Gardens have conducted regular vegetation surveys in the area, particularly focussing on the Genowlan peninsula. The most comprehensive description of vegetation communities in the park was prepared by the agency in 2006. This project modelled 16 different floristic assemblages in the Mount Airly – Genowlan area. The MMSCA is regarded as a site of high floral diversity, with up to 340 plant species known to occur on the mesas.

Many of the vegetation communities identified within the MMSCA contain threatened species, although the exact number of threatened species in the park is yet to be determined. The table below, copied from the Draft Plan of Management lists the threatened plant species known to occur in the MMSCA.

Table 1. Threatened plants recorded in Mugii Murum-ban SCA

| Common name | Scientific name | TSC Act status | EPBC Act status |
|---|---|---|---|
| Capertee stringybark | *Eucalyptus cannonii* | Vulnerable | |
| | *Grevillea obtusiflora* | Endangered | Endangered |
| Mount Vincent mint bush | *Prostanthera stricta* | Vulnerable | Vulnerable |
| | *Pultenaea* sp. Genowlan Point | Critically endangered | Critically endangered |

The following descriptions, copied from the MMSCA Draft Plan of Management advises;

The MMSCA is particularly important to Pultenaea sp. Genowlan Point which is listed as critically endangered on both the TSC Act and EPBC Act. (Note well Genowlan Point is outside the Study Area). This small shrub is known only from a single small population within a restricted area (250 square metres) on the tip of Genowlan Point. The species was first collected in 1997 and was subject to regular monitoring between 2002 and 2005, over which time a decline of 53 per cent in the number of specimens was recorded. The status of Pultenaea sp. Genowlan Point is currently regarded as critical as surveys conducted in 2005 revealed that most specimens had low foliage cover and showed no signs of flowering or fruiting. The MMSCA has been identified as a key management site in the conservation project for Pultenaea sp. Genowlan Point (OEH 2013c).

Capertee stringybark (Eucalyptus cannonii) is restricted to an area of about 6000 square kilometres in the NSW central tablelands (OEH 2014a). In MMSCA it is found on the south-east flanks of Genowlan Mountain. The species is threatened by loss of habitat due to land clearing, and inappropriate fire regimes, specifically too-frequent fires. The Priorities Action Statement identifies a number of actions required to support the recovery of Capertee stringybark across the State, including identifying the location, tenure and threats to extant populations of the species.

Mount Vincent mint bush (Prostanthera stricta) is present on Genowlan Mountain, Airly Turret and Point Hatteras. Immediate threats to this bush include loss of habitat, inappropriate fire regimes, and grazing and trampling by domesticated and feral animals.

CA has engaged RPS to undertake a similar baseline ecology study over the South-eastern area of the Genowlan mesa. The RPS report titled, “Baseline Biodiversity Report MW17-19 EP Area and CLZ (ML1814) EP Area”, dated 26 September 2022, characterises the biodiversity values of the Study Area, particularly the presence or probability of threatened species, populations and ecological habitats occurring over the South-eastern area of the Genowlan mesa.

### 7.7.1. Predictions for the MMSCA

The predicted levels of subsidence over the south-eastern area of the Genowlan mesa are very low and not greater than 125 mm. No measurable subsidence is predicted at Genowlan Point, which is outside the Study Area.

Given the predicted levels of subsidence over the South-eastern area of mesa the proposed extraction should not result in physical impacts (i.e., surface cracking) that could potentially change the environment or habitat for the natural vegetation.

### 7.7.2. Comparison of the predictions for the MMSCA with those provided in the EIS Application

The predicted levels of subsidence over the South-eastern area of the MMSCA are similar to those provided in the 2014 EIS.

### 7.7.3. Impact assessments for the MMSCA

Given that the predicted levels of subsidence over the South-eastern area of the MMSCA are very low and not greater than 125 mm, it is unlikely that the South-eastern area of the MMSCA will be adversely impacted (i.e., surface cracking) by the proposed mini wall extraction.

### 7.7.4. Recommendations for the MMSCA

The assessments and recommended management strategies for the MMSCA, therefore, are the similar to those in the EIS Application and those previously discussed and agreed to with the IRP.

Consultation with the owner (NPWS and MMSCA) and the various occupiers should be undertaken to develop an appropriate management plan for these features.

## 7.8. Natural Vegetation

See discussion under Section 7.7 regarding the natural vegetation that has been identified over and near the South-eastern area of Genowlan Mountain.

The following sections provide the descriptions, predictions and impact assessments for the built features identified within the Study Area, as summarised in Chapter 2.

The significant built features that are located outside the Study Area, which may be subjected to valley-related or far-field horizontal movements and may be sensitive to these effects, have also been included as part of these assessments.

## 8.1. Unsealed roads and tracks

There are no sealed roads within the Study Area.

The locations of the unsealed roads and tracks are shown in Fig. 1.4.

These roads/tracks are accessible only by 4WD vehicles and these roads/tracks are located across the Study Area and above the proposed MWs 17 & 18.

### 8.1.1. Predictions for the unsealed roads and tracks

The unsealed roads and tracks are located across the Study Area and, therefore, they could experience the full range subsidence effects up to the maximum predicted values summarised in Chapter 4, i.e., subsidence up to 88 mm, tilts up to 2.5 mm/m and strains up to 2 mm/m.

### 8.1.2. Comparison of the predictions for the unsealed roads and tracks with those provided in the EIS Application

The predicted levels of subsidence over the South-eastern area of the MMSCA are similar to those provided in the 2014 EIS.

### 8.1.3. Impact assessments for the unsealed roads and tracks

Surface cracking and heaving of unsealed road and track surfaces occur when wide longwall panels are directly mined beneath them. However, the unsealed roads and tracks located across the Study Area will only be subjected to low levels of subsidence that are not greater than 125 mm, hence it is unlikely that the unsealed road and track surfaces over South-eastern area of Genowlan Mountain will be adversely impacted by the proposed mini wall extraction.

### 8.1.4. Recommendations for the unsealed roads and tracks

If needed, the unsealed roads and tracks within the Study Area can be maintained in safe and serviceable conditions throughout the mining period using normal road maintenance techniques. It is recommended that these same maintenance strategies are used to maintain the unsealed roads and tracks located within the Study Area. It is also recommended that these roads and tracks are periodically inspected during active subsidence.

## 8.2. Aboriginal heritage sites

### 8.2.1. Descriptions of the Aboriginal heritage sites

MMSCA lies within the traditional lands of the Wiradjuri People.

Cultural Heritage Impact Assessment (RPS 2014) for the Airly Mine Extension Project identified 25 Aboriginal sites located within the Airly Project Application Area, nine of which were located above the proposed mining areas. However, as shown in Fig. 8.1, not one of those nine are located within the Study Area for the proposed extraction of MWs17 & 18.

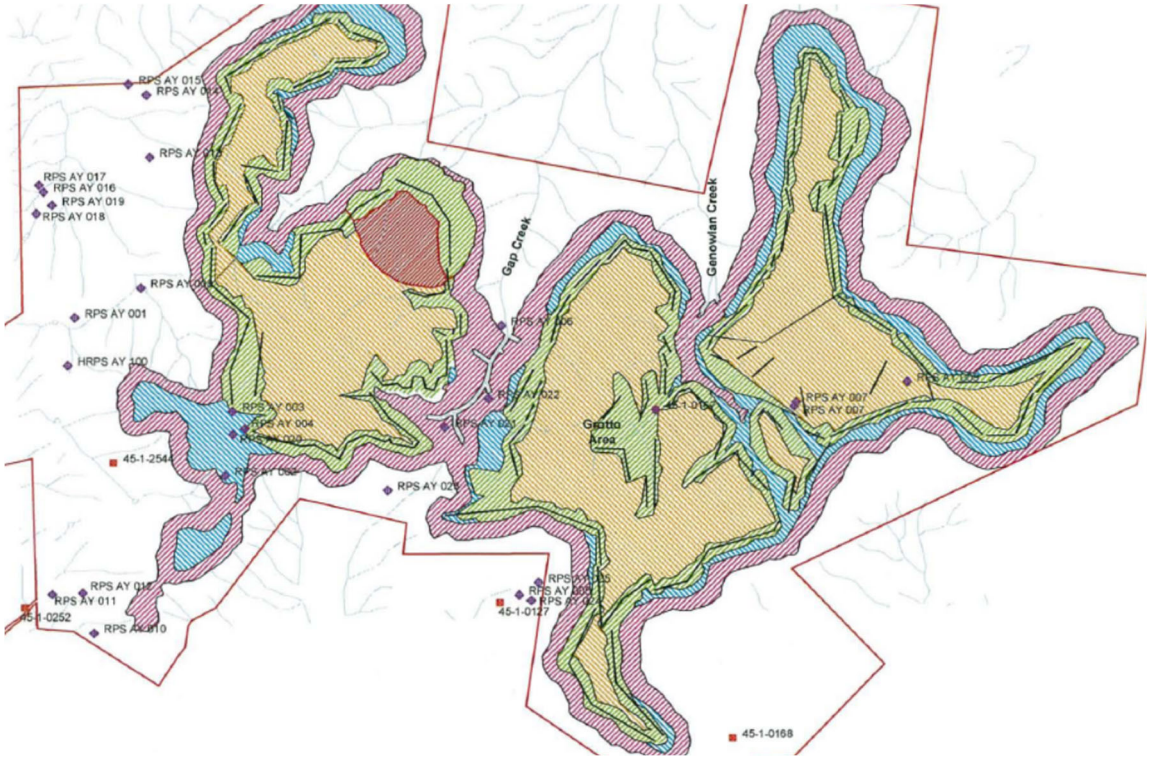



**Fig. 8.1 Location of Known Aboriginal Heritage Sites and Proposed Mining Zones over Mount Airly and Genowlan Mountain (Golder Associates, 2014)**

More recent studies undertaken by RPS, including baseline assessments for historic heritage (RPS, 2022) and Aboriginal Cultural Heritage (RPS, 2023a), have confirmed, see Fig. 8.2, that there are no known historical archaeological sites and no known Aboriginal Cultural Heritage sites located within the MW17-18 Extraction Plan Area.

CA have management plans that include protocols for unexpected finds. It is predicted the low levels of subsidence, tilt and strain would not pose a risk of harm to heritage sites typically found in the Airly Mine development consent boundary.

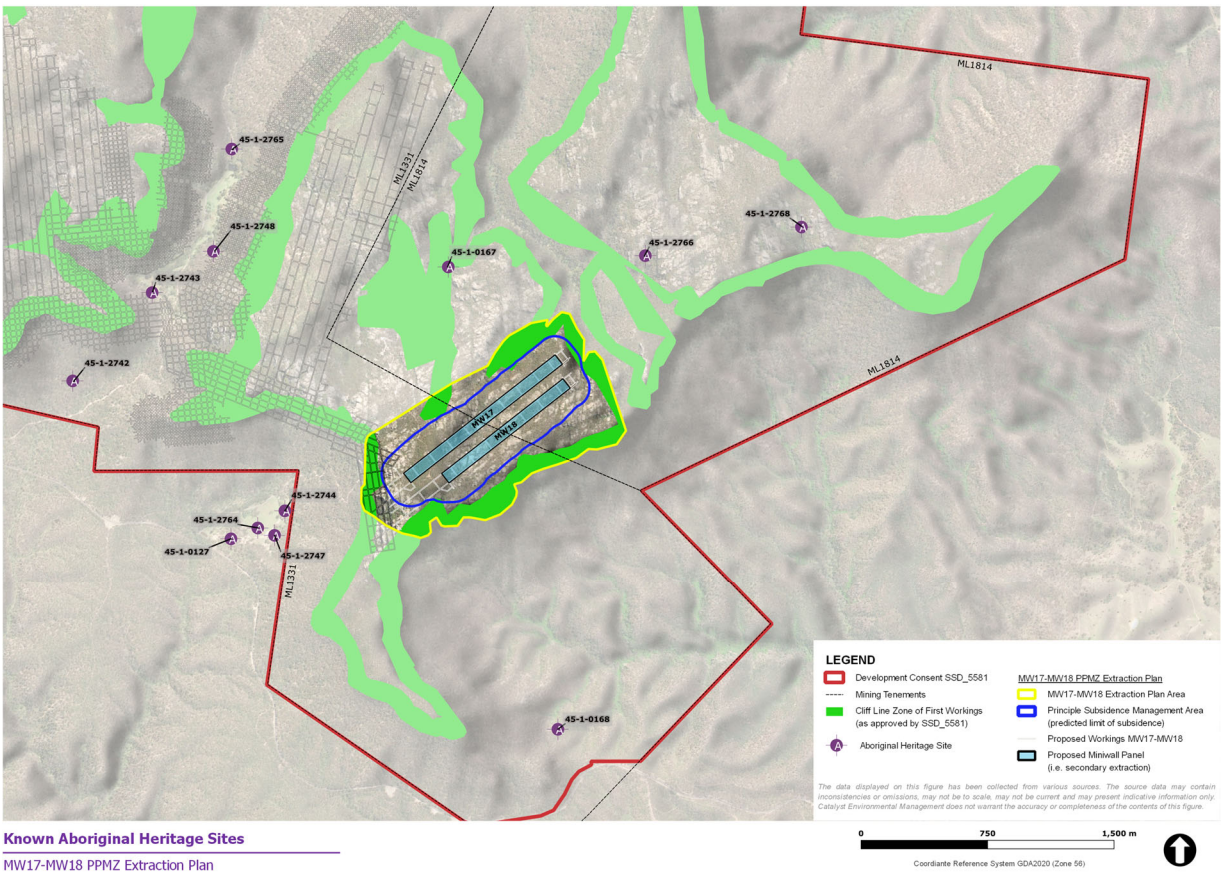



**Fig. 8.2 Location of Known Aboriginal Heritage Sites and Proposed Mining Zones over Mount Airly and Genowlan Mountain (RPS, 2021)**

## 8.3. State Survey Control Marks

A State Survey Trig Station exists at the Genowlan Trig Station site, which is located within the Study Area near the finishing end of MW18. This site of the Trig Station is apparently overgrown as it doesn't seem to be maintained any more. (See, Fig. 8.3)

(https://dingogap.net.au/other/trig-stations)

**Fig. 8.3 Genowlan Trig Station location and photograph**

Additionally, CA has advised that a search was undertaken for survey marks near the Study Area on the Survey Control Information Management System (SCIMS) database that contains the coordinates, heights and related attributes for Permanent Survey Marks constituting the State Control Survey established under the direction of the Surveyor-General of NSW. This search revealed that, as well as the Genowlan Trig Station, there are two permanent marks located near the Telecommunications Tower on Airly Turret at the south-western end of the Genowlan Mountain mesa and another two marks are located in the Airly Gap area near the Genowlan Mountain mesa, about 700 m from the Study Area.

The two permanent marks located on Airly Turret at the south-western end of the Genowlan Mountain mesa are shown in Fig. 8.4 with a dark blue square marker. The two marks located in the Airly Gap area are shown in a light blue square marker in Fig. 8.4.

The Genowlan Trig Station, TS7138 Genowlan,

**Fig. 8.4 Location of Survey Marks over and near the Study Area**

### 8.3.1. Predictions and Impact assessments for the State Survey Control Marks

The Trig Station is located near the proposed mini walls, and it could experience the full range of predicted subsidence effects. It may be necessary on the completion of the proposed mini walls, when the ground has stabilised, to re-establish the positions of this state survey control marks.

The Permanent Marks (PMs) that were identified in the SCIMS search will be subsided and moved by the proposed mining of MWs 13 to 16 a. The Department of Lands (Land and Property Information Division) have been informed of the proposed mining (under the previous Extraction Plan).

It may be necessary on the completion of the proposed mini walls, when the ground has stabilised, to re-establish any state survey control marks that are required for future use.

### 8.3.2. Comparisons of the predictions for the State Survey Control Marks with those provided in the EIS Application

The predicted levels of subsidence at these sites are similar to those provided in the 2014 EIS.

### 8.3.3. Recommendations for the State Survey Control Marks

Contact should be made with the Department of Lands (Land and Property Information Division) to advise them that small movements may occur at these survey control marks.

# Glossary of Terms, Abbreviations and Definition

Some of the more common mining terms used in the report are defined below:

| | |
|---|---|
| **Airly** | Airly Mine. |
| **Angle of draw** | The angle of inclination from the vertical of the line connecting the goaf edge of the workings and the limit of subsidence (which is usually taken as 20 mm of subsidence). |
| **AoD** | Angle of draw. |
| **AHD** | Australian Height Datum. |
| **CA** | Centennial Airly Pty Limited. |
| **Chain pillar** | A block of coal left unmined between the longwall extraction panels. |
| **Cover depth (H)** | The depth of cover measured from the surface to the top of the seam. Cover depth is often provided as an average over the area of the panel. |
| **Cliffs** | Continuous rockfaces having minimum heights of 10 metres, minimum lengths of 20 metres and minimum slopes of 2 to 1, i.e., having minimum angles to the horizontal of 63° |
| **CLZ** | Cliff Line Zone |
| **Closure** | The reduction in the horizontal distance between the valley sides. The magnitude of closure, which is typically expressed in the units of *millimetres (mm)*, is the greatest reduction in distance between any two points on the opposing valley sides. It should be noted that the observed closure movement across a valley is the total movement resulting from various mechanisms, including conventional mining induced movements, valley closure movements, far-field effects, downhill movements and other possible strata mechanisms. |
| **Critical area** | The area of extraction at which the maximum possible subsidence of one point on the surface occurs. |
| **Curvature** | The change in tilt between two adjacent sections of the tilt profile divided by the average horizontal length of those sections, i.e., curvature is the second derivative of subsidence. Curvature is usually expressed as the inverse of the **Radius of Curvature** with the units of *1/kilometres (km-1)*, but the value of curvature can be inverted, if required, to obtain the radius of curvature, which is usually expressed in *kilometres (km)*. Curvature can be either **hogging** (i.e., convex) or **sagging** (i.e., concave). |
| **DoC** | Depth of cover or cover depth. |
| **DTIRIS** | NSW Dept of Trade & Investment, Regional Infrastructure & Service |
| **EIS** | Environmental Impact Study |
| **Extracted seam** | The thickness of coal that is extracted. The extracted seam thickness is thickness normally given as an average over the area of the panel. |
| **Effective extracted seam thickness (T)** | The extracted seam thickness modified to account for the percentage of coal left as pillars within the panel. |
| **Face length** | The width of the coalface measured across the longwall panel. |
| **Far-field movements** | The measured horizontal movements at pegs that are located beyond the longwall panel edges and over solid unmined coal areas. Far-field horizontal movements tend to be bodily movements towards the extracted goaf area and are accompanied by very low levels of strain. |
| **FLAC** | Fast Lagrangian Analysis of Continua, is numerical modelling software for 2D geotechnical analysis of soil, rock, groundwater, and ground support |
| **GNSS** | Global Navigation Satellite System. |
| **Goaf** | The void created by the extraction of the coal into which the immediate roof layers collapse. |
| **Goaf end factor** | A factor applied to reduce the predicted incremental subsidence at points lying close to the commencing or finishing ribs of a panel. |
| **Horizontal displacement** | The horizontal movement of a point on the surface of the ground as it settles above an extracted panel. |
| **IEP** | Independent Expert Panel |
| **Inflection point** | The point on the subsidence profile where the profile changes from a convex curvature to a concave curvature. At this point the strain changes sign and subsidence is approximately one half of S max. |

| | |
|---|---|
| **Incremental subsidence** | The difference between the subsidence at a point before and after a panel is mined. It is therefore the additional subsidence at a point resulting from the excavation of a panel. |
| **IRP** | Independent Review Panel |
| **Kms** | Kilometres. |
| **m** | metres |
| **mesa** | An isolated relatively flat-topped natural elevation usually more extensive than a butte and less extensive than a plateau. |
| **MGA56** | Map Grid Australia Zone 56 |
| **MW** | Mini Wall |
| **MWs** | Mini Walls |
| **Minor Cliffs** | Continuous rockfaces having heights between 5 metres and 10 metres, minimum lengths of 20 metres and a minimum slope of 2 to 1. |
| **MMSCA** | Mugii Murrum-ban State Conservation Area. |
| **MNC** | Michael Nicholson Consulting |
| **MSEC** | Mine Subsidence Engineering Consultants. |
| **Pagoda** | A conical or sub conical rock formation, whether smooth, platy, stepped or terraced, generally between 5 and 20 metres in height that is not a cliff or minor cliff |
| **Panel** | The plan area of coal extraction. |
| **PPMZ** | Panel and Pillar Mining Zone**.** |
| **PM** | Permanent Mark. |
| **Panel length (L)** | The longitudinal distance along a panel measured in the direction of (mining from the commencing rib to the finishing rib. |
| **Panel width (Wv)** | The transverse distance across a panel, usually equal to the face length plus the widths of the roadways on each side. |
| **Panel centre line** | An imaginary line drawn down the middle of the panel. |
| **Pillar** | A block of coal left unmined. |
| **Pillar width (Wpi)** | The shortest dimension of a pillar measured from the vertical edges of the coal pillar, i.e., from rib to rib. |
| **RFS** | NSW Rural Fire Service. |
| **SCT** | Strata Control Technology. |
| **Shear deformations** | The horizontal displacements that are measured across monitoring lines and these can be described by various parameters including; horizontal tilt, horizontal curvature, mid-ordinate deviation, angular distortion and shear index. |
| **steep slope** | An area of land having a gradient between 1 in 3 (33% or $18.3^0$) and 2 in 1 (200% or $63.4^0$) |
| **Strain** | The change in the horizontal distance between two points divided by the original horizontal distance between the points, i.e., strain is the relative differential displacement of the ground along or across a subsidence monitoring line. Strain is dimensionless and can be expressed as a decimal, a percentage or in parts per notation.<br>**Tensile Strains** are measured where the distance between two points or survey pegs increases and **Compressive Strains** where the distance between two points decreases. Whilst mining induced **strains** are measured **along** monitoring lines, ground **shearing** can occur both vertically, and horizontally **across** the directions of the monitoring lines. |
| **Sub-critical area** | An area of panel smaller than the critical area. |
| **Subsidence** | The vertical movement of a point on the surface of the ground as it settles above an extracted panel, but, 'subsidence of the ground' in some references can include both a vertical and horizontal movement component. The vertical component of subsidence is measured by determining the change in surface level of a peg that is fixed in the ground before mining commenced and this vertical subsidence is usually expressed in units of *millimetres (mm)*. Sometimes the horizontal component of a peg's movement is not measured, but in these cases, the horizontal distances between a particular peg and the adjacent pegs are measured. |
| **Subsidence Effects** | The deformations of the ground mass surrounding a mine, sometimes referred to as 'components' or 'parameters' of mine subsidence induced ground movements, including vertical and horizontal displacements, tilts, curvatures, strains, upsidence and closure. |

| | |
|---|---|
| **Subsidence Impacts** | The physical changes or damage to the fabric or structure of the ground, its surface and natural features, or built structures that are caused by the subsidence effects. These impacts considerations can include tensile and shear cracking of the rock mass, localised buckling of strata, bed separation, rock falls, collapse of overhangs, failure of pillars, failure of pillar floors, dilation, slumping and also include subsidence depressions or troughs. |
| **Subsidence Consequences** | The knock-on results of subsidence impacts, i.e., any change in the amenity or function of a natural feature or built structure that arises from subsidence impacts. Consequence considerations include public safety, loss of flows, reduction in water quality, damage to artwork, flooding, draining of aquifers, the environment, community, land use, loss of profits, surface improvements and infrastructure. Consequences related to natural features are referred to as environmental consequences. |
| **Super-critical area** | An area of panel greater than the critical area. |
| **Tilt** | The change in the slope of the ground as a result of differential subsidence, and is calculated as the change in subsidence between two points divided by the horizontal distance between those points. Tilt is, therefore, the first derivative of the subsidence profile. Tilt is usually expressed in units of *millimetres per metre (mm/m)*. A tilt of 1 mm/m is equivalent to a change in grade of 0.1 %, or 1 in 1000. |
| **UCS** | Uniaxial Compressive Strength |
| **UDEC** | Universal Distinct Element Code - a two-dimensional numerical program that simulates the quasi-static or dynamic response to loading of media containing multiple intersecting joint structures. – for 2D modelling of Jointed and Blocky material |
| **UNSW** | University of New South Wales |
| **Uplift** | An increase in the level of a point relative to its original position. |
| **Upsidence** | Upsidence results from the dilation or buckling of near surface strata at or near the base of the valley. The term uplift is used for the cases where the ground level is raised above the pre-mining level, i.e., when the upsidence is greater than the subsidence. The magnitude of upsidence, which is typically expressed in the units of *millimetres (mm)*, is the difference between the observed subsidence profile within the valley and the conventional subsidence profile which would have otherwise been expected in flat terrain. |

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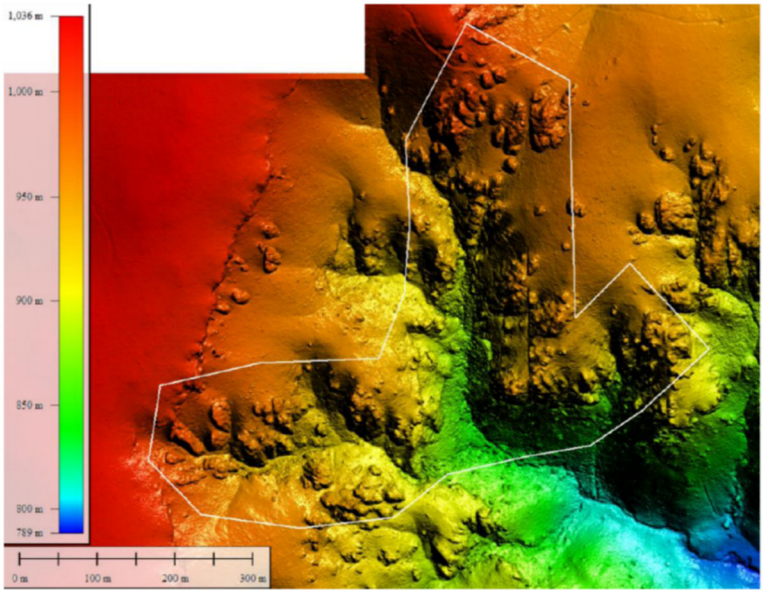
# APPENDIX A: AEROMETREX CLIFF IDENTIFICATION PROCESS

Aerometrex used a detailed LiDAR point cloud of 4 points per sq. m. with classified ground points to improve the accuracy of the process. They used a 2cm 3D mesh integrated into a 3D interactive platform.

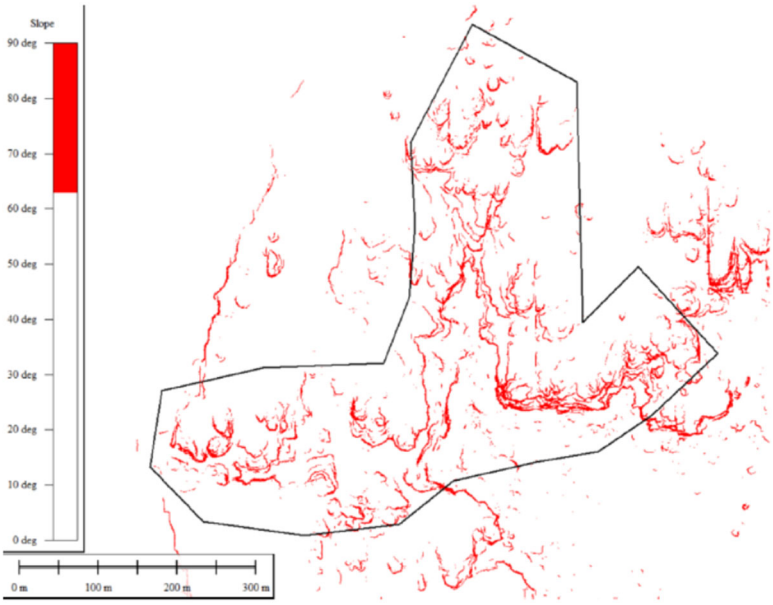
Aerometrex advised that the first step they used to extract cliffs was to generate a 50cm digital terrain model from the LiDAR point-cloud as shown in Fig. A.0.1.




**Aerometrex (2020)**

**Fig. A.0.1 Aerometrex cliff identification studies 50cm digital terrain model from the LiDAR point-cloud**

The next step was to derive a slope map, see Fig. A.0.2, which highlights where the slope is greater than 63º. Those areas are vectorized and a maximum height – minimum height attribute is extracted for each polygon.




**Aerometrex (2020)**

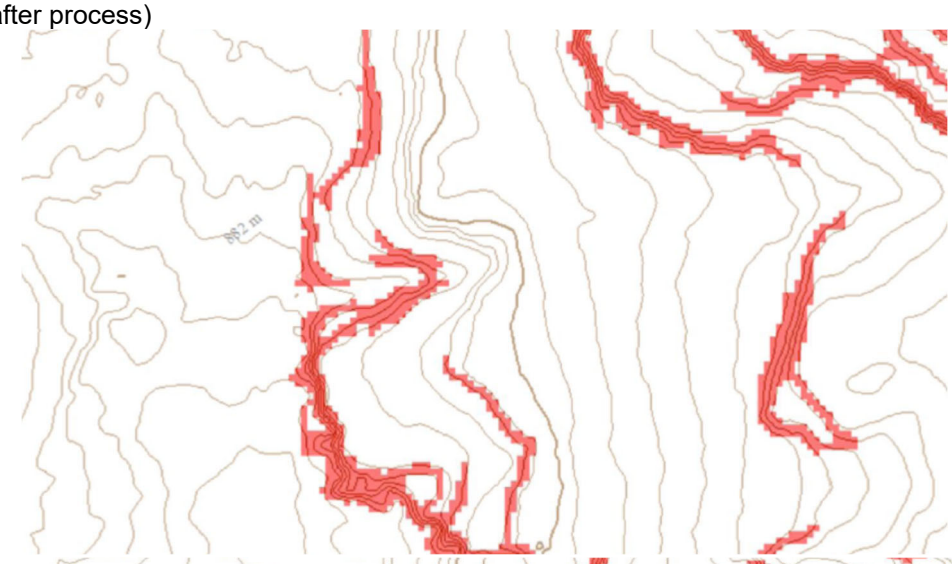
**Fig. A.0.2 Aerometrex cliff identification studies - slope map**

A first filtering of the data is applied to remove polygons with a height difference lower than 10m. see Fig. A.0.3.

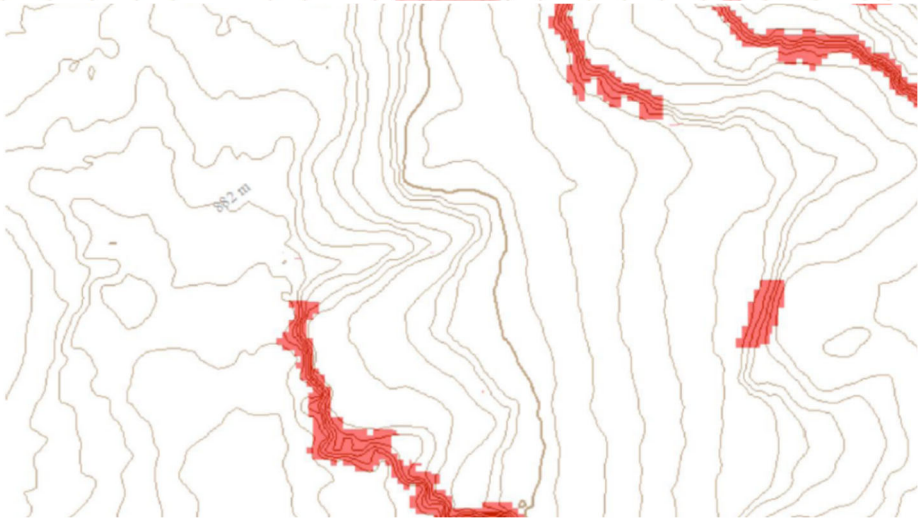
**Aerometrex (2020)**

**Fig. A.0.3 Aerometrex cliff identification studies - 50cm digital terrain model from the LiDAR point-cloud**

A second filtering step consist in generating a contour map (in this case 2m contours) and removing part of the polygons where the potential cliff width contains less than 4 iso-lines. (see Fig. A.0.4 to review the before and after process)



**Before**



**After Aerometrex (2020)**

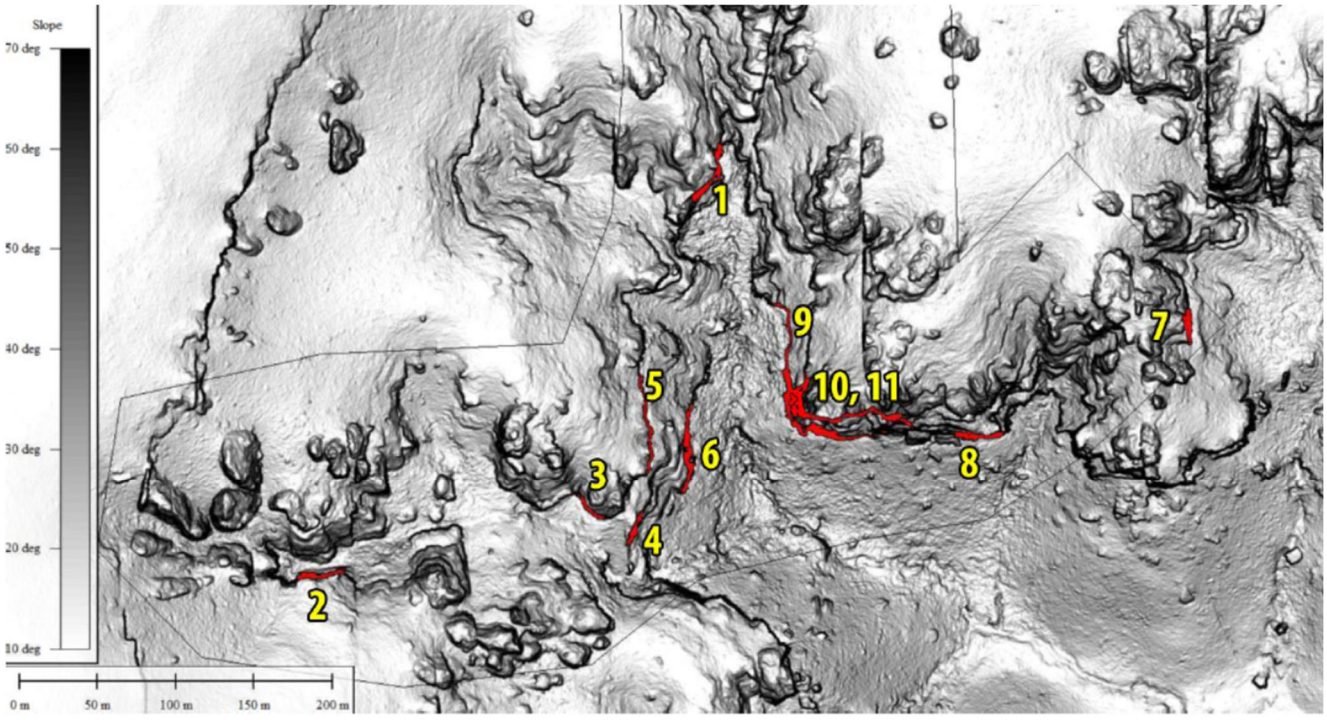
**Fig. A.0.4 Aerometrex cliff identification studies – potential cliffs**

Polygons, where the length < 20m, were then removed with the resulting filtered polygons as shown in Fig. A.0.5. A first visual assessment of the 3D mesh with polygon overlay is needed to remove potential cliffs polygons with an obvious discontinuity which can be observed in 3D and resulting in segments smaller than 20m long.

**Aerometrex (2020)**

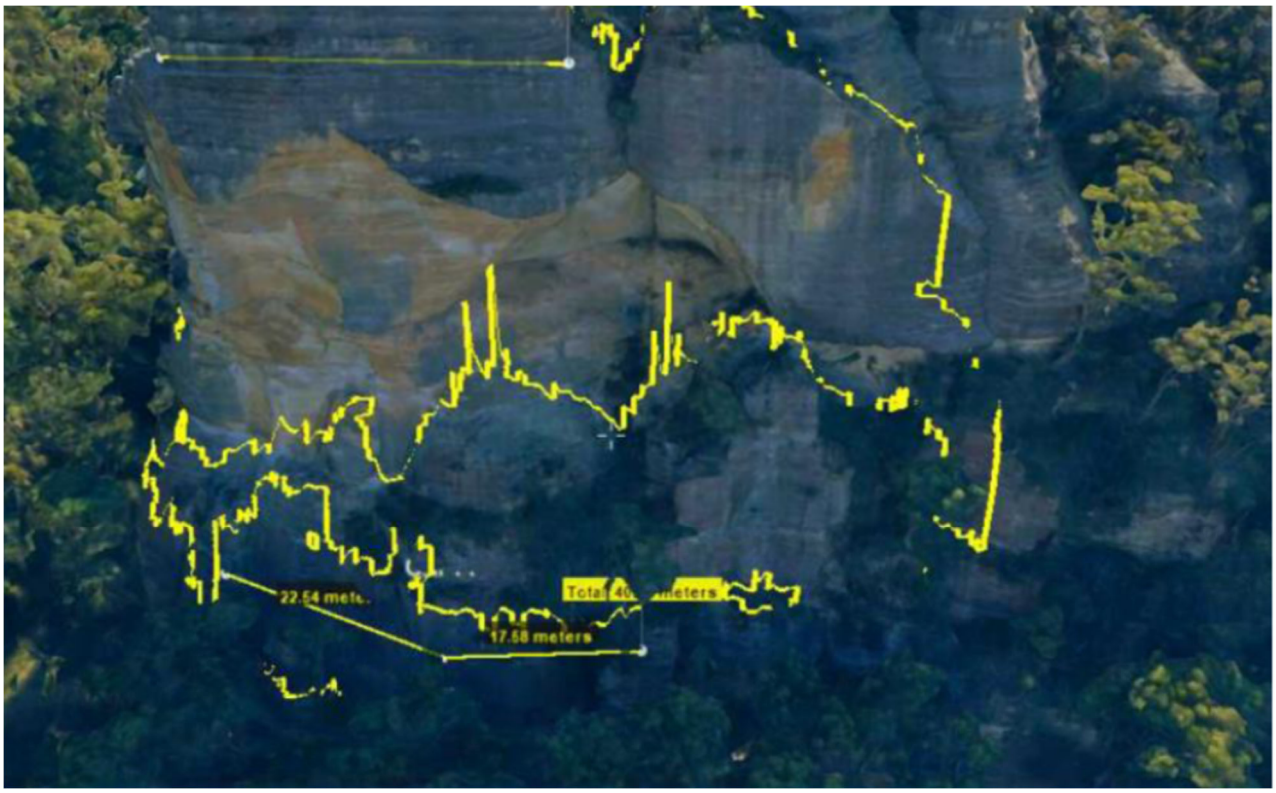
**Fig. A.0.5 Aerometrex cliff identification studies filtered polygons for cliffs**

For this example, the final cliff areas that were identified and mapped are shown in Fig. A.0.6 and detailed mapping of cliffs were provided as shown in Fig. A.0.7 and Fig. A.0.8.



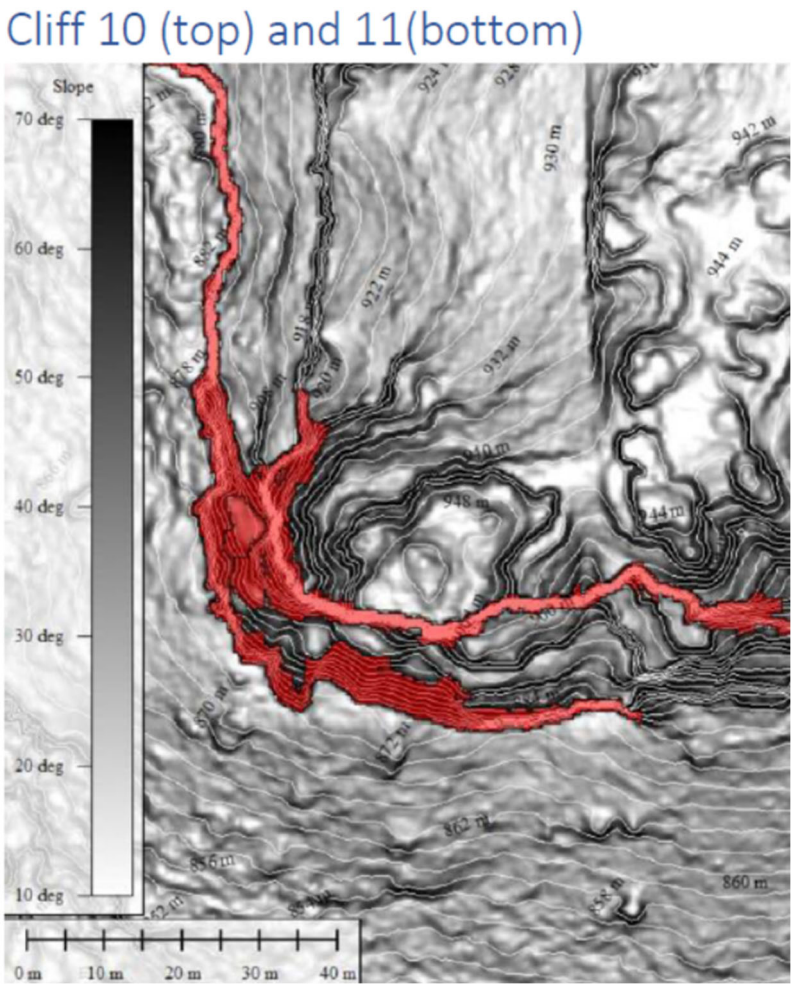

**Aerometrex (2020)**

**Fig. A.0.6 Aerometrex cliff identification studies final cliff line mapping example**




**Aerometrex (2020)**

**Fig. A.0.7 Aerometrex cliff identification studies filtered polygons for cliffs**




**Aerometrex (2020)**

**Fig. A.0.8 Aerometrex cliff identification studies filtered polygons for cliffs**

# APPENDIX B: FURTHER REVIEW OF EFFECT OF SUBSIDENCE GROUND MOVEMENTS ON CLIFFS

The literature reviews of past papers on mining induced cliff falls that have been presented in previous MSEC cliff impact assessment reports have confirmed that mining induced subsidence ground movements have caused many cliff falls over mined longwalls and total extraction areas. Generally speaking the higher the mining induced subsidence ground movements and the higher and less stable the cliff faces are, then the bigger the mining induced cliff falls are. This Appendix re-analyses that information and provides an assessment of the likely factors that have caused mining induced cliff impacts in the past.

## B.1 Update on Cliff Fall Analysis

The available cliff line monitoring data that was measured during the 1991 NERRDC funded study (Kay, 1991) and in the follow up report (Kay,1994) have been revisited, after extra rock fall data was gathered from more recent sites, in order to review which of the following factors are likely to most influence the likelihood of rock falls along cliff lines.

This updated cliff fall analysis is now based on measurements and observations at rock falls over many collieries in the Western and Southern Coalfields of NSW plus one major cliff fall case from Mount Mulligan in Queensland, which, like the Nattai North Mine, resulted in the closure of a mine because of the high risk of further rock falls.

New data was gathered into an improved data base containing information on each of the factors that were thought to influence the likelihood of rock falls. Graphs have been prepared to show trends in this data and to assess which of these factors most influenced the rock fall occurrences.

After reviewing the available literature on coal mining subsidence and effects of subsidence on slopes and rock falls, the following factors were listed as possibly influencing whether particular cliffs could fall that were about to experience mining induced subsidence ground movements.

**Cliff Stability Factors**

- Height and width of the undermined cliff line,
- Shape of the cliff falls, in particular, whether the cliff is;
  - an isolated formation which is separated from other cliff faces, and/or
  - undercut by a cave feature, (what is the width, height and depth of the cave).
- existence of natural jointing near cliff falls, and existing stress fields, and
- geomechanical properties of cliff strata,

**Location Factors**

- location of cliff face with respect to the longitudinal goaf edges,
- location of cliff face with respect to the starting and finishing panel edges,
- location of cliff face with respect to the longwall face,

**Mining Factors**

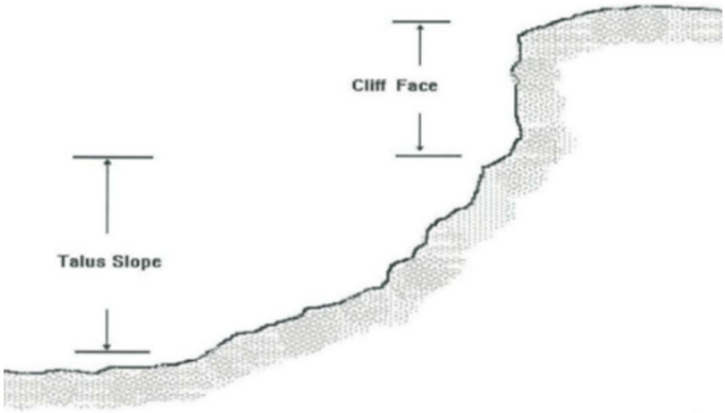
- direction of mining, i.e. whether mining approached the cliff from the plateau or valley side, or whether the mining direction was parallel to cliff line,
- extent of mining (w/h ratio, Smax over panel) ,
- rate of mining,
- magnitude of mining induced subsidence and horizontal displacements, and strain and tilt movements at the cliff face, in valley in front of cliff, on plateau above cliff, at the time of the fall,
- differential subsidence across the cliff face, and
- presence of a fresh mining induced surface cracks near the rock fall.

## B.2 Review of each Factor Influencing Rock Falls

### B.2.1 Height of Cliff Line

The largest reported rock fall due to coal mining in N.S.W. occurred above the Nattai North Colliery. The initial fall occurred just after the cliff line was undermined, but the size of this fall increased by later secondary falls, over a twenty-year period, to be 200m to 270m high and 800m wide.
Estimates of the total volume of rock that fell ranges from 5,000,000 to 14,000,000 m3.
It has been suggested that the reason why this rock fall was the largest mining-induced fall, could be because that cliff face was very high and hence it could have been more susceptible to failure than smaller cliffs.

The minimum cliff fall height observed was 4m, the cliff height maximum observed was 270 m, the average height of the cliff faces that fell was 45 m and the standard deviation was 58 m.




The average height of the talus slopes that were below the cliff faces that fell was 58 m. Whilst the minimum talus slope height observed was 5m, the maximum observed was 300 m and the standard deviation was 64 m. The average height of the talus slopes plus the cliff faces that fell was 104 m.

Whilst the minimum talus slope plus cliff face height observed was 10m, the maximum observed was 500 m and the standard deviation was 117 m.

Following site inspections after the cliff falls, it was found that the immediate cliff faces, from where the rock falls occurred, were not necessarily higher than the surrounding cliffs and at many of these cliff lines there were similar or higher cliff faces that were also undermined but experienced no rock fall damage.

It was therefore concluded that other factors must also influence the likelihood of cliffs falling and that further analysis was required to reveal the extent of influence of cliff height on the likelihood of a particular cliff falling.

Subsequentially, if the other factors are constant, the percentage of damage experienced at higher cliffs may be greater than the percentage of damage experienced at lower cliffs.

Percentage of cliff damage was initially defined as the total width of the rock falls within a given area divided by the total width or length of the undermined cliff line within that given area and multiplied by one hundred.

Subsequentially, the percentage of cliff damage was re-defined as the face area of the rock fall, i.e. the fall height times fall width, divided by a given area of cliff line that was undermined and multiplied by one hundred.

These calculations of percentage damage were undertaken on a cliff line by cliff line basis, a longwall panel by longwall panel basis, within groups of longwalls or within various Collieries, depending on the need of the calculation.

The table below shows the results of percentage damage calculations for a longwall by longwall basis and some groups of longwall basis.

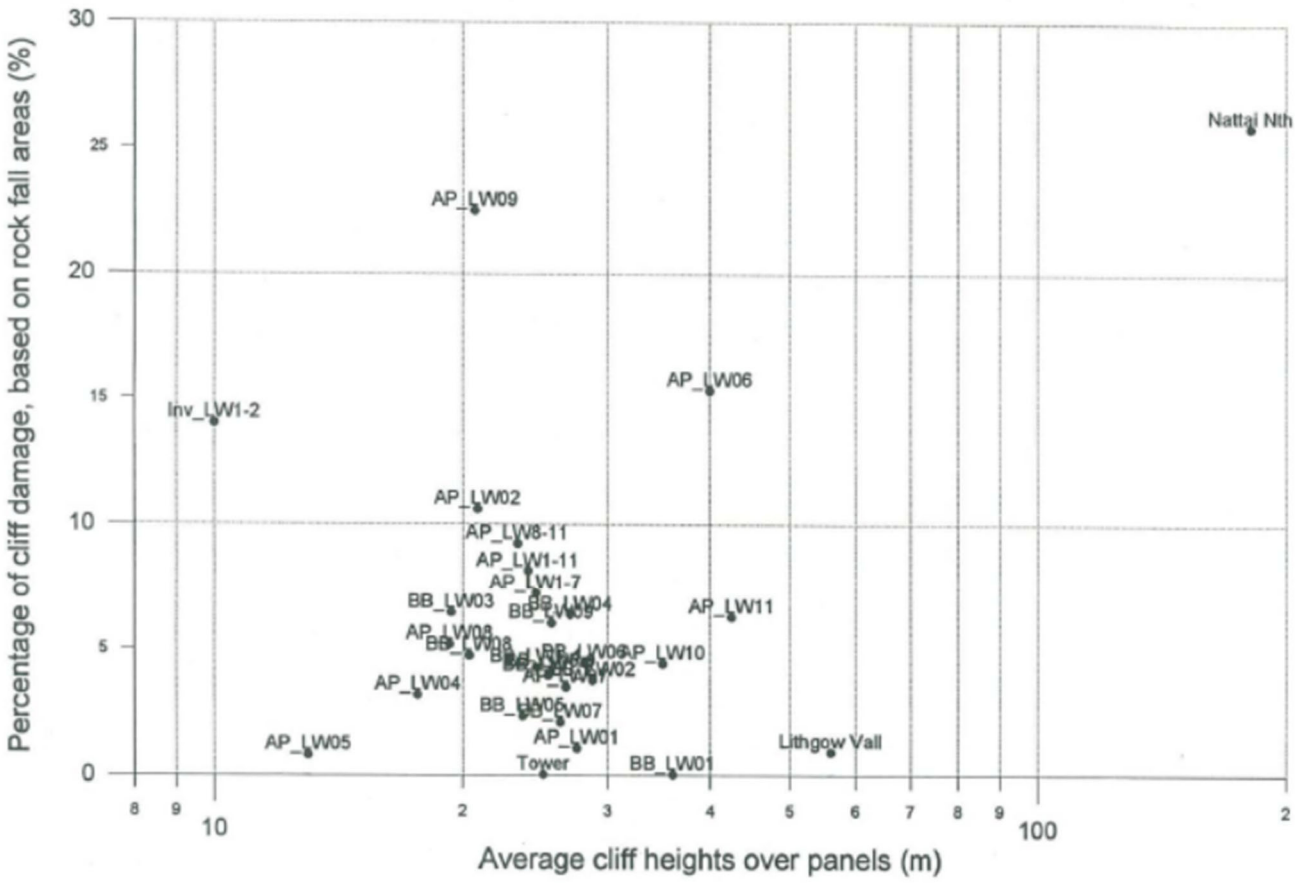
| Panel no or Groups of panels | No. of rock falls in panels | Average cliff height at falls (m) | Total length of cliffs mined (m) | Total widths of rock falls (m) | % damaged based on fall widths | % damaged based on fall areas |
|---|---|---|---|---|---|---|
| AP_LW01 | 4 | 28 | 400 | 12 | 3.00 | 1.06 |
| AP_LW02 | 6 | 21 | 420 | 80 | 19.05 | 10.62 |
| AP_LW04 | 6 | 18 | 440 | 23 | 5.23 | 3.19 |
| AP_LW05 | 4 | 13 | 650 | 17 | 2.62 | 0.79 |
| AP_LW06 | 5 | 40 | 650 | 140 | 21.54 | 15.33 |
| AP_LW07 | 9 | 27 | 980 | 103 | 10.51 | 3.50 |
| AP_LW08 | 7 | 19 | 910 | 72 | 7.91 | 5.18 |
| AP_LW09 | 13 | 21 | 900 | 277 | 30.78 | 22.52 |
| AP_LW10 | 2 | 35 | 740 | 78 | 10.54 | 4.42 |
| AP_LW11 | 2 | 43 | 730 | 60 | 8.22 | 6.29 |
| BB_LW01 | 1 | 36 | 1180 | 3 | 0.25 | 0.03 |
| BB_LW02 | 4 | 29 | 1220 | 71 | 5.82 | 3.76 |
| BB_LW03 | 8 | 19 | 1550 | 163 | 10.52 | 6.44 |
| BB_LW04 | 5 | 27 | 1320 | 118 | 8.94 | 6.36 |
| BB_LW05 | 15 | 24 | 2050 | 155 | 7.56 | 2.35 |
| BB_LW06 | 42 | 28 | 2250 | 357 | 15.87 | 4.45 |
| BB_LW07 | 12 | 26 | 1830 | 142 | 7.76 | 2.10 |
| BB_LW08 | 17 | 20 | 1330 | 143 | 10.71 | 4.75 |
| BB_LW09 | 23 | 26 | 1910 | 197 | 10.31 | 6.03 |
| AP_LW1-7 | 34 | 25 | 3540 | 375 | 10.59 | 7.22 |
| AP_LW8-11 | 24 | 23 | 3280 | 487 | 14.85 | 9.23 |
| AP_LW1-11 | 58 | 24 | 6820 | 862 | 12.64 | 8.13 |
| BB_LW1-4 | 18 | 25 | 5270 | 355 | 6.74 | 4.28 |
| BB_LW5-9 | 109 | 26 | 8780 | 994 | 11.32 | 4.10 |
| BB_LW1-9 | 127 | 25 | 14640 | 1349 | 9.21 | 3.96 |
| Lithgow Vall | 5 | 56 | 4400 | 150 | 3.41 | 0.91 |
| Nattai Nth | 16 | 181 | 4600 | 1365 | 29.67 | 25.91 |
| Tower | 1 | 25 | 1500 | 5 | 0.33 | 0.03 |
| Inv_LW1-2 | 1 | 10 | 150 | 30 | 20.00 | 14.00 |
| All above cliff falls | 208 | 38 | 32110 | 3761 | 11.71 | 20.39 |
| All above cliff falls, except Nattai North | 192 | 26 | 27510 | 2396 | 8.71 | 4.32 |

From the above table it can be seen that the average percentage damage from mining observed over the all of above cliff lines was 12 %, when calculations are undertaken based on fall widths, or 20% when calculations are undertaken based on fall areas.

The average percentage damage from mining observed over the above cliff lines excluding Nattai North was 9 %, when calculations are undertaken based on fall widths, or <5% when calculations are undertaken based on fall areas.

The reason why the latter figures are substantially lower is that the total area of the Nattai North falls accounted for 88% of the total fall area.

The plot below shows the percentage cliff damage that was calculated summing the cliff fall areas over a longwall panel and dividing it by the area of the cliff lines that were undermined. In each plot the data points have been labelled, for example, the panels which experienced the most damage, i.e. Nattai North and Angus Place Longwall 9, are labelled NN and AP LW09 respectfully.




**Coal mining induced cliff damage, based on fall areas, versus average cliff heights, (MSEC)**

A general trend of increasing damage with increasing height can be seen in this plot although it shows a wide scatter in damage percentage. Similar scatter and trends were noticed when plots were prepared of damage percentage versus talus slope height and damage percentage versus cliff face plus slope heights.

When we were in the field gathering the data for this data base, it was noticed that the cliff faces that fell were not necessarily the highest cliffs that were undermined. Indeed, some of the cliff faces that did not collapse were higher than the cliffs that did experience rock falls even though both sets of cliffs would have been exposed to similar subsidence ground movements.

Therefore, it is concluded that the height of cliffs has some influence on the likelihood of rock falls. However, because of the wide scatter in the data relating the influence of cliff height on cliff damage, other factors must have more influence determining where the failures will occur.

### B.2.2 Cliff face slope

Reports on the geology of the Western Coalfields noted that the cliff face strata are generally slowly weathering sandstone units, whilst at the base of most of the cliff faces in the Western Coalfield lies a weaker claystone layer. When this claystone layer weathered and eroded away the cliff face becomes undercut to form a cave feature. However not all the cliff faces that experienced cliff falls were undermined were undercut and it was found that many of them were found to be leaning backwards.
It was suspected that perhaps many of the cliffs that fell were undercut and were therefore unstable and hence were more likely to experience rock falls than cliffs which were laid back.
Accordingly, when cliffs were re-visited a note was made of the cliff face slope. Where a cliff face was undercut a slope of less than 90 degrees was entered into the data base and where the cliff face was leaning backwards an angle of greater than 90 degrees was entered.
Figures were prepared to show the observed vertical angle of the cliff faces prior to mining for 182 rock falls that were re-visited. The statistical mean of the observed cliff fall slopes was 91 degrees, whilst the minimum was 45 degrees, the maximum was 120 degrees, and the standard deviation was 16 degrees It should also be stated that because there were some significantly undercut cliff faces did not fall, the degree of undercutting of the cliff face by itself does not necessarily determine whether a rock fall will occur and accordingly other factors may have a greater influence on the likelihood of rock falls.
It should also be stated that because there were some significantly undercut cliff faces did not fall, the degree of undercutting of the cliff face by itself does not necessarily determine whether a rock fall will occur and accordingly other factors may have a greater influence on the likelihood of rock falls.

### B.2.3 Extent of the cliff - Width/Length of cliff line

The width of the escarpment or the length of the cliff line, at the site of each fall, was measured off the plans or aerial photographs, to assess whether that cliff face was part of a large plateau, a narrow ridge line, or whether it was an isolated rock formation, such a pagoda or bee hive. Where the cliff face was located along a narrow ridge line, then the width of the ridge line was entered into the data base, or if the width of the plateau region was greater than the length of the local cliff line was noted. This data was gathered to assess whether the size of the plateau region may have an influence on the likelihood of rock falls.
The table below represents the resulting data in a frequency table.

| Range of the plateau widths above each rock fall, (see above discussion) (m) | Number of rock falls occurring within plateau width ranges | Cumulative frequency of rock falls occurring within plateau width ranges |
|---|---|---|
| 0-30 | 0 | 0 |
| 30 - 49 | 22 | 22 |
| 50 - 99 | 70 | 92 |
| 100 - 149 | 60 | 152 |
| 150 - 199 | 11 | 163 |
| 200 - 299 | 21 | 184 |
| 300 - 399 | 8 | 192 |
| 400 - 499 | 3 | 195 |
| > 500 | 29 | 224 |

Of the 224 rock falls in the data base none fell off cliff lines of widths of less than 30m. i.e. not one of the rock falls occurred off a cliff face that could have been described as a pagoda.
Ninety per cent of the falls occurred off rock formations with widths greater than 50 metres that could have been described as part of an escarpment or continuous cliff line feature. The average width of the lesser width of the plateau region above the rock falls was 161 m, the minimum width was 30 m, the maximum width was assigned as 500m and the standard deviation was 148 m.
It should be noted that, although many pagoda type formations were undermined within the collieries that were visited to establish the data base, no specific statistics were gathered on the plateau region widths of all the areas that were undermined that did not experience rock falls.
Accordingly damage percentages can not be calculated for cliffs of various plateau widths. It is suspected that a greater proportion of the massive cliffs were damaged than pagoda cliffs, because these cliffs could not move freely in response to subsidence and hence they cracked and experienced rock falls. However, no field data exists on the plateau widths of undamaged cliffs and hence this suspicion can not be statistically tested.

### B.2.4 Orientation of the cliff line with respect to the direction of mining

When a cliff line in the monitoring data base was oriented parallel to the direction of mining an angle of 0 degrees was entered into the database, when the cliff line was perpendicular to the direction of mining an angle of 90 degrees was entered. This orientation angle was determined for each available rock fall to the nearest 5 degrees.

The table below shows the results of this review in a frequency table for ranges of angles.

| Ranges of orientation angles between the cliff line and the direction of mining ( see above discussion ) (degrees) | Number of rock falls occurring at within various orientation angles |
|---|---|
| 0 | 13 |
| 5 | 3 |
| 10 | 10 |
| 15 | 7 |
| 20 | 8 |
| 25 | 3 |
| 30 | 11 |
| 35 | 2 |
| 40 | 15 |
| 45 | 15 |
| 50 | 12 |
| 55 | 6 |
| 60 | 13 |
| 65 | 9 |
| 70 | 11 |
| 75 | 8 |
| 80 | 11 |
| 85 | 1 |
| 90 | 52 |
| Unknown angle | 14 |

From this table, it could be concluded that cliffs orientated normal to the direction of mining are more vulnerable to falling than cliffs orientated parallel to the direction of mining, however, at this stage of the study, this finding is not considered conclusive as this result may be influenced by the available sample, i.e. most of the cliff lines at Angus Place and Baal Bone Collieries were oriented perpendicular to
the direction of mining.

But from these results it is concluded that the orientation of the cliff line with the direction of mining is not considered a major factor influencing rock falls.

### B.2.5 Natural jointing and existing stress fields

When each rock fall site was inspected, a note was made as to whether the fall occurred off a pre-existing joint or a freshly cracked surface. It was relatively easy to decide whether or not the Angus Place and Baal Bone rock falls occurred off fresh cracks as these falls usually occurred within the one stratigraphic unit and mining had taken place recently. However, some of the larger rock falls, i.e. above the Nattai North Colliery and the Dombarton Colliery, included many differing stratigraphic units and many of these have now weathered extensively so that it was difficult to tell whether these falls occurred off natural joints or new mining-induced joints.
Fortunately for most of these larger falls records were kept of observed surface cracking above the cliff face before the fall and these surface cracks did not follow pre-existing jointing.
It was found that of the 224 falls listed in the data base, four falls, i.e. only 1.7% of the total, were found to have definitely occurred off pre-existing natural joints. These four rock fall faces did not show the freshly cracked sandstone appearance of the new mining-induced joints but had clear signs of secondary mineralogy, fillings, or weathering. Three of these falls were at Angus Place and one was at Baal Bone. Three were sized as minor and one was classified as a medium rock fall.
In conclusion, the available statistics indicates that the presence of natural joints was not a major factor affecting rock falls, but further data could be gathered to confirm this interim finding.

### B.2.6 Location of falls with respect to the longitudinal (main gate or tail gate) goaf edges

Angus Place Colliery observed that most rock falls over their longwalls 3 to 7 were located over the centre of these longwall panels whilst most falls over their longwalls 8 to 11 were located over the chain pillars. This observation became more interesting when it was realised that the width of Angus Place longwalls 3 to 7 was increased from 147m to 212m for longwalls 8 to 11.
Although the Colliery did not monitor the actual subsidence movements near the cliff lines, because of the risk to surveyors, and no field measurements were made of the exact location of each fall with respect to the goaf edges, the Colliery assessed that;

- Longwalls 1 to 7's width of 147m was sub-critical under the plateau regions and supercritical under the valley, i.e. the width to height ratio varied from 0.7 to 1.5.
- Because of the change in depth of cover, the final subsidence on the plateau areas over centre of longwalls 1 to 7 was estimated to be much less than the subsidence in the valley areas in front of the cliffs by up to

1000mm, causing large tilts across the cliff faces, that could explain why most of the falls were located in the centre of the panels.

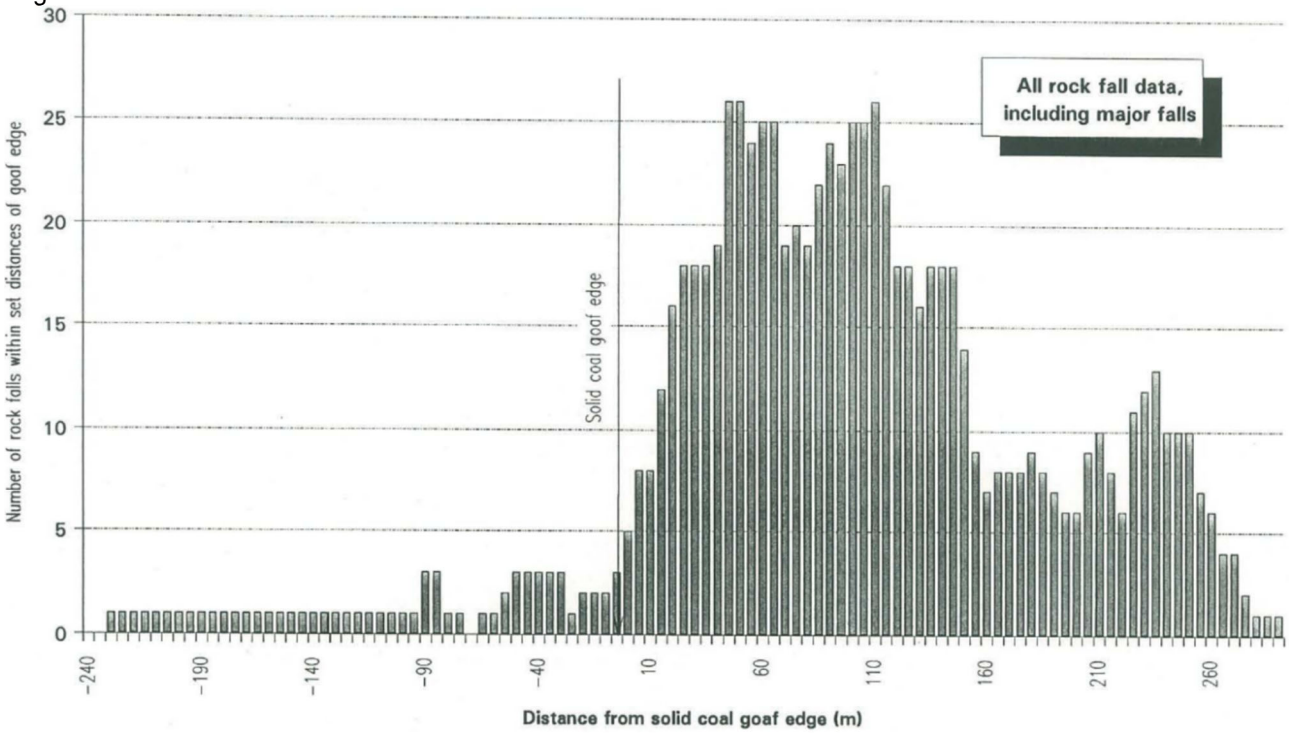
- Longwalls 8 to 11 's width of 212m was super critical in the valley regions and almost super-critical under the plateau.
- The differential subsidence across the cliff faces over the centre of longwalls 8 to 11 was not as great as over longwalls 1 to 7, because both regions were supercritical.
- The increased levels of subsidence over longwalls 8 to 11, due to the extra excavation width (147m to 212m) and increased cutting height (2.6m to 3.2m). would have caused higher tensile strains over their chain pillars than over the chain pillars between longwalls 1 to 7. This increase in estimated tensile strain could explain why most of the falls were located over the edges of these panels.

Accordingly, fall frequency analyses were then undertaken to find the number of rock falls occurring within set positions from the various goaf edges. The table below shows results of the first fall frequency analyses, in which the numbers of falls occurring within 50 m wide intervals from the solid goaf edge was first calculated and then the percentage of falls within this intervals of the total number of falls was calculated.
In these analyses the larger falls were counted several times, i.e. wherever parts of these large falls were located within the set distances from the goaf edges. The fall frequency analyses were undertaken from both the solid goaf edge (or the main gate), or if nearer, the tail gate goaf edge which abuts a previously mined panel.

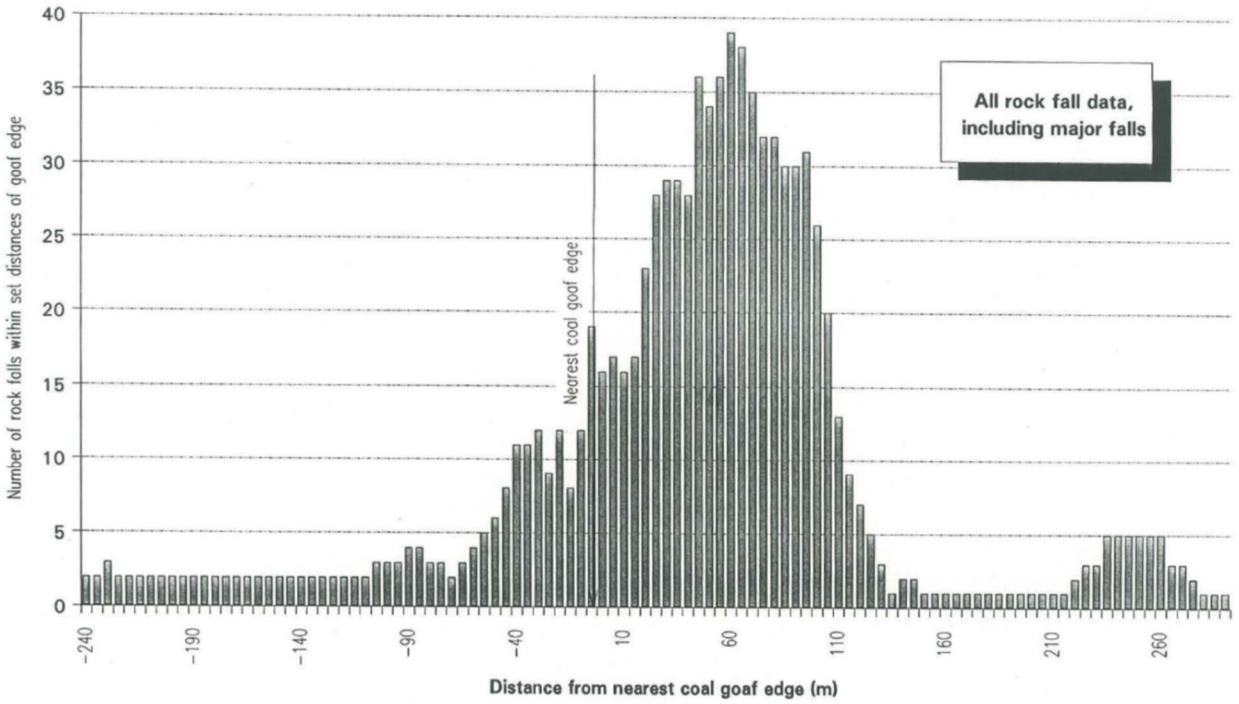
| Distances from Goaf Edge for all observed rock falls(m) | Percentage of falls observed within distance range from the solid goaf edge | Percentage of falls observed within distance ranges from nearest goaf edge |
|---|---|---|
| -250 to -55 | 2% | 3% |
| -50 to -5 | 2% | 11% |
| 0 to 45 | 19% | 32% |
| 50 to 95 | 28% | 40% |
| 100 to 145 | 22% | 10% |
| 150 to 195 | 14% | 0% |
| 200 to 245 | 9% | 2% |
| 250 to 295 | 4% | 2% |

From these distributions it can be seen that only a small proportion of the observed rock falls occurred over the solid coal and the most common location of rock falls is within 50 to 95 m from the nearer goaf edge. Nevertheless, falls have been observed over each of the distance intervals that were undermined.

The plots below show more detail of the fall frequency analyses. These plots show the number of rock falls that occurred within 5 m distances from the solid goaf edges.
These plots are useful in assessing the distribution of falls about the solid goaf edge, but they cannot be used for comparing the distribution within the panel or about the tail gate longitudinal rib because the various mined panels had differing panel widths. Hence further tables below represents this same data within 5 m distance bands about the nearer goaf edge, i.e. the closer of the main gate or tail gate, rather than the distance from the falls to the solid goaf edge.



**Number of rock falls at set locations about nearest solid goaf edge, (MSEC)**

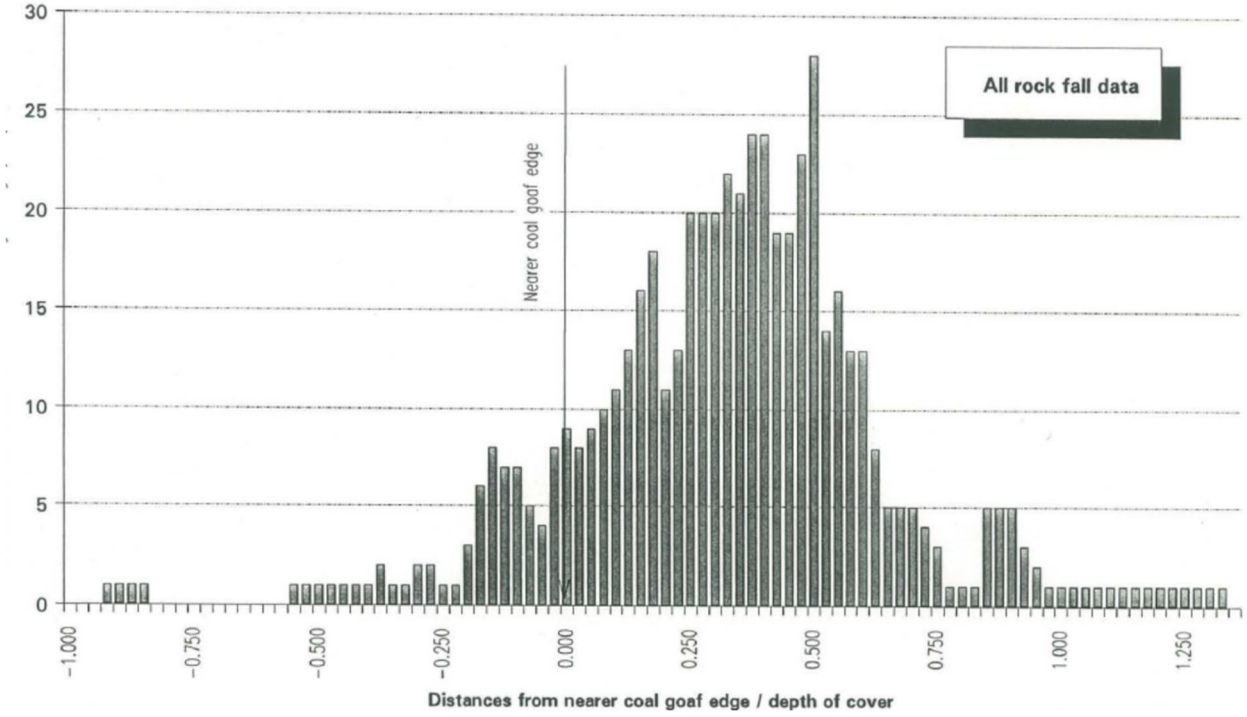



**Number of rock falls at set locations about the nearest goaf edge, (MSEC)**

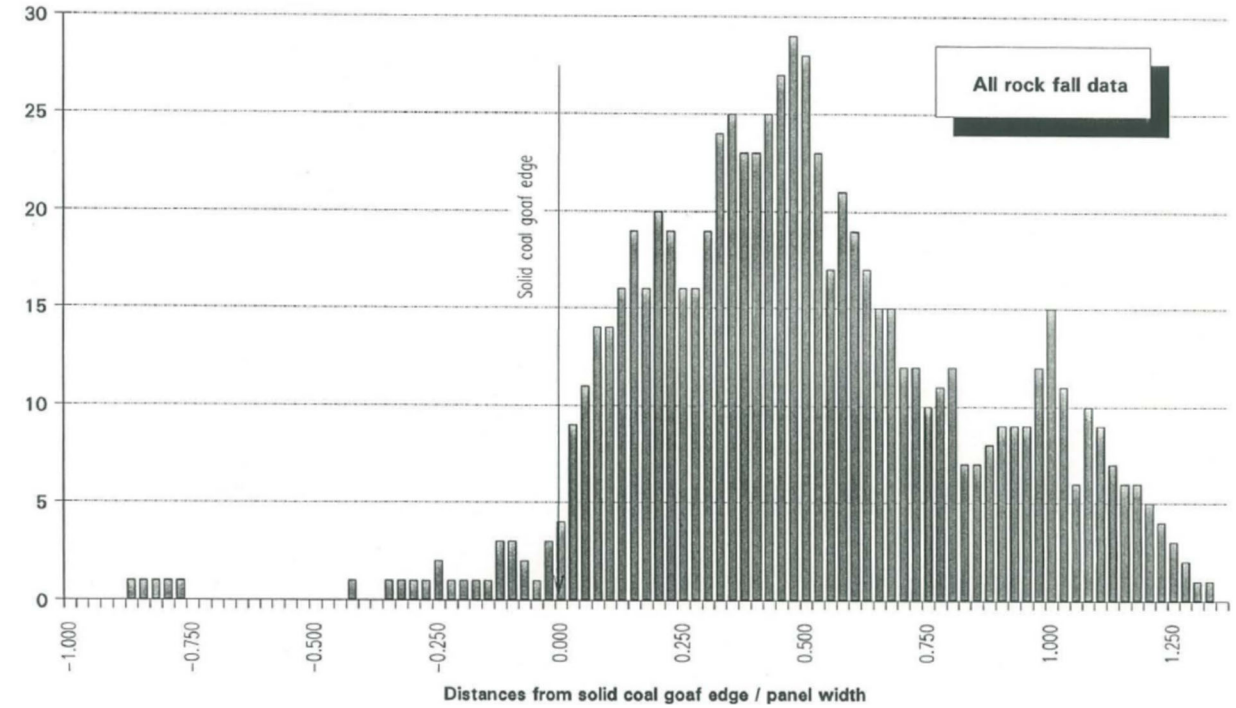
Therefore, the plot above provides a clearer understanding of the distribution of rock falls about goaf edges. It indicates that the more cliff falls occurred between 60 to 65m from goaf edges than at any other location. For example there were approximately four times more falls in this location than near the chain pillars. It can also be noted that the major reason why, in this plot, the number of falls observed beyond 100m reduced significantly is that most of the mined panels at the Baal Bone and Angus Place Collieries, which provided some 75% of the rock falls in the data base, were 211 m wide.

As the number of falls within distances intervals from the goaf edge could be influenced by changing depth of covers at the various collieries, the fall frequency analysis was extended or modified. Rather than counting the number of falls within set distances of the goaf edges, now the number of falls within set distances of the goaf edges divided by the depth of cover at each rock fall site. The following table indicates that 4% of the rock falls fell over the unmined coal, 43% and 37% of the rock falls occurred within the ranges of 0 to 0.5 times the depth of cover and 0.5 to 1 times the depth of cover and 16% were observed beyond the tail gate.

| Distances from Goaf Edge for all observed rock falls divided by the depth of cover | Percentage of falls observed within distance range from the solid goaf edge divided by the depth of cover | Percentage of falls observed within distance ranges from nearest goaf edge divided by the depth of cover |
|---|---|---|
| -1 to 0 | 4% | 10 |
| 0 to 0.5 | 43% | 60 |
| 0.5 to 1 | 37% | 24 |
| > 1 | 16% | 6 |




**Number of rock falls at set locations about main gate goaf edge / depth of cover, (MSEC)**




**Number of rock falls at set locations about main gate goaf edge / panel width, (MSEC)**

This plot indicates that 10% of the rock falls fell outside the mined panel, i.e. over the previously mined panel, chain pillar, or over solid unmined coal areas, 60% of the rock falls occurred within the range 0.1 to 0.5 times the depth of cover and 24% were observed between 0.5 and 1 times the depth of cover.

This plot shows the number of rock falls at set distances from the main gate edge divided by the width of the mined panel. It shows that the most common position for the falls was in the centre of the panels;
In summary, the cliff fall frequency analyses have shown that;

- 96% of the falls occurred over the mined panels, or 4% fell over unmined solid coal areas beyond the main gate, and 60% fell between the range of 0 to 0.5 times the depth of cover inside the mined panel from the nearest goal edge
- the most common fall position was 0.25 to 0.35 times the depth of cover inside the mined panel from the goal edge, which corresponds to the point of inflection, i.e. where tilt and horizontal movement are a maximum.

It was also concluded that the likelihood of a rock fall would be four to ten times greater if the cliff face is located near the point of inflection (*where the horizontal movements are greatest*) than if it was located over the main gate or tail gate chain pillars.

A review was undertaken of those few falls that were observed beyond the solid goaf edges, i.e. outside the sides of the mined panels. The table below identifies these falls and detailed notes are provided on the circumstances of each fall. It can be noticed that only one small fall occurred over solid unmined coal and that fall was the smallest being classified as insignificant. Some of these falls occurred at natural joints or at major fault zones and many occurred over development headings or first workings.

| FALL No. & SIZE | FALL LOCATION | NOTES |
|---|---|---|
| AP18 (Medium) | Over chain pillars and development headings of Longwall 9 at Angus Place Colliery. | This fall was one of the few that has occurred off an existing natural joint. The exposed surface of this rock fall showed the joint was filled with soil and tree roots. |
| AP26 (Insignificant) | Over the then solid coal of longwall 10 when longwall 9 was mined, i.e. beyond the development headings of longwall 9 at Angus Place Colliery | This was a very small rock fall occurring when a surface tension crack, which commonly occurs beyond the extracted panel at Angus Place Colliery, ran through small cliff at the head of a V shaped valley. |
| AP29 and AP30 (Medium) | These falls occurred next to each other over the development headings of Longwall 11 at Angus Place Colliery. | Both falls occurred when a surface tension crack ran onto a cliff line that was orientated parallel to the mining direction. |
| H1 (Medium) | Between extensive 'total extraction' panels of Huntley and Avon Collieries. | Although no detailed location survey has been undertaken, it appears that the fall occurred over first workings and near the barrier pillar. |
| D1 (Major) | Between extensive 'total extraction' panels of Dombarton and Nebo Collieries, where a major fault, intersected an escarpment. | Although the workings under this fall were not 'totally extracted', most pillars were split in varying degrees. |
| NN2 and NN3 (Medium) | Over 'first workings' in the Nattai North Colliery. | Also located above the car parking area of the colliery pit entrance. |
| NN17 and NN18 (Medium) | Over 'first workings' in the Nattai North Colliery. | These falls occurred soon after mining. After continuing secondary falls these became part of the largest mining-induced rock fall. |

### B.2.7 Location of falls with respect to the commencing, travelling or finishing ends of panels

Rock fall locations were also recorded with respect to the panel starting and finishing ribs to assess if there is a particular location where most falls occur. Only 7% of the falls occurred over solid unmined coal areas beyond the sides or longitudinal ends of the panels.

It is also interesting to note that during the NERRDC funded monitoring study of mining induced cliff falls at Baal Bone Colliery (Kay, 1991), no cliff falls were monitored to fall beyond the commencing, travelling or finishing ends of panels. However, many falls have been observed at other mines, as has been discussed in the previous MSEC mining induced cliff impact assessment reports and detailed in the following table.

| ROCK FALL NUMBER | FALL LOCATION | NOTES |
|---|---|---|
| AP33 and 34 (Minor & Medium) | Over chain pillars and starting development headings of Longwall 2 at Angus Place Colliery. | No detailed location survey has been undertaken. The cliff line is orientated parallel to the direction of mining. |
| AP35 (Minor) | Over solid coal, i.e. beyond the mined panel and starting development headings of Longwall 2 at Angus Place Colliery. | No detailed location survey has been undertaken. The cliff line is orientated parallel to the direction of mining. |
| AP37 (Minor) | Over chain pillars and starting development headings of Longwall 1 at Angus Place Colliery. | No detailed location survey has been undertaken. The cliff line is orientated parallel to the direction of mining. |
| H1 (Medium) | Between extensive 'total extraction' panels of Huntley and Avon Collieries. | Although no detailed location survey has been undertaken, it appears that the fall occurred over first workings and near the barrier pillar. |
| D1 (Major) | Between extensive 'total extraction' panels of Dombarton and Nebo Collieries, where a major fault, intersected an escarpment. | Although the workings under this fall were not 'totally extracted', most pillars were split in varying degrees. |
| NN2 and NN3 (Medium) | Over 'first workings' in the Nattai North Colliery. | Also located above the car parking area of the colliery pit entrance. |
| NN17 and NN18 (Medium) | Over 'first workings' in the Nattai North Colliery. | These falls occurred soon after mining. After continuing secondary falls these became part of the largest mining-induced rock fall. |

### B.2.8 Direction of and rate of mining

When mining approached a cliff line from the valley side, it was appreciated that the base of the cliff was subsided first causing the cliff face to tilt forward towards the valley, and when mining approached from the plateau side, the top or back of the cliff was subsided first causing the cliff face to be tilted back from the valley. Accordingly, it has been long thought that mining towards a cliff from the plateau side would cause less rock fall damage than mining from the valley side.

It had also been proposed that less conservative angles of protection need be specified if mining approaches from the plateau side. To test this hypothesis the direction of mining for each cliff fall was entered into the data base.

However, it was found that 52% of the cliff falls resulted from plateau to valley mining, 36% resulted from valley to plateau mining and 12% followed mining parallel to the cliff line and the following table presents further data. In summary these statistics indicate that the direction of mining approach did not significantly influence the number, size or location of rock falls.

| | Valley-plateau | Parallel | Plateau-valley |
|---|---|---|---|
| No. of observed rock falls | 22 | 9 | 36 |
| No. of cliff lines undermined | 4 | | 5 |
| No. of rock falls per cliff line | 6 | | 7 |
| Total length of cliff lines undermined | 4270m | 1260m | 9110m |
| Observed falls per 1000 metres undermined | 5.15 | 7.15 | 3.95 |
| Total width of rock falls | 249m | 69m | 336m |
| Percentage of cliff line length damaged | 5.8% | 5.5% | 3.7% |
| Average size of rock falls | $196m^3$ | | $145m^3$ |
| Average location of falls w.r.t. the goaf edge / depth of cover | 0.29 | | 0.30 |
| Average location of falls w.r.t. the longwall face / depth of cover | 0.59 | | 0.93 |

Although it is understood that increased rates of mining can reduce the impacts of subsidence on surface development, the data that was gathered on the influence of the rate of mining on cliff falls was not sufficient to assess whether this potential variable contributes towards cliff falls.

### B.2.9 Extent of mining

Fewer rock falls were noticed over first working and narrow partial mining areas with stable pillars than over total extraction or longwall areas. The successful operations over the past decades at Clarence Colliery highlight this.

Many falls have been observed over mined wide longwall panels where the mining induced subsidence movements were high and fewer falls have been observed beyond the goaf edges, particularly where the subsidence ground movements were low.

Accordingly, it was likely that the extent of mining and the extent of the induced subsidence ground movements influenced the possibility of rock falls and hence data on the extent of mining and the extent of cliff line damage was gathered to quantify the effect.

In order to quantify the extent of damage further use has been made of the percentage calculations, that were discussed in Section B.2.8.

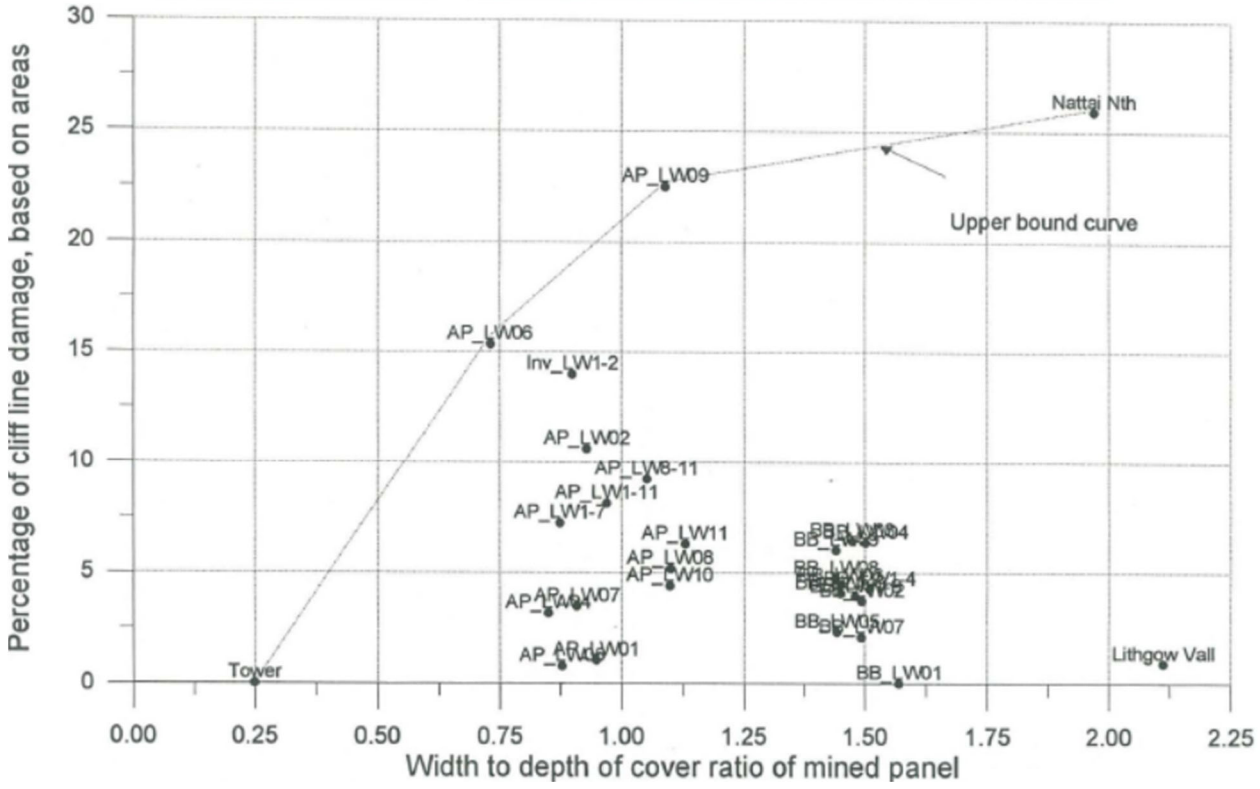
The percentages of cliff line damage were determined by dividing the total cross sectional area of rock falls within a longwall panel, groups of panels, or colliery by the total areas of undermined cliffs within these areas.

These percentage of cliff damage, based on area of falls divided by the undermined cliff area, present a better overview of the extent of damage than other indicators such as the number of rock fall incidents over a mined panel.

This 'panel by panel' percentage damage data is represented in the table and Figure below to also show the percentage of cliff damage versus the width to height ratio of the panel mined. The width to height ratio of the single panel below the relevant cliff faces has been chosen as an approximate indicator of the extent of mining because as

the width to height ratio increases up to a limit, called supercritical subsidence conditions, the magnitude of subsidence movements generally increases.

| Panel no or Groups of panels | Total length of cliffs mined (m) | Total areas of rock falls (sq.m.) | No. of rock falls in panels | % damaged based on fall areas | Average Width to Depth ratio of single panel at cliff base |
|---|---|---|---|---|---|
| AP_LW01 | 400 | 117 | 4 | 1.06 | 0.95 |
| AP_LW02 | 420 | 929 | 6 | 10.62 | 0.93 |
| AP_LW04 | 440 | 248 | 6 | 3.19 | 0.85 |
| AP_LW05 | 650 | 67 | 4 | 0.79 | 0.88 |
| AP_LW06 | 650 | 3986 | 5 | 15.33 | 0.73 |
| AP_LW07 | 980 | 914 | 9 | 3.50 | 0.91 |
| AP_LW08 | 910 | 909 | 7 | 5.18 | 1.10 |
| AP_LW09 | 900 | 4194 | 13 | 22.52 | 1.09 |
| AP_LW10 | 740 | 1146 | 2 | 4.42 | 1.10 |
| AP_LW11 | 730 | 1950 | 2 | 6.29 | 1.13 |
| BB_LW01 | 1180 | 12 | 1 | 0.03 | 1.57 |
| BB_LW02 | 1220 | 1318 | 4 | 3.76 | 1.49 |
| BB_LW03 | 1550 | 1934 | 8 | 6.44 | 1.47 |
| BB_LW04 | 1320 | 2265 | 5 | 6.36 | 1.50 |
| BB_LW05 | 2050 | 1135 | 15 | 2.35 | 1.44 |
| BB_LW06 | 2250 | 2811 | 42 | 4.45 | 1.45 |
| BB_LW07 | 1830 | 1011 | 12 | 2.10 | 1.49 |
| BB_LW08 | 1330 | 1285 | 17 | 4.75 | 1.44 |
| BB_LW09 | 1910 | 2948 | 23 | 6.03 | 1.44 |
| AP_LW1-7 | 3540 | 6261 | 34 | 7.22 | 0.87 |
| AP_LW8-11 | 3280 | 7053 | 24 | 9.23 | 1.05 |
| AP_LW1-11 | 6820 | 13314 | 58 | 8.13 | 1.93 |
| BB_LW1-4 | 5270 | 5529 | 18 | 4.28 | 1.51 |
| BB_LW5-9 | 8780 | 9190 | 109 | 4.10 | 1.45 |
| BB_LW1-9 | 14640 | 14719 | 127 | 3.96 | 1.45 |
| Lithgow Valley | 4400 | 2250 | 5 | 0.91 | 2.11 |
| Nattai Nth | 4600 | 216000 | 16 | 25.91 | 1.97 |
| Tower | 1500 | 10 | 1 | 0.03 | 0.25 |
| Inv_LW1-2 | 150 | 210 | 1 | 14.00 | 0.90 |



**Influence of width to depth ratio of mined panel on damage percentage, (MSEC)**

It is known that the width to height ratio of the single panel, by itself, does not accurately indicate the likely magnitude of subsidence movements at the cliff face, as other factors including the overall width of all adjacent mined panels, the width of the chain pillars and seam thickness mined, have to also be considered.

However it has been observed that, at cliff lines in the Western Coalfields, the depth of cover in the valley areas at the base of the cliffs is relatively shallow, ( averaging approximately 120 m ), and the width of the chain pillars between the successive longwall panels is relatively wide, ( averaging 30 m ), to the effect that generally the subsidence profiles from adjacent panels do not significantly interact.

Accordingly, in this situation the width to depth ratio of the single panel does give a reasonable indication of the extent of mining. Although the plot above confirms that the percentage of cliff damage increased with increasing W/H ratio, which indicates that the extent of mining is an influence on the likelihood of cliff falls. The wide scatter in the results, i.e. below the dashed upper bound curve, would be a result of the influence of the other factors that are discussed in this report.

### B.2.10 Minimum threshold of ground movements initiating falls at Baal Bone Colliery

It was not possible to have surveyors in the field all the time whilst the cliffs were being undermined and most collapses occurred in between the surveyor's site visits. Accordingly, an element of judgement was required in interpolating between the available monitoring data of the survey 'just before' the cliff fell and the monitoring data of the survey 'just after' the cliff fell.

The sixteen cliff falls that fell at the lowest subsidence values during the Baal Bone monitoring study were examined more closely to determine what was the minimum threshold subsidence level at the time of the cliff collapse. Details for these falls are presented in table below.

The minimum observed subsidence at the cliff face just after a cliff fell was 63 mm for rock fall BB30, closely followed by falls BB42 and BB8 that fell when subsidence of 72 mm and 75 mm were observed at those cliff face sites. Although, these three cliffs are located in the centre of the panel and over the chain pillars, two fell due to mining in the plateau to valley direction and one fell when the valley was undermined first.
After studying the data in the above table it is inferred that, at the time of the monitored Baal Bone rock falls, the minimum vertical subsidence movement;

- at the rock fall sites was 63 mm,
- in the valley in front of the rock fall sites was 150 mm, and
- on the plateau above the rock fall sites was 136 mm.

The minimum horizontal movement ( parallel to the direction of mining) at a cliff that was observed 'just after' a cliff fall was 10 mm for rock fall BB42, closely followed by falls BB37 and BB11 that fell when 14 and 16 mm of movement was observed.

| Cliff Fall No. | Fall Location Dist. from Goaf Edge (g/h) | Mining Direction | Subs. Range at Cliff (mm) | Tensile Strain Range at Cliff (mm/m) | Compress. Strain Range at Cliff (mm/m) | Tilt Range at Cliff (mm/m) | Horiz. Movement Parallel to Mining at Cliff (mm) | Horiz. Movement Perpend. to Mining at Cliff (mm) |
|---|---|---|---|---|---|---|---|---|
| 42 | -0.11 | plat.-to-valley | 72-100 | -2.6 to -2.7 | | 6.7 to 6.9 | -10 to -36 | 56 to 62 |
| 8 | 0 | plat.-to-valley | 78-84 | | 4.7 to 5.3 | 5.5 to 7.8 | -130 to 170 | 160 to 170 |
| 44 | 0.06 | plat.-to-valley | 87-219 | -4.7 to -5.4 | 0.5 to 0.7 | 4.2 to 11.5 | -34 to -130 | -34 to -51 |
| 7 | 0.10 | plat.-to-valley | 150-230 | -0.3 | 2.2 to 5.3 | 6.9 to 7.8 | -90 to -130 | 120 to 190 |
| 16 | 0.11 | valley-to-plat. | 50-120 | -1.9 | | 11.6 | -39 to 60 | -12 to -90 |
| 58 | 0.14 | plat.-to-valley | 7-150 | -0.2 to -3.0 | 0.6 to 2.6 | 0.6 to 11.8 | 5 to -89 | -2 to 137 |
| 62 | 0.16 | plat.-to-valley | 25-95 | -0.1 to -0.2 | 0.7 to 2.1 | 2.1 to 8.3 | -110 to -220 | 38 to 140 |
| 63 | 0.21 | valley-to-plat. | 28-350 | -0.4 to -0.6 | 1.2 to 2.9 | 5.3 to 5.6 | 35 to 118 | 1 to 577 |
| 10 | 0.22 | plat.-to-valley | 150-300 | -3.5 to -9.8 | 2.4 to 6.8 | 11.1 to 12.5 | -100 to -215 | 185 to 345 |
| 54 | 0.26 | plat.-to-valley | 200-240 | -2.2 to -3 | 0.5 | 4.2 to 9.9 | -70 to -90 | 160 to 240 |
| 15 | 0.29 | valley-to-plat. | 18-150 | -1.2 to -2.1 | 2.2 to 10.9 | 8.2 | -1 to 200 | -95 to -105 |
| 53 | 0.34 | plat.-to-valley | 220-250 | -2.2 to -3 | 0.5 | 4.2 to 9.9 | -80 to -100 | 170 to 250 |
| 30 | 0.38 | valley-to-plat. | 48-63 | -0.1 to -8.8 | 0.1 to 0.7 | 5.3 to 19.9 | 62 to 79 | 43 to 69 |
| 41 | 0.43 | valley-to-plat. | 100-112 | -0.4 to -8.8 | 1.2 | 5.3 to 19.9 | 61 to 83 | 36 to 68 |
| 31 | 0.47 | valley-to-plat. | 136-177 | -1.1 to -5.5 | 0.2 to 1 | 5.3 to 15.8 | 64 to 88 | 32 to 68 |
| 57 | 0.71 | plat.-to-valley | 32-187 | -1.3 to -8.2 | 4.3 to 11.9 | 16.8 to 17.5 | -30 to -62 | -84 to -133 |

The smallest maximum strains observed at near or around these rock fall sites "just before" the fall in the valley to plateau case was 0.5 mm/m at Fall BB63 and, in the plateau to valley case, Fall BB58 was the smallest maximum observed strain at 0.6 mm/m. Both these sites are located near chain pillars. "Just after" the falls the smallest maximum strains observed around these rock fall sites in the plateau to valley case was 0.7 mm/m at Falls BB59, BB60, BB61 and BB62. and 2.9 mm/m at Fall BB63 and in the valley to plateau case.

The smallest maximum tilts observed around these rock fall sites "just before" for those rock fall sites that were mined in the valley first was 0.24 mm/m at Fall BB28 and 0.6 mm/m for Fall BB58, which was undermined on the plateau side of the cliff first. Both these rock fall sites are located over the chain pillar. "Just after" the falls the smallest maximum tilts observed around these rock fall sites in the valley to plateau case was also 0.24 mm/m but this time at Fall 13 and 1.7 mm/m at Fall BB39 for the plateau to valley case. Both these sites were in the central area of the panel.

Regardless of these relatively low subsidence, tilts and strains measured at, near or around the cliffs when they fell, it should be remembered that much higher subsidence parameters were being measured over the goafed areas. It should also be remembered that at cliffs over the Clarence Colliery, where subsidence over the mined panels was limited to 100mm, no cliff falls were observed when the subsidence over those panels was measured to be up to 70mm. Perhaps the subsidence over the panel is more important than the subsidence at, near or around the cliffs.

### B.2.11 Surface cracking near falls

At 59 out of the 67 rock fall sites that were monitored at Baal Bone surface cracks could be seen in the exposed plateau rock near the cliff face running towards the rock fall site. This proportion represented 88% of the observed rock falls.

Accordingly, there appears to be a high correlation between the presence of surface cracks near the cliff line and rock falls so data was entered into the database on the distance from the edge of the rock fall to the nearest surface crack. The table below presents the resulting data and shows 164 cases out of the 181 falls for which data is available, i.e. 91 %, a surface crack was observed running through the rock fall. The falls that did not have surface cracks running through them ranged in size from "insignificant" to "minor" in classification.

| Distance from edge of rock fall to nearest surface crack in plateau region (m) | Number of rock falls within distances ranges | Percentage of observed rock falls with distances ranges |
|---|---|---|
| 0 | 164 | 91% |
| 0 to 5 | 1 | 1% |
| 6 to 10 | 10 | 5% |
| 11 to 15 | 2 | 1% |
| 16 to 20 | 4 | 2% |

In summary there is a high correlation between the presence of mining induced surface cracks and rock falls. It is therefore deduced that surface cracking is an important factor influencing the probability of rock falls. If the extent of mining can be reduced so that there are no surface cracks then there could be few rock falls.

## B.3 Conclusions from Review of Cliff Fall Data Base & Review of Factors Influencing Rock Falls

The prediction of impacts to cliffs resulting from coal panel extraction is considered to be extremely difficult.

The ACARP 2002 method, that was prepared by Waddington Kay & Associates (now MSEC), is the only available published prediction method for cliff impact assessments. It is recognised that the upper bound empirically derived curves in the ACARP 2002 model produces conservative results for percentages of impacted cliff length, or cliff area. It should however be used with due consideration of the potential limitations and conservative nature of the method. In particular, it should be noted that the ACARP 2002 method does not take into account;

- the proximity of cliffs located outside panels (i.e. the method will produce an impact percentage for cliffs beyond the edges of an extracted panel even when predicted subsidence parameters beyond the goad edges are much lower than the over the panel ),
- the length of the cliff line, because no allowance was made in the calculations for the observations from a large database of observed rock fall information that no rock falls have been observed from cliff lines, terraces or rock outcrops where the length of the cliff is less than 30 metres and 80% of the observed rock falls occurred at cliff lines that were longer than 60 metres.
- a fall frequency analyses was undertaken, using our data base of all known cliff impacts, to find the number of rock falls occurring within set positions from the various goaf edges. The larger cliff fall sites were counted wherever the falls were located within the set distances from the goaf edges. Hence, the larger falls were included within several of the distance ranges, whilst, the smaller rock falls may have only been counted once, i.e. in the one position relative to the goaf edge. This review showed that:
  - 96% of all the observed cliff falls occurred over the mined panels,
  - 60% of all the observed cliff falls fell between the range 0.1 to 0.5 times the depth of cover inside the mined panel from the nearest goal edge,
  - the most common cliff fall position was 0.25 to 0.35 times the depth of cover inside the mined panel, which corresponds to the point of inflection, i.e. where tilt and horizontal movement are a maximum.
  - 4% of all cliff falls have been observed over and beyond the main gate or solid coal goal edge.

  Lower fall frequency percentages would have occur if each fall was counted at its centre as the above review purposefully counted larger falls several times within differing set distances from the goaf edges. Nevertheless, the important observation is that few mining induced falls have occurred over solid, unmined coal areas, especially if the cliffs are isolated and short in length. That is, if the cliffs, minor cliffs and cliff terraces are not continuous massive units and each small rock formation is free to move independently as individual cliff features, then, the probability of rock falls is significantly lower than if the cliff lines had been long continuous rigid structures. Being isolated small rock outcrops, these cliffs are able to move independently with the travelling subsidence wave as it passes along the cliffs with significantly lower impacts.

Almost all of the mining-induced cliff falls that were found in the literature review have resulted from longwall extraction or total extraction that caused high levels of subsidence, tilt and strains over the mined panels, (i.e. with Smax greater than 1,000mm), and high levels of subsidence at the cliffs. No cliff falls were observed at Clarence Mine where subsidence was limited to less than 100mm.

Studies and analyses of the factors that appear to be influencing the likelihood of mining induced cliff falls usually include a factor relating to the existing stability of the cliff face. Factors such as the height of the cliff, degree of undercutting, presence of cave features, particularly where creeks flow over the cliff line in a curved re-entrant cave have been identified, etc. are all seen to cause more impacts than plan small and short cliffs. Natural cliff falls are regularly recorded and the rates of natural weathering of cliff lines and waterfalls etc. have been determined in cases where extensive records are available. Natural weathering and erosion processes at cliffs often causes regular natural rock falls off cliffs, usually after a period of heavy rainfall. Since some rock falls at cliffs may be about to occur naturally, it is not possible to design a mine layout near a cliff that provides total protection from all cliff impacts - as rock falls can occur naturally every few years.

This revised review of the available cliff fall data and monitoring data at cliffs highlights the main factors that are found to be influencing the likelihood of cliff falls are the:

- **natural instability of the cliff**; (rock falls can occur naturally every 3-4 years);
- **extent of the cliff line** (no falls where cliff lines of widths are less than 30m in length. i.e. not one of the rock falls occurred off a cliff face that could have been described as a single isolated pagoda;
- **increased levels of subsidence ground movements**, (no falls observed at Clarence where the maximum subsidence at the cliffs and over the mined panels was less than 100 mm); and the
- **presence of mining induced surface cracking at the cliff face. (**88% of the observed rock falls that were monitored in a major rock fall monitoring study had mining induced surface cracks running across the exposed plateau rock at the rock fall site).

Hence, these reviews of coal mining-induced cliff impact assessment studies have confirmed that, where low levels of subsidence movements of less than 100mm were experienced over the mined panels and at cliffs, then, no cliff damage was observed; especially when these low levels of subsidence caused no surface cracks near the cliff lines. (*That is, far less rock falls are observed from cliff lines over narrow panels or mini walls with stable pillars and with no mining induced surface cracks than have been observed above wide panels or longwalls*).

# BASELINE BIODIVERSITY REPORT

## MW17-19 EP Area and CLZ (ML1814) EP Area

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2
01 February 2023

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## Document status

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## Approval for issue

Mark Aitkens 26 September 2022

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**Prepared by:**

**RPS**

Tara Boreham
Ecologist

Unit 2A, 45 Fitzroy Street
Carrington NSW 2294

T +61 2 4940 4200
E tara.boreham@rpsgroup.com.au

**Prepared for:**

**Centennial Airly Pty Ltd**

Sam Price
Environmental and Community Coordinator

Glen Davis Road
Capertee NSW 2846

T +61 2 6359 2108
E sam.price@centennialcoal.com.au

# EXECUTIVE SUMMMARY

This Baseline Biodiversity Report characterises the existing biodiversity values within areas subject to future underground coal mining, these being the MW17-19 Extraction Plan (EP) area and the Cliff Line Zone (CLZ) EP area within Mining Lease (ML) 1331 and 1814. Emphasis is placed on the presence or likelihood of threatened species, populations, and ecological communities (or their habitats) occurring within the EP areas as listed under the NSW *Biodiversity Conservation Act* 2016 (BC Act), *Fisheries Management Act 1994* (FM Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

This baseline assessment has informed the subsidence and environmental risk assessment for these EP areas, as well as the relevant management and monitoring measures to be included in the EP and associated Biodiversity Monitoring Plans (BMPs). Potential mining induced impacts and management measures will be addressed in each EP and associated BMP.

**Landscape context**

The EP areas are within the Capertee Uplands of the South Eastern Highlands Interim Biogeographic Regionalisation for Australia, and is within the Mugii Murum-ban State Conservation Area. Connectivity through the Greater Blue Mountains World Heritage Area is provided through the Gardens of Stone National Park to the south and Capertee National Park to the north. The study area contains diverse geological and geomorphological features, such as pagoda rock formations and precipitous sandstone escarpments with elevations of above 1000m.

The underlying geology of the study area comprises Narrabeen Group—fine-grained lithic sandstone occasionally interbedded with thin shale lenses. The EP areas span four soil landscapes with ridgetops predominately ‘Warragamba’ and ‘Wollangambe’ soil landscapes, with isolated patches of basalt influence within “Mount Tomah’ soil landscape. Lower elevations consist of ‘Hassans Walls’ soil landscape. The EP area forms a part of the Capertee River sub-catchment with several first, second and third order drainage lines which flow into the main tributary of Genowlan Creek which is predominately fed by rainfall based flows. However, rainfall is held in the Quaternary strata and released slowly into the reaches of Genowlan Creek above the Grotto and the Oasis areas. Flows through the Oasis are constant and are considered a component of baseflow (GHD 2014).

**Biodiversity values**

Broadscale vegetation types occurring in the EP areas include dry sclerophyll forest, wet sclerophyll forest and heath with finer scale mapping identifying the presence of at least 12 plant community types (PCTs). Sensitive biodiversity features within the EP areas include:

- Sensitive landscape features;
- Threatened Ecological Communities (TECs);
- Facultative Ecosystems;
- Threatened flora; and
- Threatened fauna.

Vegetation by EP area is further described as follows.

## MW17-19 EP area

The vegetation predominately consists of PCTs 3865, 3686 and 3695 which are heath communities and open forests typical of ridgetops. No TECs occur within this EP area.

No GDEs have been identified within the EP Area (GHD 2014). One facultative ecosystem may occur within the gullies on the edges of the EP area, this being vegetation described as Western Blue Mountains Monkey Gum Gully Forest (PCT 3495), which occurs along moist gullies. This vegetation is identified as a ‘Facultative Ecosystem’ as it is unlikely to be entirely dependent on groundwater resources, and may rely on groundwater on a seasonal basis or only during extended drought periods (Serov et al 2012; RPS 2014).

One threatened flora species is known to occur within this EP area. *Prostanthera stricta* (Mount Vincent Mint Bush; BC Act: Vulnerable; EPBC Act: Vulnerable).

One threatened fauna species is persistent within the EP area. The Glossy Black-Cockatoo (*Calyptorhynchus lathami*; BC Act: Vulnerable), frequents the area feeding on abundant stands of *Allocasuarina* species.

Other mobile threatened fauna species particularly woodland birds, microbats, reptiles and arboreal mammals would utilise the habitat features within the area. Key habitat features include:

- Sandstone habitats: pagodas, steeps cliffs and escarpments, rocky outcrops or piles of sandstone boulders, caves, crevices and ledges for microbats and reptiles such as the Broad-headed Snake (*Hoplocephalus bungaroides;* BC Act: Endangered; EPBC Act: Vulnerable) and Rosenburg's Goanna (*Varanus rosenbergi;* BC Act: Vulnerable);
- Flowering and fruiting plants: utilised as foraging habitat for woodland birds and mammals such as the Flame Robin (*Petroica phoenicea*; BC Act: Vulnerable), the Gang-gang Cockatoo (*Callocephalon fimbriatum*; BC Act Vulnerable; EPBC Act: Endangered) and the Greater Glider (*Petauroides volans*; EPBC Act: Endangered);
- *Allocasuarina* species: for foraging Glossy Black-Cockatoos (*Calyptorhynchus lathami*; BC Act: Vulnerable); and
- Koala feed trees: within woodland vegetation including *Eucalyptus cypellocarpa, Eucalyptus piperita* and *E. punctata*.

**Implications for mining and recommendations**

Approvals for Panel and Pillar Mining within MW17-19 EP area are based on predicted surface subsidence levels of up to 100-125mm (Centennial 2021). Based on this mine design, the proposed MW17-19 EP area is unlikely to have negative implications on the aforementioned key biodiversity feature.

During the 2022 monitoring programme across the Mining Lease Area, the following baseline monitoring was conducted:

- Continued monitoring of threatened species and their habitats;
- Additional *Prostanthera stricta* monitoring transects established within the EP Area; and
- Additional glossy black-cockatoo monitoring be established within the EP area.

## CLZ EP area

The CLZ EP area contains sensitive landscape features including the deeply incised gorges named the Grotto and Oasis which forms a tributary of the Genowlan Creek.

**Vegetation communities**

The vegetation varies from PCT 3686, 3695 and 3865 along ridgetop cliff edges, to PCT 3226 and 3495 within the gullies. One TEC occurs within this EP area. PCT 3859 within the study area forms a part of the Genowlan Point *Allocasuarina nana* Heathland EEC listed under the BC Act.

No high priority GDEs have been identified within the study area, although there is potential for facultative ecosystems existing as moist sheltered gully forests or along creek lines (RPS 2014; GHD 2017). PCTs association with facultative ecosystems include the following:

- 3226: Western Blue Mountains Montane Wet Fern Forest;
- 3495: Western Blue Mountains Monkey Gum Gully Forest; and
- 3731: Capertee Conglomerate Grey Gum-Stringybark Forest.

**Threatened flora**

Two threatened flora species are known to occur within the CLZ EP area (**Figure 3-8)**:

- *Prostanthera stricta* (Mount Vincent Mint Bush; BC Act: Vulnerable; EPBC Act: Vulnerable); and
- *Pultenaea sp*. Genowlan Point (BC Act: Critically Endangered; EPBC Act: Critically Endangered).

**Threatened fauna**

Threatened fauna utilise the diverse habitats of the CLZ EP area including diurnal bird species, forest owls, mammals, microbats and reptiles. Key habitats for threatened fauna within. the CLZ EP area include:

- Sandstone habitats: pagodas, steeps cliffs and escarpments, rocky outcrops or piles of sandstone boulders, caves, crevices and ledges for microbats and reptiles such as the Broad-headed Snake (*Hoplocephalus bungaroides;* BC Act: Endangered; EPBC Act: Vulnerable) and Rosenburg's Goanna (*Varanus rosenbergi;* BC Act: Vulnerable);
- Hollow-bearing trees: are known to be common within the EP area and surrounds and include a diversity of eucalypt species of various ages. Smaller trees of woodland communities typically support smaller trunk and branch hollows whereas forest communities in sheltered gullies around the Grotto, support large trees and large branch hollows.
- Aquatic habitats: in the form of ephemeral first, second and third order creek lines which flow into the main tributary of Genowlan Creek then on into the Capertee River. These habitats may offer habitat to frogs such as the threatened *Heleioporus australiacus* (Giant Burrowing Frog), *Mixophyes iteratus* (Giant Barred Frog) and *Pseudophryne australis* (Red-crowned Toadlet).
- Flowering and fruiting plants: utilised as foraging habitat for woodland birds and mammals such as the Flame Robin (*Petroica phoenicea*; BC Act: Vulnerable), the Gang-gang Cockatoo (*Callocephalon fimbriatum*; BC Act Vulnerable; EPBC Act: Endangered) and the Greater Gliders (*Petauroides Volans*; EPBC Act: Endangered);
- *Allocasuarina* species: for foraging Glossy Black-Cockatoos (*Calyptorhynchus lathami*; BC Act: Vulnerable); and
- Koala feed trees: within woodland vegetation including *Eucalyptus cypellocarpa, Eucalyptus piperita* and *E. punctata*.

**Implications for mining and recommendations**

The CLZ EP area intersects with many sensitive landscape features restricted to the Genowlan Point area including:

- *Pultenaea sp*. Genowlan Point (BC Act: Critically Endangered; EPBC Act: Critically Endangered);
- Genowlan Point *Allocasuarina nana* Heathland EEC; and
- The Grotto;
- Facultative ecosystems (GDEs).

The CLZ EP area is restricted to first workings only. The subsidence assessment of the CLZ ML1331 Extraction Plan (Centennial 2017) states that "no surface impacts would be expected at these levels of subsidence. Specifically, no surface impacts would be expected to cliff lines, pagodas and steep slopes at these negligeable levels of subsidence". However, repeatable and measurable monitoring should continue, or be established. It is to note that monitoring of *Pultenaea* sp. Genowlan Point and Genowlan Point *Allocasuarina* nana Heathland EEC is carried out by NPWS.

During the 2022 monitoring programme across the Mining Lease Area, the following baseline monitoring was conducted:

- Continued monitoring of threatened species and their habitats;
- Biodiversity monitoring within facultative ecosystems, with a focus on the Grotto habitat following a Before After Control Impact design where feasible; and
- Additional *Prostanthera stricta* monitoring transects established within the EP Area.

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# 1 INTRODUCTION

## 1.1 Background

RPS was engaged by Centennial Airly Pty Ltd (Centennial Airly) to provide a Baseline Biodiversity Report to accompany the Extraction Plan (EP) and Biodiversity Management Plan (BMP) for two EP areas; the Cliff Line Zone (CLZ) within Mining Lease (ML)1814 and the MW17-19 EP areas (hereafter referred to as the study area).

Airly Mine operates an approved coal mining lease (SSD_5581) to extract thermal coal at Mount Airly, Point Hatteras and Genowlan Mountains, which form part of the Mugii Murum-ban State Conservation Area (SCA). Centennial Airly is the operator of the mine and is a wholly owned subsidiary of Centennial Pty Limited. Airly Mine currently holds two leases (Mining Lease ML1331 and ML1814), which together covers about 3,980 ha (**Figure 1-1**).

## 1.2 Objectives and scope

The aim of this Baseline Biodiversity Report is to characterise the biodiversity values within CLZ EP area and the MW17-19 EP area (see **Figure 1-1**), with emphasis on identifying entities that may be sensitive to mining induced change. The findings of this Baseline Biodiversity Report would inform the subsidence and environmental risk assessment for the study area, as well as the relevant management and monitoring measures to be included in the corresponding EPs and BMPs.

The scope of this report is to:

- Undertake a desktop review of databases, reports, aerial imagery, vegetation and habitat mapping relevant to the study area;
- Identify and map existing vegetation communities including any threatened ecological communities (TECs);
- Describe key fauna habitat values of the EP area;
- Determine the presence or likely occurrence of threatened entities [species, populations and ecological communities (or their habitats)] occurring within the study area, as listed under the NSW *Biodiversity Conservation Act* 2016 (BC Act);
- Determine the presence or likely occurrence of threatened entities [species, populations and ecological communities (or their habitats)] occurring within the study area, as listed under the *Fisheries Management Act 1994* (FM Act); and
- Determine the presence or likely occurrence of threatened entities and other matters of national environmental significance [i.e. species, migratory species, ecological communities (or their habitats)) as listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act); Matters of National Environmental Significance (MNES)].

## 1.3 Study area

The study area consists of the two proposed EP areas (see **Table 1-1**) located on Genowlan Mountain and Genowlan Point situated on the northern fringe of the Western Coalfields. It is about 40 km north-west of Lithgow and 4 km north-east of Capertee township; within the Lithgow City Local Government Area (LGA). See **Figure 1-1** for the study area context. The land is zoned as E1: National Parks and Nature Reserves under the Lithgow City Local Environment Plan (LEP).

**Table 1-1 The study area**

| EP area | Mining Lease | Area (ha) |
|---|---|---|
| CLZ | ML1814 | 211.41 |
| MW17-19 | ML1331 and ML1814 | 121.62 |
| **Total** | | |

## Legend

- Development Consent (SSD_5581)
- MW17-19 EP Area
- CLZ EP Area (ML1814)
- CLZ EP Area (ML1331)
- Second Workings
- Mining Tenements
- Workings Existing / Approved
- Proposed Workings
- Roads and Tracks

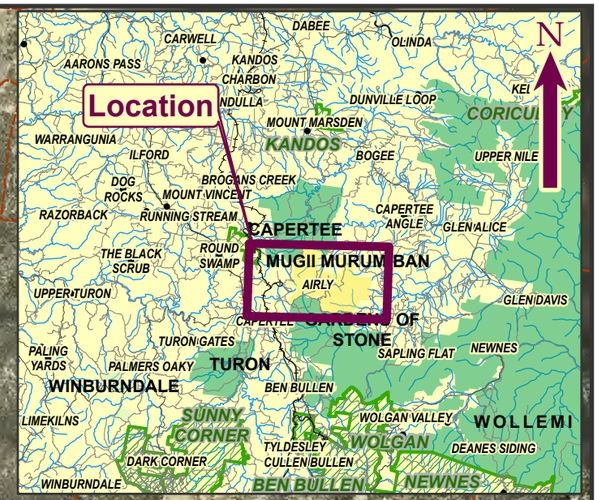




**FIGURE 1-1:**
**PROJECT AREA LOCATION**

LOCATION: **AIRLY**

VERSION: **A**
DATE EXPORTED: **26/09/2022**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m

SCALE 1:35,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial Airly**
PROJ: **PR152229**
PURPOSE: **Baseline Assessment**

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MAKING COMPLEX EASY

The study area is located entirely within the Mugii Murum-ban State Conservation Area (SCA). The Gardens of Stone National Park is located to the south and Capertee National Park to the north. The study area is typified by steep and rugged areas of pagodas, cliffs and valleys with topography ranging from 770 to 1040 m Above Sea Level (ASL). Broad habitat types within the study area include dry sclerophyll forest, wet sclerophyll forest, grassy woodlands, heath and cleared and cleared areas (DEC 2006; RPS 2014).

## 1.4 Regulatory Context

Legislation and policies relevant to the proposal is outlined in **Table 1-2**.

**Table 1-2 Relevant Legislation, Policy and Guidelines**

| Legislation, Policy and Guidelines | Comment |
|---|---|
| **Local Policy and Legislative Guidelines** | |
| *Lithgow Local Environmental Plan* 2014 | The study area has been identified as an 'Environmentally Sensitive Areas - Biodiversity' area under the *Lithgow Local Environmental Plan* 2014 (LEP). The following are to be considered:<br>• any adverse impact on the condition, ecological value and significance of the fauna and flora on the land;<br>• any adverse impact on the importance of the vegetation on the land to the habitat and survival of native fauna;<br>• any potential to fragment, disturb or diminish the biodiversity structure, function and composition of the land; and<br>• any adverse impact on the habitat elements providing connectivity on the land.<br>The study area has additionally been identified as 'Environmentally Sensitive Areas – Watercourses', 'Environmentally Sensitive Areas – Groundwater'. The following are to be considered:<br>• the water quality and flows within the watercourse;<br>• aquatic and riparian species, habitats and ecosystems of the watercourse;<br>• the stability of the bed and banks of the watercourse;<br>• the free passage of fish and other aquatic organisms within or along the watercourse;<br>• the likelihood of groundwater contamination from the development (including from any on-site storage or disposal of solid or liquid waste and chemicals);<br>• any adverse impacts the development may have on groundwater dependent ecosystems;<br>• the cumulative impact the development may have on groundwater (including impacts on nearby groundwater extraction for a potable water supply or stock water supply); and<br>• any appropriate measures proposed to avoid, minimise, or mitigate the impacts of the development. |
| **State Policy and Legislative Guidelines** | |
| *Environmental Planning and Assessment Act* 1979 | The project is a State Significant Development in accordance with Clause 8 and Schedule 1 (Item 5) of *State Environmental Planning Policy (State and Regional Development)* 2011. The Airly Mine operates under existing consent SSD_5581. |
| *Biodiversity Conservation Act* 2016 | The BC Act is administered by Department of Planning, Industry and Environment (DPE). The BC Act gives provisions to declare and protect threatened species, populations, and ecological communities with a legal threatened status in NSW. Threatened species (and populations) and ecological communities are listed in Schedules 1 and 2 of the BC Act, respectively. The BC Act also lists Key Threatening Process's (KTPs) that may threaten the survival of these threatened entities. The BC Act also introduces the Biodiversity Offsets Scheme (BOS) and Biodiversity Assessment Method (BAM). |
| *Biosecurity Act* 2015 | Prescribes the statutory requirements for managing pests, diseases, weeds and contaminants in NSW. Applies to construction activities and occupation of the Activity area. |

| Legislation, Policy and Guidelines | Comment |
|---|---|
| *Fisheries Management Act* 1994 | The FM Act provides for the identification, conservation and recovery of threatened fish, aquatic invertebrates and marine vegetation. The Act also covers the identification and management of KTPs which affect threatened species or could cause other species to become threatened. |
| *State Environmental Planning Policy (Resources and Energy) 2021* | Airly Mine operates under the existing Development Consent Section 89E of the Environmental Planning & Assessment Act 1979, SSD_5581. As such, activities outlined in Part 2.2 of the SEPP are permissible. |
| **Commonwealth Policy and Legislative Guidelines** | |
| *Environment Protection and Biodiversity Conservation Act* 1999 | The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, defined in the EPBC Act as Matters of National Environmental Significance (MNES). The MNES protected under national environment law include:<br>• listed threatened species and communities;<br>• listed migratory species;<br>• Ramsar wetlands of international importance;<br>• Commonwealth marine environment;<br>• world heritage properties;<br>• national heritage places;<br>• the Great Barrier Reef Marine Park;<br>• nuclear actions; and<br>• a water resource, in relation to coal seam gas development and large coal mining development.<br>Under the EPBC Act, actions that have, or are likely to have, a significant impact on a MNES require approval from the Commonwealth Department of the Agriculture, Water and Environment (DAWE). |
| *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (DoE 2013) | These significant impact guidelines aid in determining if a proposed action is likely to have a significant impact on a MNES. Consideration of survey methods for specific MNES required where potential impacts are identified. |

## 1.5 Terms and definitions

| Abbreviation | Definition |
|---|---|
| Airly Mine | Current mining lease area, Mining Lease ML1331 and ML1814, which together covers about 3,980 hectares |
| API | Aerial photo interpretations |
| ASL | Above sea level |
| BACI | Before-After-Control-Impact |
| BC Act | *Biodiversity Conservation Act* 2016 |
| Centennial Airly | Centennial Airly Pty Limited |
| CMA | Catchment Management Authority |
| CMLR | Centre for Mine Land Rehabilitation |
| DCCEEW | Department of Climate Change Energy, the Environment and Water |
| DPE | Department of Primary Industries and the Environment |
| EEC | Endangered Ecological Community |
| EP&A Act | *Environmental Planning and Assessment Act* 1979 |
| EPBC Act | *Environment Protection and Biodiversity Conservation Act* 1999 |
| FM Act | *Fisheries Management Act* 1994 |
| GBMWHA | Greater Blue Mountains World Heritage Area |
| IBRA | Interim Biogeographic Regionalisation for Australia |

| Abbreviation | Definition |
|---|---|
| KTP | Key Threatening Process |
| LEP | Local Environmental Plan |
| Locality | 10 kilometre radius of the study area |
| LoOA | Likelihood of Occurrence Analysis |
| MNES | Matters of National Environmental Significance |
| NPWS | National Parks and Wildlife Service |
| Study area | The areas encompassing the CLZ and MW17-19 EP areas. See **Figure 1-1**. |
| MW | Mini Wall |
| RDP | Rapid Data Point |
| SB | Sydney Basin |
| SCA | State Conservation Area |
| TEC | Threatened Ecological Community |
| VIS | Vegetation information system |

## 1.6 Report structure

This report is divided into four sections as follows:

1. Introduction: providing project context, objective and scope, introducing the study area and regulatory framework.
2. Methods: outline the steps methods taken to conduct both the literature review and ground truthing assessment.
3. Results: detailing the outcomes of the assessment as follows:
   - Literature review consisting of
     - Landscape context (i.e. location and topography; connectivity; climate; NSW (Mitchell) Landscape; geology and soils; and hydrology); and
     - Likelihood of Occurrence Analysis (LoOA) for threatened flora, fauna and ecological communities;
   - Vegetation communities (including plant community types (PCTs) and associated TECs);
   - Threatened flora;
   - Threatened fauna; and
   - BC and EPBC Act listed KTPs identifies key threats to biodiversity relevant to the study area.
4. Summary of findings, implications for mining and recommendations.

# 2 METHODS

## 2.1 Literature review

A literature review is initially undertaken to gather available data and understand the context of the study area prior to field surveys. RPS has previously conducted extensive field surveys within and adjacent to the study area. These surveys were undertaken in compliance with the Airly Biodiversity Management Plan (required by consent condition 15, Schedule 4 of SSD-5581; delivered by RPS since 2015). Surveys undertaken include threatened flora and fauna surveys, vegetation mapping and ongoing seasonal monitoring of sensitive ecological receivers.

Monitoring within the Airly Development Consent Area was developed by the Centre for Mine Land Rehabilitation (CMLR) and was commenced in 2012 by the University of Queensland (UQ). The monitoring methods were based on a Before-After-Control-Impact (BACI) approach and have been varied by RPS where necessary to reflect operational circumstances.

To inform this report, a desktop assessment was undertaken considering the biodiversity dataset collected within the Project as part of the ongoing monitoring by RPS. Internal RPS documents reviewed, informing all aspects of the study include:

- 2012-2013 Flora and Fauna Baseline Survey Report (RPS 2013);
- 2012-2014 Flora and Fauna Baseline Survey Report (RPS 2014a);
- Airly Mine Extension Project Flora and Fauna Assessment, March 2014, RPS Australia East (RPS 2014b);
- Seasonal Flora and Fauna Monitoring Report 2015/2016 (RPS 2016);
- Biodiversity Management Plan Extraction Plan Airly Mine (Centennial 2016);
- Airly Mine Splitting and Quartering Extraction Plan (ML1331) - Biodiversity Management Plan - Report to Centennial Coal (RPS 2018);
- Airly Mine Flora and Fauna Monitoring Report 2016/2017. Report to Centennial Coal (RPS 2017a);
- Airly Mine Seasonal Flora and Fauna Monitoring Report 2015/2016. Report to Centennial Coal (RPS 2017b);
- Annual Flora and Fauna Monitoring Report 2016-2017 (RPS 2017c);
- Final Biodiversity Management Plan for Cliff Line Zone of First Workings within ML1331 Airly Mine (Centennial 2018);
- Annual Flora and Fauna Monitoring Report 2017-2018 (RPS 2019);
- Annual Flora and Fauna Monitoring Report 2019-2020 (RPS 2020);
- Annual Flora and Fauna Monitoring Report 2020-2021 (RPS 2021a); and
- Ecology Baseline Assessment Report – Point Hatteras (RPS 2021b).

### 2.1.1 Landscape context

A biogeographic overview of the study area was obtained from the published descriptions of the Michell landscapes (NPWS 2003), Interim Biogeographic Regionalisation for Australia (IBRA) subregions and Soil Landscapes of Central and Eastern NSW - V2.1 (DPE 2020a). Other published and unpublished resources of relevance to the study area were also evaluated in incorporated where appropriate.

Information sources were reviewed for a 10 km radius of the study area (hereafter referred to as the ‘locality’) to inform the landscape context description include:

- Vegetation of the Western Blue Mountains including the Capertee, Coxs and Jenolan-Gurnang Areas (DEC, 2006) Vegetation Information System (VIS)_ID 2231
- Mitchell Landscapes (NPWS 2003);

- eSPADE Soil Landscapes of Central and Eastern NSW - v2.1 (DPE 2020a);
- IBRA Region and subregion mapping (IBRA7); and
- Recent aerial imagery of the study area.

### 2.1.2 Likelihood of Occurrence Analysis

The Likelihood of Occurrence Analysis (LoOA) has been informed by the results of the biogeographic overview for the study area. In addition, the following datasets have informed the LoOA:

- Flora and fauna records contained the BioNet database (DPE 2022);
- Threatened biodiversity records contained in the Department of Climate Change, Energy, the Environment and Water (DCCEEWW) Protected Matters Search tool (DCCEEWW 2021);
- Habitat descriptions as provided by the online Threatened Species Profile Database (TSPD) (DPE 2021c);
- Biodiversity Assessment Method Calculator (BAM-C);
- Vegetation community, flora and fauna data from RPS's database;
- DPE VIS database; and
- Fisheries NSW Spatial Data Portal (DPI 2021).

Threatened species, populations and communities previously recorded within the locality, or with potential habitat within the locality inform the subject species list for consideration.

Five 'likelihood of occurrence' categories have been attributed to identify the chance of threatened biodiversity within the study area. The attribution of a likelihood of occurrence category has had regard for:

- The recency of threatened species observations;
- Proximity to the study area (i.e. application of landscape factors such as patch size and connectivity);
- Habitat descriptions as provided in the TSPD (DPE 2021c);
- Habitat values and condition as determined through the study area specific literature review; and
- The effect of existing KTPs.

The five likelihood of occurrence ratings are described in **Table 2-1**.

**Table 2-1 Likelihood of Occurrence Analysis criteria**

| Likelihood Rating | Description |
|---|---|
| None | Species specific habitat types (i.e. important habitat features) and known vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are absent from the study area. The study area is also likely located outside the species known 'area of occurrence' and may also occur outside the species 'extent of occurrence' [i.e. standard grid size of 2x2 km (IUCN 2017)]. Species incidence is not expected and, if detected, would likely represent atypical occurrence (e.g. incidence linked with transient Activity). Presence unlikely associated with habitat occupancy involving important lifecycle processes. |
| Low | Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The study area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2 km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species Activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. |
| Moderate | Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the study area. The study area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as |

| Likelihood Rating | Description |
|---|---|
| | connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Council SAII indicative habitat mapping indicates potential for the species to occur. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. |
| High | Habitat values within the study area are generally consistent with descriptions provided in the BCS TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Council SAII indicative habitat mapping indicates potential for the species to occur. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. |
| Known | Species observed or previous reliable record exists and/or habitat values within the study area are generally consistent with research or descriptions provided in the BCS TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). |

## 2.2 Vegetation Communities

Vegetation communities were typified using the State Vegetation Type Map (SVTM) is a regional-scale map of NSW Plant Community Types. This map represents the current extent of each Plant Community Type, Vegetation Class and Vegetation Formation, across all tenures in NSW (DPE 2022d). The SVTM maps the distribution of each Plant Community Type (PCT), Vegetation Class and Vegetation Formation with data input from the NSW BioNet Flora Survey Plots – PCT Reference Sites (DPE 2022e).

Subsequent flora surveys were undertaken that involved ground-truthing of vegetation communities through rapid data points (RDPs) which document the most dominant flora species of the canopy, midstorey and ground stratum within a 10 m radius of the point and 20 x 20 m flora quadrats which document all species as well as cover and abundance within the quadrant (RPS 2014; Figure 2-1 **Figure 2-1**.).

Previous and current quadrat and RDP data was compiled into GIS and overlain on a range of aforementioned data sets. These data layers and the floristic data were then used to predict the vegetation type present within polygons. Fine-scale (a scale of approximately 1:5000) alterations using aerial photo interpretations (API) were subsequently undertaken to improve polygon accuracy. This was undertaken digitally (i.e. on screen) using API techniques, involving the delineation of polygons based on similarities and differences between patterns observed in the vegetation as seen in the air photo.

The following data sources were utilised to provide the most up to date vegetation mapping for the study area:

- Vegetation community, flora and fauna data from RPS's database;
- DPE SVTM (DPE 2022);
- DPE vegetation information system (VIS) database (DPE 2021a);
- Vegetation of the Western Blue Mountains including the Capertee, Coxs and Jenolan-Gurnang Areas (DEC, 2006) VIS_ID 2231;
- Mitchell Landscapes (NPWS 2003);
- eSPADE Soil Landscapes of Central and Eastern NSW - v2.1 (DPE 2020a); and
- IBRA Region and subregion mapping (IBRA7).

### 2.2.1 Threatened Ecological Communities

TECs were ground thuthed by 20 x 20 m flora quadrats which document all species as well as cover and abundance within the quadrant. Two flora quadrants were undertaken within the Genowlan Point *Allocasuarina nana* Heathland EEC (**Figure 2-2**).

### 2.2.2 Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems were determined utilising a desktop assessment of:

- Relevant documents (e.g. Environmental Impact Statement, Groundwater Assessment (GHD 2014), Flora and Fauna Assessment (RPS 2014);
- Groundwater Dependent Ecosystems Atlas (BOM 2022);
- Vegetation community, flora and fauna data from RPS's database;
- DPE SVTM (DPE 2022);
- DPE vegetation information system (VIS) database (DPE 2021a).

Surveys of relevant PCTs were undertaken that involved ground-truthing of potential GDEs through RDPs which document the most dominant flora species of the canopy, midstorey and ground stratum within a 10 m radius of the point and photography.

Vegetation surveys were undertaken from the 20 to 24 July 2022 (**Figure 2-2**).

#### 2.2.2.1 Monitoring

Baseline monitoring was established on 12 to 16 December 2022.

GDE plots were monitored using plots both BAM plots (i.e. measuring flora composition, vegetation structure and ecological function as defined by the BAM) and a rapid aquatic assessment modified from the Australian River Assessment System (AUSRIVAS) methodology. Ten GDE BAM plots and five rapid aquatic assessments have been established at the base of Pt Hatteras and the Grotto for the Pt Hatteras BMP and CLZ ML1814 BMP to establish baseline and gather repeated monitoring data. The location and method applied at these plots are summarised in **Table 2-2**.

**Table 2-2: Location, PCT and monitoring method of GDE plots**

| Plot | BMP Location | PCT | Monitoring method |
|---|---|---|---|
| 1 | Pt Hatteras | 941 | • BAM plot |
| 2 | Pt Hatteras | 941 | • BAM plot |
| 3 | Control | 941 | • BAM plot |
| 4 | Control | 941 | • BAM plot |
| 5 | Grotto (CLZ ML1814 BMP) | 1615 | • BAM plot<br>• Rapid aquatic assessment |
| 6 | Grotto (CLZ ML1814 BMP) | 1615 | • BAM plot<br>• Rapid aquatic assessment |
| 7 | Grotto (CLZ ML1814 BMP) | 1615 | • BAM plot<br>• Rapid aquatic assessment |
| 8 | Grotto (CLZ ML1814 BMP) | 1615 | • BAM plot<br>• Rapid aquatic assessment |
| 9 | Grotto (CLZ ML1814 BMP) | 941 | • BAM plot |
| 10 | Grotto (CLZ ML1814 BMP) | 941 | • BAM plot<br>• Rapid aquatic assessment |

A rapid aquatic assessment modified from the AUSRIVAS methodology. The start and end points of each 50 m GDE plot are marked with wooden stakes and labelled. Location data for each of these points was recorded using a differential GPS. Photographs were taken of each GDE plot from a standardised point at an approximate height of 1.5 m. A horizontal field of view of approximately 40 degrees is achieved, which is within the central angle of view for human vision (i.e. 40-60 degrees).

The following assessments are conducted during each monitoring period:

a. Stream condition:

i. Flow width (m) averaged from set distance along the stream (5 m, 15 m, 25 m, 35 m, 45 m);
ii. Max flow width (m);
iii. Min flow width (m);
iv. Soil moisture ±3% VWC averaged from set distance along the stream (5 m, 15 m, 25 m, 35 m, 45 m);
v. Clarity/sediment load (0 [no clarity] – 5 [clearest]);
vi. Erosion (0 [no signs of erosion] - 5 [severe]).

b. Stream type:
   i. Stream flow type:
      1. Pooling;
      2. Flowing;
      3. Continuous;
      4. Discontinuous;
      5. Riffles.
   ii. Aquatic vegetation type:
      1. Submerged;
      2. Floating;
      3. Emergent.
   iii. Substrate type:
      1. Bedrock;
      2. Boulder (>256mm);
      3. Cobble (64-256mm);
      4. Pebble (16-64mm);
      5. Gravel (2-16mm);
      6. Sand (0.06-2mm);
      7. Clay/Silt (<0.06mm).
   iv. Bank slope:
      1. Flat <10°;
      2. Low 10 - 30°;
      3. Moderate 30 - 60°;
      4. Steep 60 - 80°;
      5. Vertical 80 – 90.

## 2.3 Threatened flora

Threatened flora within the study area have been characterised from the following database searches:

- BioNet database (DPE 2022b);
- RPS database (RPS 2021); and
- UQ Monitoring Program, Sustainable Minerals Institute Centre for Mined Land Rehabilitation (SMI CMLR) (UQ 2013).

Threatened flora records were then cross-checked with vegetation community mapping and previous flora records and monitoring efforts within the RPS database (RPS 2021; **Figure 2-1**.). Additional threatened flora

surveys were conducted at Mount Genowlan by means of 'random meander' from the 20 to 24 July 2022 (**Figure 2-2**).

### 2.3.1 Threatened flora monitoring

Previous flora monitoring work has occurred for Mount Vincent's Mint-bush (*Prostanthera stricta*) and Capertee Stringybark (*Eucalyptus cannonii*). See **Figure 2-1**. Detailed monitoring methodology are outlined in *Airly Mine 2012-2014 Flora and Fauna Baseline Survey Report* (RPS 2014a) and summarised in **Table 2-3**.

**Table 2-3: Threatened flora monitoring**

| Target Species | Monitoring Methods |
|---|---|
| *Prostanthera stricta* | Point intercept method and floristic density plots in permanent survey sites |
| *Eucalyptus cannonii* | Eighteen individual trees assessed for condition, crown extent and growth changes |

Results relevant to the study areas were compiled from previous monitoring years to display population trends.

## 2.4 Threatened fauna

### 2.4.1 Habitat for threatened fauna

A literature review of past documents relating to the study area was carried out to identify potential habitat niches for threatened fauna within the study area. This assessment included consideration habitat condition and complexity, including the occurrence of microhabitats. Such habitat niches include tree hollows, fallen logs, bush rock, caves and crevices, manmade structures, riparian areas, wetlands and water bodies, taking into consideration for past land uses, connectivity and underlying geology of the study area.

### 2.4.2 Threatened fauna records

Threatened flora within the study area have been characterised from the following database searches:

- BioNet database (DPE 2021b);
- RPS database (RPS 2021); and
- UQ Monitoring Program, Sustainable Minerals Institute Centre for Mined Land Rehabilitation (SMI CMLR) (UQ 2013).

Threatened fauna records were then cross-checked for consistency between data sources and relevant reports.

Additional field fauna surveys were conducted by means of 'opportunistic sightings' from 20 to 24 July 2022 (**Figure 2-2**).

### 2.4.3 Threatened fauna monitoring

Fauna surveys have previously been conducted by RPS yearly in spring/summer under the current Biodiversity Monitoring Programs (RPS 2017; RPS 2018; RPS 2019; RPS 2020, RPS 2021) across the entire Airly Mine lease area. Detailed monitoring methodology are outlined in *Airly Mine 2012-2014 Flora and Fauna Baseline Survey Report* (RPS 2014a) and summarised in **Table 2-4**.

**Table 2-4: Threatened fauna monitoring methods**

| Target Species | Monitoring Methods |
|---|---|
| Glossy Black-Cockatoos | Percent cover of *Allocasuarina* species present at permanent survey sites and the presence of chewed orts was recorded |
| Large Forest Owls | Targeted call-playback, spotlighting and surveys near previously identified roost trees/habitat |

| Target Species | Monitoring Methods |
|---|---|
| Diurnal Birds | 30-minute surveys across permanent transects and opportunistic surveys |
| Cave Dwelling Micro-bats | Anabat units to detect presence of microbat species |
| Other Targeted Species (Spotted-tailed Quoll (*Dasyurus maculatus*), Broad-headed Snakes (*Hoplocephalus bungaroides*) and Rosenberg's Goanna (*Varanus rosenbergi*) | Suitable habitat for these species was targeted via camera trapping/ opportunistic sightings |
| Feral Species | Camera trapping/ opportunistic sightings |

Results relevant to the study area were compiled from previous monitoring years to display population trends.

## 2.5 Key Threatening Processes

Potential KTPs relevant to the study area were explored amongst those currently list under the BC Act, FM Act and EPBC Act. A literature review of previous documents relating to the study area and any relevant databases (see **Section 2.1**) helped identification of KTPs likely to be relevant to the study area (at least to some degree).

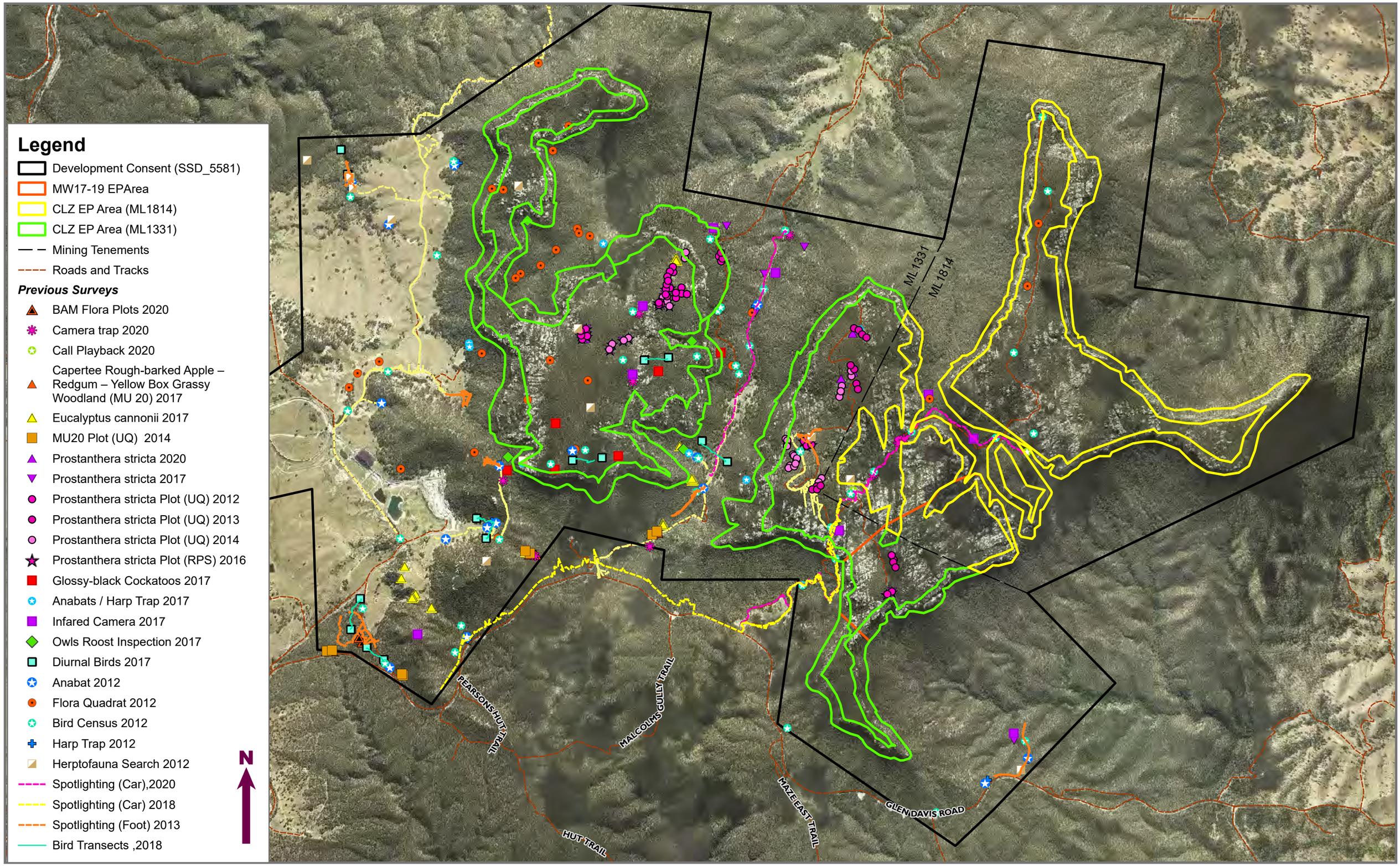


**FIGURE 2-1 :**
**PREVIOUS SURVEY RESULTS**

LOCATION: **AIRLY**

VERSION: **A**
DATE EXPORTED: **26/09/2022**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m

SCALE 1:30,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial Airly**
PROJ: **PR152229**
PURPOSE: **Baseline Assessment**

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PROJECT PATH: S:\Centennial\All Jobs\5568 - 152229 - Airly Cliff Line Zone EP BMP Update\10 - Drafting\ECO_BMPGeneralFigures_.aprx

MAKING COMPLEX EASY

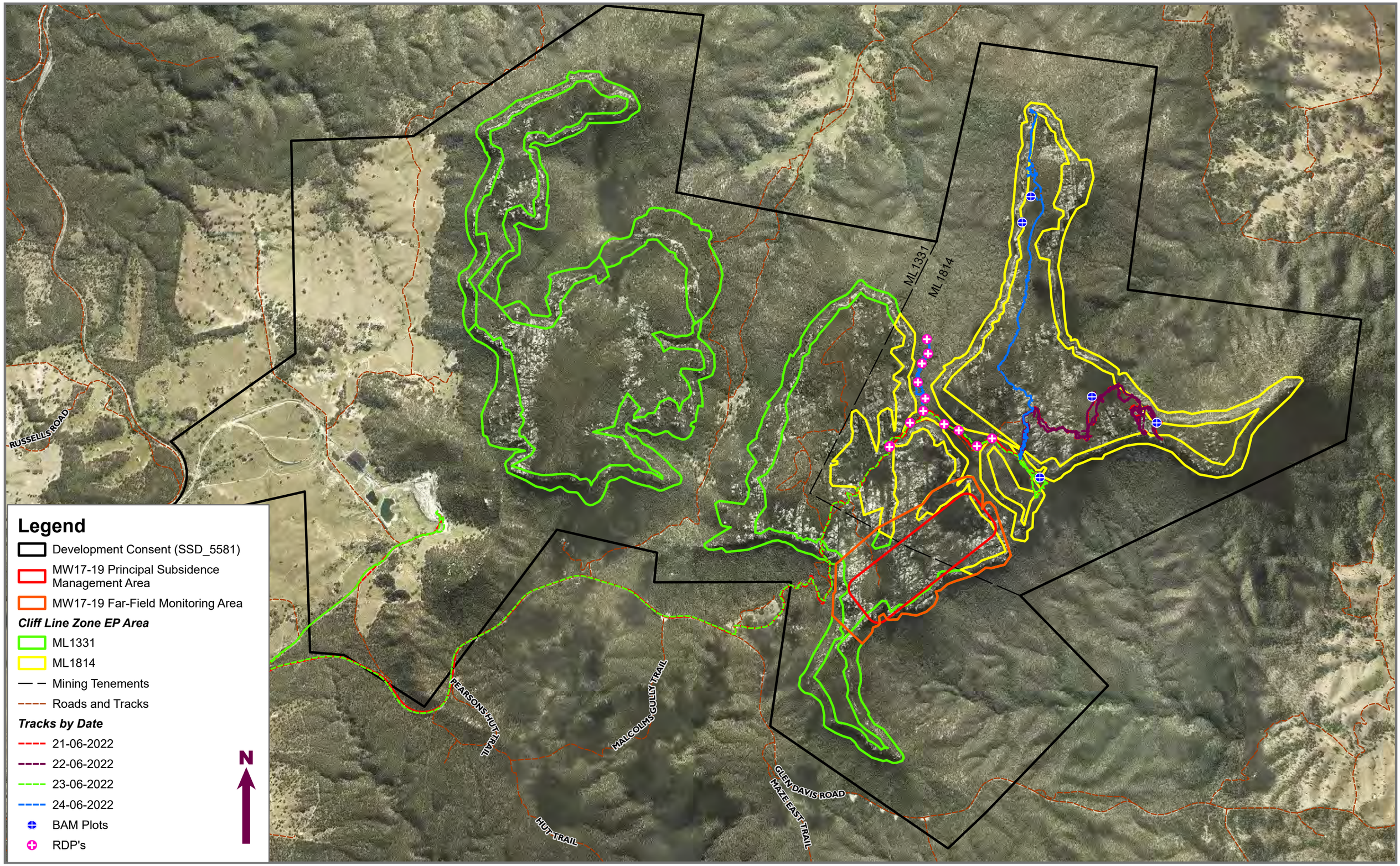


**FIGURE 2-3 :**
**SURVEY EFFORT**

LOCATION: **AIRLY**

VERSION: **A**
DATE EXPORTED: **26/09/2022**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m

SCALE 1:30,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial**
PROJ: **PR152229**
PURPOSE: **Baseline Assessment**

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MAKING COMPLEX EASY

## 2.6 Limitations

The results of the baseline assessment adopted a desktop approach only, consisting of existing data compiled from previous surveys within and adjacent to the study area. No further on ground assessment were included here.

Vegetation mapping has not been ground-truthed within the study area. Vegetation mapping is reliant on vegetation surveys conducted in vegetation contiguous with the study area in 2014 and from correspondence with existing broadscale mapping. Previous vegetation surveys within the study area were limited in spatial extent.

Some plant species that occur in the local area, such as cryptic species, are annuals and are present only in the seed bank for much of the year. Moreover, some perennial plant species can be inconspicuous or difficult to identify unless flowering.

Fauna species that have been recorded in the local area may occur on a seasonal or migratory basis, and so may be absent for much for the year. Fauna behaviours may have also affected detectability during past surveys, with some easily disturbed or cryptic species difficult to detect.

### 2.6.1 Data Availability and Accuracy

The collated threatened flora and fauna species records obtained from the BioNet Database (DPE 2021b) for the locality are known to vary in accuracy and reliability. Traditionally, this is due to the reliability of information provided to BCS for collation and/or the need to protect specific threatened species locations. For the purposes of this report this information has been considered to have an accuracy of ± 1 km, however for some threatened species, records may be denatured by up to 2 km.

These potential limitations have been addressed by a thorough literature research and review and through identification of potential habitats for flora and fauna species and assessment of the potential for targeted species to occur within the study area based on:

- Known records from previous surveys conducted by RPS;
- The type and condition of habitats present;
- The land use throughout the study area and surrounds; and
- The landscape context.

Spatial data during previous surveys by RPS were recorded with a Trimble Differential GPS unit, which is capable of sub-metre accuracy following post processing.

# 3 RESULTS

## 3.1 Literature review

### 3.1.1 Landscape context

#### 3.1.1.1 Location and topography

The study area lies within the Mugii Murum-ban SCA, with the Gardens of Stone National Park to the south and Capertee National Park to the north (see **Figure 3-2**). The landscape is characterised by steep sandstone escarpments and pagoda rock formations. The study area is mostly within the Capertee Uplands of the South Eastern Highlands Bioregion (IBRA7) with some eastern slopes falling within the Capertee Valley of the NSW Western Slopes IBRA (see **Figure 3-1**). The South Eastern Highlands bioregion is situated inland from the coastal bioregions of the South East Corner and the Sydney Basin. It is bounded by the Australian Alps and South Western Slopes bioregions to the south and west, and spans about 8,375,961 ha into the ACT and Victoria (DPE 2021). The narrow, deeply incised gorges or canyons are quite common throughout the Blue Mountains region and are typified at within the study area by features such as the Grotto which forms a tributary of the Genowlan Creek.

**Plate 3-1 Example of pagoda rock formations**

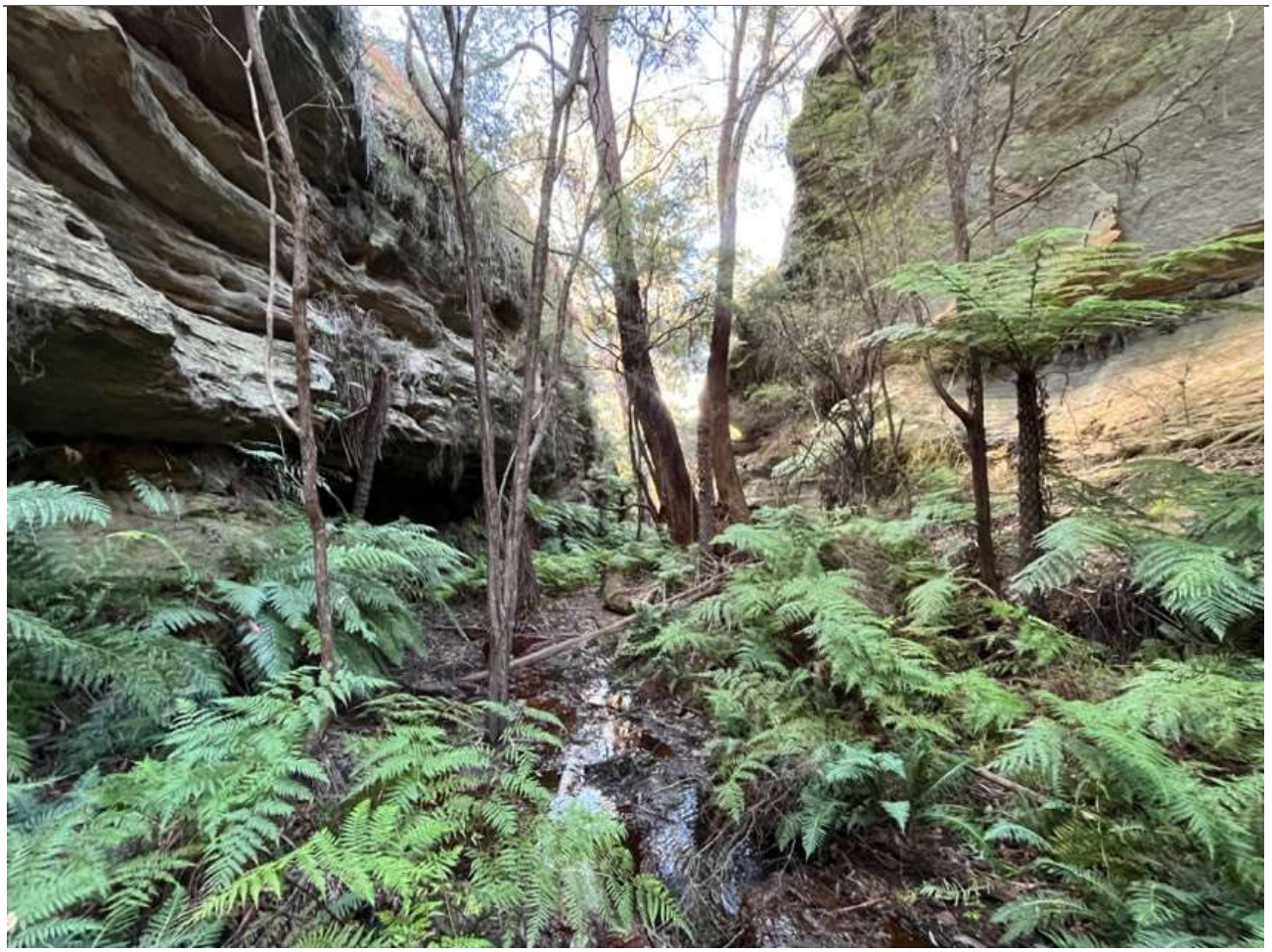

**Plate 3-2 Example of incised gorges**

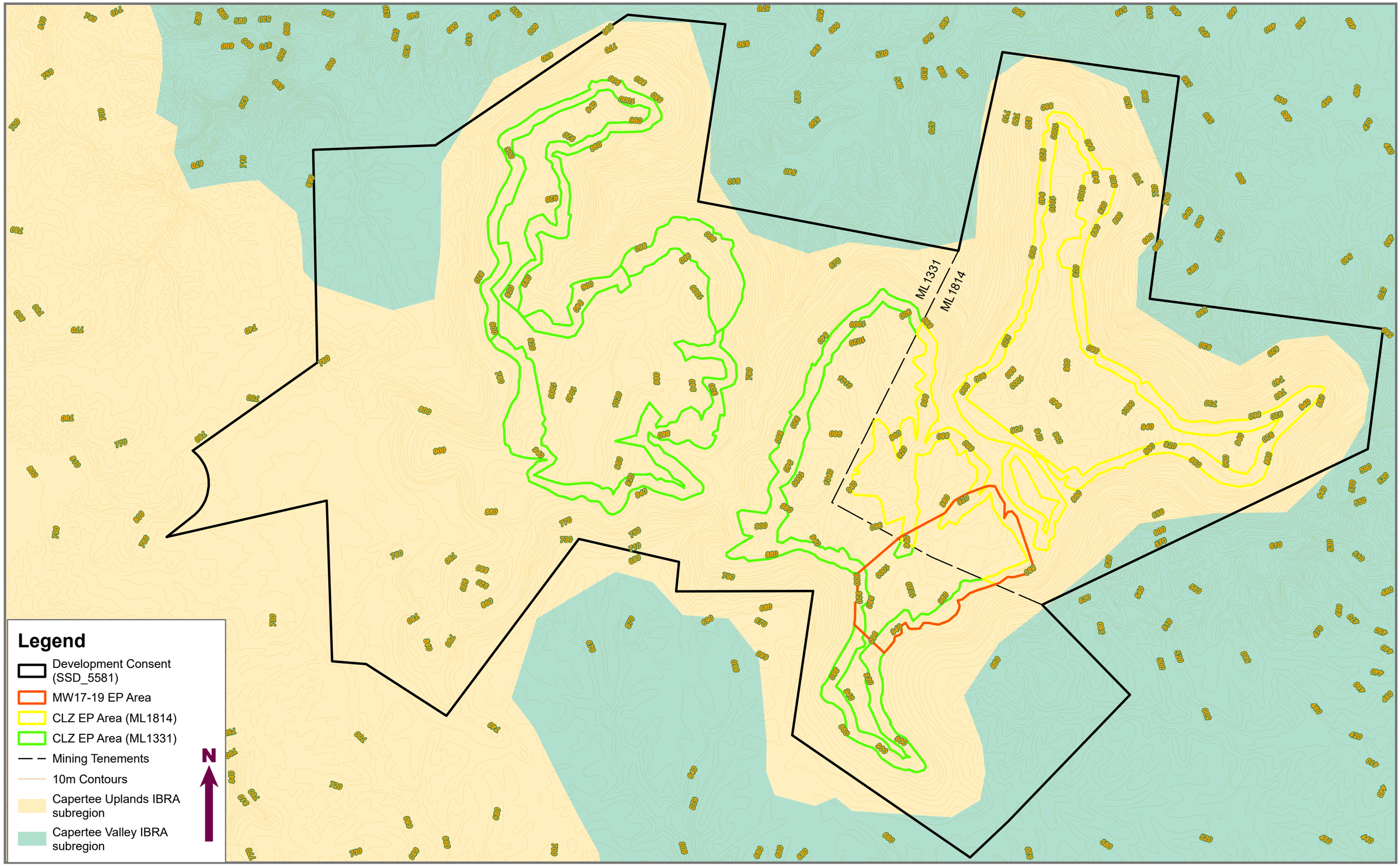


**FIGURE 3-1:**
**IBRA SUBREGIONS**

LOCATION: **AIRLY**

VERSION: **A**
DATE EXPORTED: **26/09/2022**
TECHNICIAN: **Robert.Suansri**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m

SCALE 1:30,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial**
PROJ: **PR152229**
PURPOSE: **Baseline Assessment**

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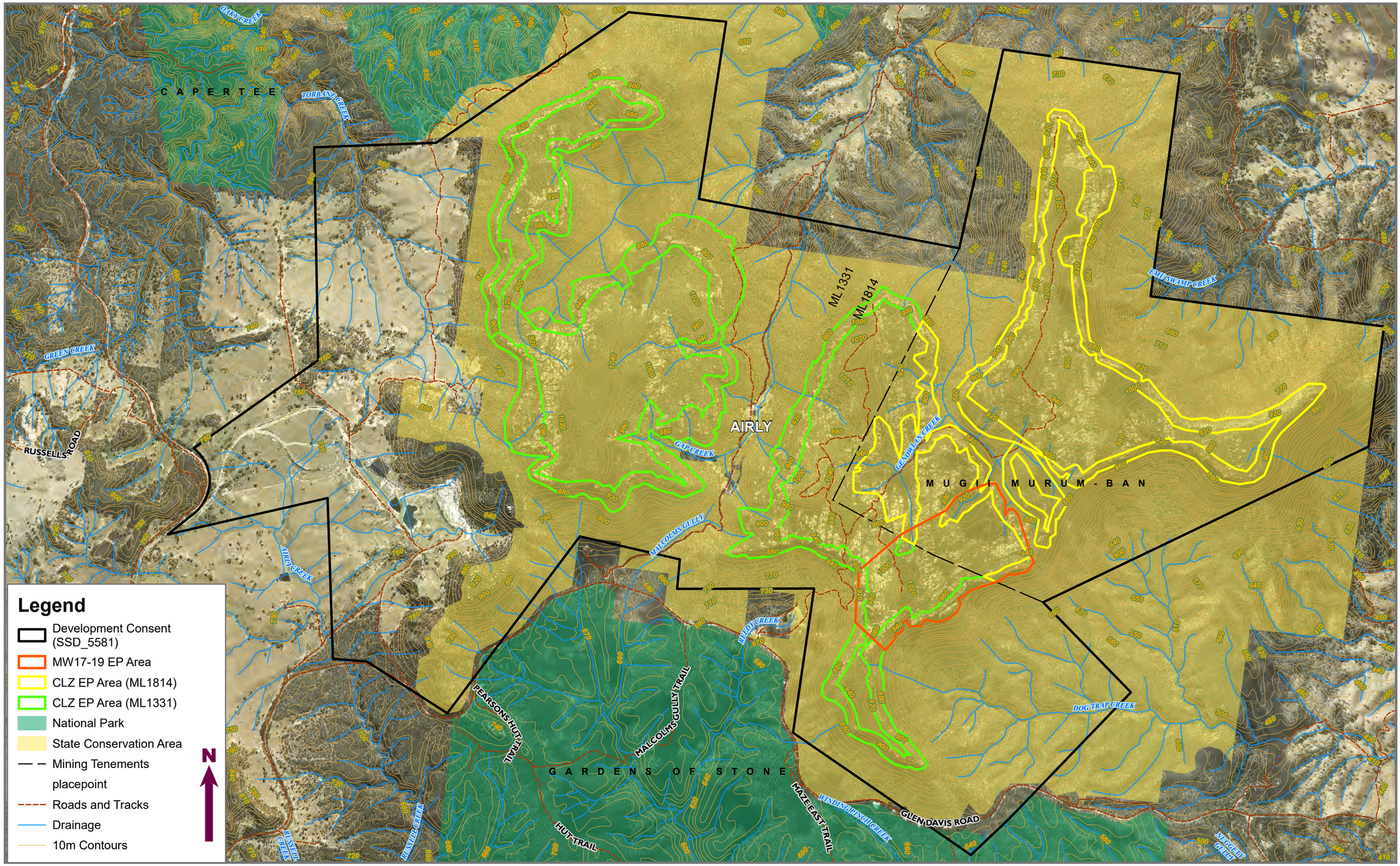


**FIGURE 3-2:**
**CONSERVATION AREAS**

LOCATION: **AIRLY**

VERSION: **A**
DATE EXPORTED: **26/09/2022**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m

SCALE 1:30,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial**
PROJ: **PR152229**
PURPOSE: **Baseline Assessment**

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### 3.1.1.2 Connectivity

The study area is located on the western margin of the Greater Blue Mountains World Heritage Area that surrounds the western rim of the Sydney Basin, preserving the sandstone-based links between the Sydney, Hunter and Central West regions of New South Wales (DECC 2008a). This vast expanse of continuous habitat facilitates the movement of many fauna species across the landscape. Animals move through habitats to obtain food, shelter and breeding resources in response to seasonal resource ability and habitat conditions. Large tracts of habitat are generally required for successful dispersal away from natal areas or seasonal migrations (Van der Ree et al 2007).

There are no significant barriers to fauna movement surrounding the study area, however in the wider locality, the landscape to the west of the study area is characterised by a mosaic of cleared agricultural land and large patches of remnant vegetation. Many of these remnants are linked by riparian vegetation that has been retained in association with drainage lines; others are linked by narrow corridors of native vegetation. Some remnants do not maintain connectivity with any other patches of vegetation in the landscape and are completely isolated amongst cleared land.

#### 3.1.1.2.1 Conservation areas

The study area is located within the Mugii Murum-ban SCA. Several other conservation reserves are in the surrounding locality (see **Figure 3-2** and **Table 3-1**). These areas protect a diversity of significant habitats such as basalt caps, sandstone escarpments, pagoda rock formations, gorges and canyons, alluvial gullies, heaths, rainforest, hanging swamps and wet sclerophyll forests. These variations in topography, altitude, aspect and microclimates support a diversity of native plants and animals, including rare and threatened species and ecological communities.

**Table 3-1 Conservation Reserves in the Surrounding Locality**

| Conservation area | Area (ha) | Location | Features |
|---|---|---|---|
| Mugii Murum-ban SCA | 3,650 | Within the study area | Vegetation and habitat of the national park are continuous with those of the study area |
| Capertee National Park | 2,839 | Directly North-west of the study area | Vegetation and habitat of the national park are continuous with those of the study area |
| Gardens of Stone National Park | 15, 010 | Directly south of the Study area | Contains pagoda formations. Supports poorly represented Yellow- Box / Ironbark Woodland communities and rare White Box / Grassy Woodland and White Box / Grass Tree / Spinifex Woodland communities. Six threatened flora species and several threatened fauna species are known to occur in park (NPWS 2009a). |
| Turon National Park | 3,103 | About 10 km south-west of the study area | Does not maintain connectivity with the study area |
| Wollemi National Park | 488,620 | About 15 km east of the study area | Contains pagoda formations, deep gorges, river valleys, canyons, hanging swamps, waterfalls and sandstone escarpments; the varied topography and vegetation provides a diversity of habitats for plants and animals. Conserves significant areas of warm temperate rainforest, Mellong swamps communities and white box and yellow box woodlands. Contains 25 rare or threatened flora species and numerous threatened fauna species known to occur. Wollemi pine *Wollemia nobilis* occurs in a remote section of the park (NPWS 2001). |
| Greater Blue Mountains World Heritage Area | 1,032,649 | Encompasses all surrounding conservation areas | Both the Gardens of Stone and Wollemi National Park contribute to the Greater Blue Mountains World Heritage Area (GBMWHA). The GBMWHA was inscribed in the World Heritage List in 2000, on the basis of its outstanding natural values. These natural values are listed in the Greater Blue Mountains World Heritage Area Strategic Plan. |

### 3.1.1.3 Climate

The South Eastern Highlands IBRA bioregion is dominated by a temperate climate with significant areas in the north and south at higher elevations having a montane climate with milder summers. Rainfall and temperature vary seasonally with the heaviest rainfalls and highest temperatures experienced in summer months, and the lowest temperatures and rainfalls generally occurring in winter months. Frosts and fogs are common in winter (RPS 2014).

### 3.1.1.4 NSW (Mitchell) landscape

The study area is characterised by the Newnes Plateau (Mitchell) landscape with Capertee Plateau, Capertee landscape occurring along the eastern boundary of the study area (see **Figure 3-3**). Small inlier patches of the Sydney Basin Diatremes landscape occur in the north (Mitchell 2002; DECC 2008b). See **Table 3-2** for the NSW (Mitchell) Landscape description and **Figure 3-3** for the locations within the study area.

**Table 3-2 Descriptions for relevant NSW (Mitchell) Landscapes**

| NSW (Mitchell) landscape | Description | EP Area |
|---|---|---|
| **Newnes Plateau Sydney Basin (SB) Wollemi** | Undulating high level plateau with shallowly incises swampy streams and occasional relics and dunes on horizontal Triassic quartz sandstones and shale, general elevation 1000 m ASL, local relief <100 m. Thin stony yellow red sands, deep yellow earths, podsols on dunes and yellow or grey texture-contrast soils on shale units. Woodland of stunted Scribbly Gum (*Eucalyptus sclerophylla*), Snow Gum (*Eucalyptus pauciflora*), Blue Mountains Ash *(Eucalyptus oreades*), Silvertop Ash (*Eucalyptus sieberi*), Grey Ironbark (*Eucalyptus paniculata*), Red Bloodwood (*Corymbia gummifera*) and Grass Trees (*Xanthorrhoea sp*.) with numerous other shrubs. Patches of Dwarf Casuarina (*Allocasuarina nana*) heath on very exposed and eroded aspects, sedge swamps with marginal heath form linear patterns in open valleys. | MW17-19<br>CLZ |
| **Sydney Basin Diatremes SB Volcanics** | Widely distributed across the Sydney Basin and distinguished as a landscape because they always contain locally different landform, soil and vegetation. Diatremes are circular volcanic vents filled with layered, brecciated country rock cemented by a fine-grained basaltic matrix. Some contain a core of basalt. In sandstone country the volcanic breccia weathers and erodes more rapidly than the sandstone and the landform is a deep circular with the appearance of a crater. Soils in the crater are dominated by sandstone detritus from the surrounding slopes but the subsoils is a fertile well, structured clay derived from the breccia and these protected sites carry more mesic variants of the local vegetation. In shale country the breccia is more resistant than the shale and the diatremes form a low rounded hill with red-brown gradational profiles of clay loam and structured clay with moderate to high fertility. General elevation varies considerably across the basin, local relief of positive landforms up to 25 m, negative landforms (‘craters’) 180 m. | CLZ |
| **Capertee Plateau SB Capertee** | Wide valleys, low rolling hills below sandstone cliffs on Permian conglomerates, sandstones, and shales with coal at the base of the Sydney Basin and exposure of underlying Devonian shale, siltstone or quartzite. Small areas of Tertiary basalt. General elevation 800 to 1000 m ASL, local relief 100-120 m. Isolated flat top mountains in the valleys formed as pinnacles or remnant pieces of plateau. Shoulder slopes with stone pillars or ‘pagodas’ above steep canyons on tributary streams falling into gorges. Low gradient swampy streamlines. Shallow stony texture-contrast profiles, usually with gritty well drained A-horizons, over tough yellow or grey poorly drained clays. | CLZ |

### 3.1.1.5 Geology and soils

The underlying geology of the study area comprises Narrabeen Group—fine-grained lithic sandstone occasionally interbedded with thin shale lenses. The study area contains a diversity of geological and geomorphological features such as pagoda rock formations and precipitous sandstone escarpments (see **Figure 3-4)**.

The MW17-19 EP area spans three mapped soil landscapes, whilst the CLZ EP area spans four mapped soil landscapes. Ridgetops are predominantly occurring on the ‘Warragamba’ and ‘Wollangambe’ soil landscape.

The higher elevation points of the study area, typically above 1000 m ASL transition into 'Mount Tomah' soil landscape, whilst as the terrain drops into lower elevation, the soil landscape transitions into 'Hassans Walls' soil landscape (DPE 2020a). See **Table 3-3** for the soil landscape descriptions and **Figure 3-4** for the locations within the study area.

**Table 3-3 Soil Landscapes of Central and Eastern NSW**

| Soil Landscape | Description | EP Area |
|---|---|---|
| **Warragamba 8931wb** | The Warragamba landscape comprises narrow convex crests and ridges and steep colluvial sideslopes on Narrabeen Group sandstones with minor cliffs and scarps on steeper slopes. Local relief is typically between 80 – 130 m ASL at elevations mostly less than 700 m ASL. Soils are shallow to deep Lithosols on crests and ridges; Brown Earths, Red Podzolic Soils on upper slopes and Yellow Podzolic Soils on lower slopes.<br>This soil landscape is typified by mass movement hazard as plant root development is limited by shallow soils and steep slopes, severe water erosion hazard, rock fall hazard and acid stony soils of low fertility.<br>The vegetation on Warragamba soil landscape generally consists of open-forest communities with a variety of tree species including Smooth-barked apple (*Angophora costata*), Blue-leaved stringybark (*Eucalyptus agglomerata*), Sydney peppermint (*Eucalyptus piperita ssp. piperita*), Cedar wattle (*Acacia elata*), Grey gum (*Eucalyptus punctata*), Turpentine (*Syncarpia glomulifera*), Red Bloodwood (*Eucalyptus gummifera*), Brown Barrel (*Eucalyptus fastigata*) and Mountain Gum (Eu*calyptus dalrympleana ssp. dalrympleana*). Understoreys contain species from the Mimosaceae, Epacridaceae, Myrtaceae, Proteaceae and Fabaceae families. | MW17-19 CLZ |
| **Wollangambe 8931wo** | The Wollangambe landscape comprises of rounded narrow crests and moderately to steeply inclined sideslopes. Localised rock outcrop are in the form of small benches, cliffs and low broken scarp. The local relief is typically less than 100 m and evaluation is generally above 600 m ASL. The underlying geology is Narrabeen Group—quartz sandstone and quartz-lithic sandstone interbedded with thin red, grey and green claystone, shale and occasional conglomerate and ironstone lenses. Thin outliers of Hawkesbury Sandstone in the<br>north-eastern corner of the map sheet may occur. The shallow soil landscape consists of Siliceous Sands/Lithosols, Earthy Sands and Yellow Earths on crests. The soil landscape is typified by high to severe water erosion hazard, steep slopes, shallow soils, localised rock fall hazard, localised rock outcrop and low soil fertility.<br>The vegetation of the Wollangambe soil landscape generally consists of open-woodland with low open-forest in more sheltered valleys. Tree species include black ash (*Eucalyptus sieberi*), narrow-leaved stringy bark (*Eucalyptus oblonga ssp. oblonga*), red bloodwood (*Eucalyptus gummifera*), blue mountains ash (E*ucalyptus oreades*), broad-leaved peppermint (*Eucalyptus dives*), grey gum (*Eucalyptus punctata*), Sydney peppermint (*Eucalyptus piperita ssp. piperita*), and narrow leaved peppermint (*Eucalyptus radiata ssp. radiata*). Shrub dominated understoreys with broad-leaved hakea (*Hakea dactyloides*), sunshine wattle (*Acacia terminalis*), hill banksia (*Banksia spinulosa var. collina*), waratah (*Telopea speciosissima*), small-leaved boronia (*Boronia microphylla*), laurel geebung (*Persoonia laurina*), broad-leaf geebung (*Persoonia levis*), dorothy's wattle (*Acacia dorothera*), phyllota (*Phyllota spp*.) and mat-rush (*Lomandra spp*.) are characteristic. | MW17-19 CLZ |
| **Hassans Walls 8931hw** | Hassans Walls soil landscape is widespread on the steep colluvial slopes and cliffs which enclose the Wolgan, Capertee and Coxs river valleys. The landscape consists of cliffs derived from Narrabeen Group sandstones and steep colluvial talus sideslopes developed over the Illawarra Coal Measures and the Shoalhaven Group. Local relief is generally greater than 100 meters at elevations of 280 to 1,000 m ASL. Soils are typically shallow discontinuous Lithosols/Siliceous Sands on small rocky ledges on cliffs; moderately deep stony Lithosols/Siliceous Sands on upper slopes and recently deposited talus; moderately deep Yellow Podzolic Soils and Brown Podzolic Soils on lower slopes; shallow Sands/Lithosols along narrow steep deeply incised drainage lines and moderately deep Sands/Lithosols along narrow drainage flats.<br>This soil landscape has severe risk of sheet erosion and rock fall which currently occurs throughout the landscape, risk of extreme water erosion hazard, mass movement hazard, severe foundation hazard, rock outcrop and localised shallow soils, high run-on, localised non-cohesive soils and is typically within mine subsidence district.<br>The Vegetation is largely uncleared open-woodland and some open-forest on the more sheltered slopes. Tree species include Scribbly Gum (*Eucalyptus rossii*), Red Stringybark | MW17-19 CLZ |

| Soil Landscape | Description | EP Area |
|---|---|---|
| | (*Eucalyptus macrorhyncha ssp. macrorhyncha*), Broad-leaved Ironbark (*Eucalyptus fibrosa ssp. fibrosa*), Red Box (*Eucalyptus polyanthemos*), Mountain Grey Gum (*Eucalyptus cypellocarpa*), Thin-leaved Stringybark (*Eucalyptus eugenioides*), Grey Gum (Eucalyptus punctata) and Yellow Box (*Eucalyptus melliodora*). An open understorey with shrubs from the families Mimosaceae, Proteaceae, Fabaceae and Myrtaceae is characteristic. Along narrow drainage flats Tea-tree (*Leptospermum spp*.) is often conspicuous. | |
| **Mount Tomah 8931to** | The Mount Tomah landscape is restricted to small basalt caps. The landscape is typified by rounded crests and rolling hills on Tertiary basalt. The local relief is generally 40 to100 m at elevation of greater than 700 m ASL. Soil are shallow stony Red Krasnozems, Structured Loams and Lithosols on crests and localised steep slopes; moderately deep to deep Red Krasnozems on upper and midslopes; moderately deep to deep Chocolate Soils and Structured Loams on lower slopes associated with the basalt, shale, sandstone transition.<br>This landscape contains localised steep slopes, localised mass movement hazard, localised shallow soil and localised rock outcrop. Mass movement including minor earth slumps is evident near and along some drainage lines.<br>The vegetation of this landscape is generally extensively cleared particularly on the more accessible larger basalt caps. The vegetation is typified by tall open-forest communities with closed-forest in sheltered valleys and woodland on some of the more north-western occurrences (Benson and Keith 1990). Blaxland's Stringybark (*Eucalyptus blaxlandii*) and Ribbon Gum (*Eucalyptus viminalis*) are the main tree species of the tall open-forest communities. Other trees include Brown Barrel (*Eucalyptus fastigata*), blue mountains ash (*Eucalyptus oreades*), Blackwood (*Acacia melanoxylon*) and Narrow-leaved Peppermint (*Eucalyptus radiata ssp. radiata*). Understorey species include Blackthorn (*Bursaria spinosa*), Fireweed Groundsel (*Senecio linearifolius*), Ivy-leaved violet (*Viola hederacea ssp. hederacea*), Bidgee-widgee (*Acaena novae-zelandiae*), Kidney Weed (*Dichondra repens*),<br>Common Bracken (*Pteridium esculentum*), Stinging Pennywort (*Hydrocotyle laxiflora*) and Old man's Beard (*Clematis aristata*).<br>A dry basalt cap woodland community (Benson and Keith 1990) occurs on caps around Mount Airly and includes Red Box (*Eucalyptus polyanthemos*) and Red Stringybark (*Eucalyptus machrorhyncha ssp. macrorhyncha*). | CLZ |

### 3.1.1.6 Hydrology

The study area occurs within the Capertee River sub-catchment, in the north-west of the Hawkesbury Nepean Catchment Management Authority (CMA). Surface hydrology of the project comprises a dendritic drainage network of ephemeral streams joining tributaries, and ultimately a main river, at acute angles. In general, flow rates fluctuate in response to rainfall patterns (RPS 2014).

The MW17-19 EP area intersects with two mapped first order drainages lines which feed into Genowlan Creek (see **Figure 3-2**). The CLZ EP area intersects with about 22 mapped first and second order drainage lines which feed into Torbane Creek in the west, Gap Creek in the centre and Genowlan Creek in the north east. All creeks are ephemeral and flow into the Capertee River. The Capertee River is a tributary of the Colo River, which ultimately flows into the Hawkesbury River and Broken Bay (RPS 2014).

**Plate 3-3 Second order stream flowering into Genowlan Creek**

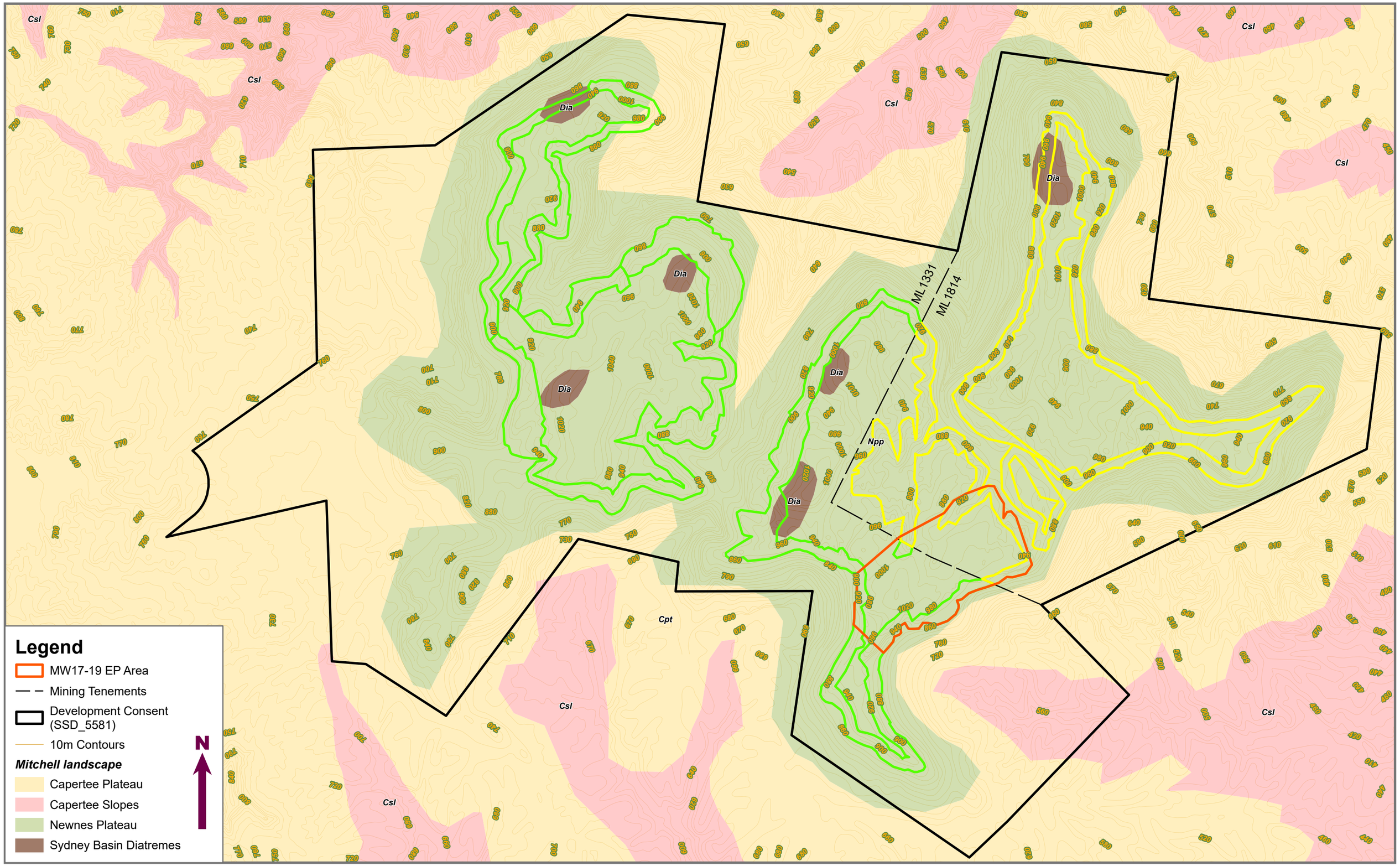


**FIGURE 3-3:**
**MITCHELL LANDSCAPES**

LOCATION: **AIRLY**

VERSION: **A**
DATE EXPORTED: **26/09/2022**
TECHNICIAN: **Robert.Suansri**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m

SCALE 1:30,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial**
PROJ: **PR152229**
PURPOSE: **Baseline Assessment**

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## Legend

- Development Consent (SSD_5581)
- MW17-19 EP Area
- CLZ EP Area (ML1814)
- CLZ EP Area (ML1331)
- Mining Tenements
- Roads and Tracks
- Drainage
- 10m Contours

***Soils Name***

- Canobla Gap
- Capertee
- Coco
- Cullen Bullen
- Glen Alice
- Hassans Walls
- Medlow Bath
- Mount Tomah
- Rowans Hole
- Three Sisters
- Umbiella
- Warragamba
- Wollangambe

N

**FIGURE 3-4 :**
**SOLIS**

LOCATION: **AIRLY**

VERSION: **A**
DATE EXPORTED: **26/09/2022**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m

SCALE 1:30,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial**
PROJ: **PR152229**
PURPOSE: **Baseline Assessment**

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### 3.1.2 Likelihood of Occurrence Analysis

A total of 127 threatened flora and fauna species were previously recorded in the locality, or associations with habitat features or vegetation communities within the locality. Flora and fauna records contained the BioNet database (DPE 2021b) identified 59 previously recorded listed threatened flora and fauna species in the locality. The Protected Matters Search Tool (PMST; DCCEEWW 2021) identified 53 listed threatened flora and fauna species as well as 12 listed migratory species and two listed TECs. The BAM-C identified 60 predicted species and 38 candidate species associated with the Plant Community Types (PCTs) and habitat types within the study areas.

Of these species, 24 threatened flora, 59 threatened fauna and one threatened insect were deemed to have a 'moderate', 'high' or 'known' likelihood to occur within the study area due to habitat suitability, consideration for connectivity and previous data collected by RPS. This is summarised in **Table 3-4**. The full LoOA and habitat descriptions are located in **Appendix A**

**Table 3-4:Results of the Likelihood of Occurrence Analysis – moderate to high LoO**

| Class | Scientific Name | Common Name | BC Act | EPBC Act | Recent Record (Y/N) | LoO |
|---|---|---|---|---|---|---|
| Amphibia | *Heleioporus australiacus* | Giant Burrowing Frog | V | V | N | Moderate |
| Amphibia | *Litoria booroolongensis* | Booroolong Frog | E | E | N | Moderate |
| Amphibia | *Litoria littlejohni* | Littlejohn's Tree Frog | V | V | N | Moderate |
| Amphibia | *Mixophyes balbus* | Stuttering Frog | E | V | N | Moderate |
| Amphibia | *Mixophyes iteratus* | Giant Barred Frog | E | E | N | Moderate |
| Amphibia | *Pseudophryne australis* | Red-crowned Toadlet | V | | N | Moderate |
| Aves | *Anthochaera phrygia* | Regent Honeyeater | CE | CE | Y | High |
| Aves | *Artamus cyanopterus cyanopterus* | Dusky Woodswallow | V | | Y | High |
| Aves | *Callocephalon fimbriatum* | Gang-gang Cockatoo | V | E | Y | Known |
| Aves | *Calyptorhynchus lathami* | Glossy Black-Cockatoo | E | | Y | Known |
| Aves | *Chthonicola sagittata* | Speckled Warbler | V | | Y | High |
| Aves | *Climacteris picumnus victoriae* | Brown Treecreeper (eastern subspecies) | V | | Y | High |
| Aves | *Daphoenositta chrysoptera* | Varied Sittella | V | | Y | High |
| Aves | *Falco subniger* | Black Falcon | V | | Y | High |
| Aves | *Glossopsitta pusilla* | Little Lorikeet | V | | Y | High |
| Aves | *Grantiella picta* | Painted Honeyeater | V | V | N | Moderate |
| Aves | *Hieraaetus morphnoides* | Little Eagle | V | | N | Moderate |
| Aves | *Lathamus discolor* | Swift Parrot | E | CE,MAR | N | High |
| Aves | *Lophoictinia isura* | Square-tailed Kite | V | | N | Moderate |
| Aves | *Melanodryas cucullata cucullata* | Hooded Robin (south-eastern form) | V | | Y | High |
| Aves | *Melithreptus gularis gularis* | Black-chinned Honeyeater (eastern subspecies) | V | | Y | High |
| Aves | *Merops ornatus* | Rainbow bee-eater | | MAR | N | Moderate |
| Aves | *Monarcha melanopsis* | Black-faced Monarch | | M,MAR | N | Moderate |
| Aves | *Myiagra cyanoleuca* | Satin Flycatcher | | M,MAR | N | High |
| Aves | *Neophema pulchella* | Turquoise Parrot | V | | Y | High |
| Aves | *Ninox connivens* | Barking Owl | V | | N | Moderate |
| Aves | *Ninox strenua* | Powerful Owl | V | | N | High |

| Class | Scientific Name | Common Name | BC Act | EPBC Act | Recent Record (Y/N) | LoO |
|---|---|---|---|---|---|---|
| Aves | *Pachycephala inornata* | Gilbert's Whistler | V | | N | High |
| Aves | *Petroica boodang* | Scarlet Robin | V | | Y | High |
| Aves | *Petroica phoenicea* | Flame Robin | V | MAR | N | High |
| Aves | *Polytelis swainsonii* | Superb Parrot | V | V | N | Moderate |
| Aves | *Pomatostomus temporalis temporalis* | Grey-crowned Babbler (eastern subspecies) | V | | Y | Moderate |
| Aves | *Pycnoptilus floccosus* | Pilotbird | | V | N | Moderate |
| Aves | *Rhipidura rufifrons* | Rufous Fantail | | M,MAR | N | High |
| Aves | *Stagonopleura guttata* | Diamond Firetail | V | | Y | High |
| Aves | *Tyto novaehollandiae* | Masked Owl | V | | N | High |
| Aves | *Tyto tenebricosa* | Sooty Owl | V | | N | Known |
| Flora | *Acacia bynoeana* | Bynoe's Wattle | E | V | N | Moderate |
| Flora | *Acacia flocktoniae* | Flockton Wattle | V | V | N | Moderate |
| Flora | *Acacia meiantha* | | E | E | N | Moderate |
| Flora | *Astrotricha crassifolia* | Thick-leaf Star-hair | V | V | N | Moderate |
| Flora | *Eucalyptus cannonii* | Capertee Stringybark | V | | Y | Known |
| Flora | *Grevillea evansiana* | Evans Grevillea | V | V | N | Moderate |
| Flora | *Grevillea obtusiflora* | | E | E | N | Moderate |
| Flora | *Haloragodendron lucasii* | | E | E | N | Moderate |
| Flora | *Homoranthus darwinioides* | Fairy Bells | V | V | N | Moderate |
| Flora | *Leionema lachnaeoides* | | E | E | N | Moderate |
| Flora | *Leionema sympetalum* | Rylstone Bell | V | V | N | Moderate |
| Flora | *Olearia cordata* | | V | V | N | Moderate |
| Flora | *Persoonia marginata* | Clandulla Geebung | V | V | Y | Moderate |
| Flora | *Phebalium bifidum* | | E | | Y | Moderate |
| Flora | *Pomaderris cotoneaster* | Cotoneaster Pomaderris | E | E | N | High |
| Flora | *Prostanthera cryptandroides subsp. cryptandroides* | Wollemi Mint-bush | V | V | N | High |
| Flora | *Prostanthera stricta* | Mount Vincent Mint-bush | V | V | Y | Known |
| Flora | *Pultenaea glabra* | Smooth Bush-Pea | V | V | N | High |
| Flora | *Pultenaea sp. Genowlan Point* | | CE | CE | N | Known |
| Flora | *Pultenaea sp. Olinda* | | E | | N | High |
| Flora | *Rhodamnia rubescens* | Scrub Turpentine | CE | CE | N | Moderate |
| Flora | *Swainsona recta* | Small Purple-pea | E | E | N | Moderate |
| Flora | *Xanthosia scopulicola* | | V | | N | Moderate |
| Flora | *Zieria murphyi* | Velvet Zieria | V | V | N | High |
| Insect | *Paralucia spinifera* | Purple Copper Butterfly, Bathurst Copper Butterfly | E | V | N | Moderate |
| Mammalia | *Cercartetus nanus* | Eastern Pygmy-possum | V | | N | High |
| Mammalia | *Chalinolobus dwyeri* | Large-eared Pied Bat | V | V | N | Known |
| Mammalia | *Dasyurus maculatus* | Spotted-tailed Quoll | V | E | N | High |
| Mammalia | *Falsistrellus tasmaniensis* | Eastern False Pipistrelle | V | | N | Moderate |
| Mammalia | *Micronomus norfolkensis* | Eastern Coastal Free-tailed Bat | V | | N | Moderate |
| Mammalia | *Miniopterus australis* | Little Bent-winged Bat | V | | N | Moderate |

| Class | Scientific Name | Common Name | BC Act | EPBC Act | Recent Record (Y/N) | LoO |
|---|---|---|---|---|---|---|
| Mammalia | *Miniopterus orianae oceanensis* | Large Bent-winged Bat | V | | N | High |
| Mammalia | *Myotis macropus* | Southern Myotis | V | | N | Moderate |
| Mammalia | *Petauroides volans* | Greater Glider | | E | N | Known |
| Mammalia | *Petaurus australis* | Yellow-bellied Glider | V | | N | Moderate |
| Mammalia | *Petaurus norfolcensis* | Squirrel Glider | V | | N | High |
| Mammalia | *Petrogale penicillata* | Brush-tailed Rock-wallaby | E | V | N | High |
| Mammalia | *Phascogale tapoatafa* | Brush-tailed Phascogale | V | | N | Moderate |
| Mammalia | *Phascolarctos cinereus* | Koala | E | E | Y | Known |
| Mammalia | *Pseudomys novaehollandiae* | New Holland Mouse | | V | N | Moderate |
| Mammalia | *Pteropus poliocephalus* | Grey-headed Flying-fox | V | V | N | High |
| Mammalia | *Saccolaimus flaviventris* | Yellow-bellied Sheathtail-bat | V | | N | High |
| Mammalia | *Vespadelus troughtoni* | Eastern Cave Bat | V | | N | High |
| Reptilia | *Aprasia parapulchella* | Pink-tailed Legless Lizard | V | V | N | Moderate |
| Reptilia | *Delma impar* | Striped Legless Lizard | V | V | N | Moderate |
| Reptilia | *Hoplocephalus bungaroides* | Broad-headed Snake | E | V | N | High |
| Reptilia | *Varanus rosenbergi* | Rosenberg's Goanna | V | | N | Known |

Note: V – Vulnerable; E – Endangered; CE – Critically Endangered; M – Migratory; MAR - Marine.

## 3.2 Vegetation types

Broadscale vegetation types include dry sclerophyll forest, wet sclerophyll forest and heathlands. Dry sclerophyll habitats dominate about half of study area, wet sclerophyll habitats are much more patchily distributed occurring in the gullies surrounding the study area, and heathlands are generally restricted to patches of sandstone rock outcrops.

### 3.2.1 Plant Community Types

The MW17-19 EP area comprises eight PCTs and the CLZ (ML1814) comprises 12 PCTs (see **Table 3-5**).

**Table 3-5 PCTs within the MW17-19 EP area**

| PCT Code | PCT Description | CLZ (ML1814) Area (ha) | MW17-19 EP Area (ha) |
|---|---|---|---|
| 0 | Not native vegetation | 0.03 | 0.08 |
| 3210 | Blue Mountains Cool Wet Eucalypt Forest | 0.13 | 0.01 |
| 3226 | Western Blue Mountains Montane Wet Fern Forest | 15.19 | 1.68 |
| 3480 | Capertee-Wolgan Escarpment Dry Forest | 0.19 | - |
| 3495 | Western Blue Mountains Monkey Gum Gully Forest | 29.21 | 11.55 |
| 3686 | Mount Airly Sandstone Forest | 89.99 | 42.21 |
| 3687 | Newnes Plateau Peppermint-Ash Tall Forest | 2.16 | 0.50 |
| 3694 | Upper Blue Mountains Ridgetop Woodland | 1.55 | - |
| 3695 | Western Blue Mountains Peppermint Sheltered Forest | 12.79 | 13.97 |
| 3731 | Capertee Conglomerate Grey Gum-Stringybark Forest | 2.31 | - |
| 3859 | Genowlan Point Heath | 2.21 | - |
| 3862 | Newnes Plateau Rockplate Heath | 1.29 | 3.49 |
| 3865 | Western Blue Mountains Pagoda Scrub | 54.36 | 48.15 |
| **Grand Total** | | **211.41** | **121.62** |

Further descriptions of the PCTs are provided below.

#### 3.2.1.1 Blue Mountains Cool Wet Eucalypt Forest (PCT 3210)

| | Vegetation Community Details |
|---|---|
| **Description:** | A very tall to extremely tall sclerophyll open forest with a layered mid-stratum of mesophyll small trees and tree ferns, with a ground layer of ferns and climbers. This PCT occurs in deeply incised elevated gullies in Kanangra Boyd National Park and sheltered slopes on basalt peaks in the Blue Mountains.<br>The tree canopy is variable in composition and is characterised by a suite of cool-climate species that individually occur no more than occasionally. *Eucalyptus fastigata* is most frequently recorded with other species including *Eucalyptus viminalis*, *Eucalyptus smithii, Eucalyptus oreades* are all rare though locally dominant. Very localised stands of *Eucalyptus bicostata* occur in the Coxs catchment and very protected creeks in the Kowmung Gorge are dominated by *Casuarina cunninghamiana subsp. cunninghamiana.* The mid-stratum is very frequently layered with a mid-dense layer of smaller trees, very frequently dominated by a high cover of Doryphora sassafras commonly with *Acacia melanoxylon* and rarely with *Toona ciliata*. A lower layer of tall shrubs includes *Melicytus dentatus* and *Hedycarya angustifolia*, with tree ferns *Cyathea australis* or *Dicksonia antarctica,* common. The ground layer very frequently includes *Urtica incisa,* particularly near canopy openings along with small ferns such as *Pellaea falcata.* Small climbers are also common including *Pandorea pandorana subsp. pandorana, Hackelia latifolia, Smilax australis* and *Tylophora barbata.*<br>The distribution of this PCT is partitioned by substrate. In the Blue Mountains it is localised around the sheltered slopes of the large basalt peaks of Mount Wilson and Mount Tomah, generally at elevations of above 800 metres asl. In Kanangra Boyd National Park it occupies drier climates, however in very protected, steep and incised gullies on a range of metasediments with elevations that fall to around 500 metres asl. Collectively however, these environments are amongst the coolest in the Sydney |

| | Vegetation Community Details |
|---|---|
| | Basin region. This community shares a moderate floristic overlap with rainforest PCT 3047, however in Kanangra Boyd National Park it receives less than two thirds of the annual rainfall of that PCT and includes a simpler assemblage of rainforest species. |
| **Vegetation formation:** | Wet Sclerophyll Forests (Shrubby sub-formation) |
| **PCT lineage:** | Previously PCT 706 |
| **Percent cleared:** | 3.06% |
| **Associated TEC:** | Relates to the NSW Blue Mountains Basalt Forest TEC where it occurs in the Sydney Basin Bioregion and on basalt influenced substrates consistent with the Final Determination paragraph 2.2.<br>Relates to the Commonwealth Upland Basalt Eucalypt Forests TEC where it occurs on soils derived from basalt or basalt like substrates within or adjoining the Sydney Basin bioregion (IBRA Version 6.1) and satisfies the condition thresholds as per section 5 of the Listing Advice. |

### 3.2.1.2 Western Blue Mountains Montane Wet Fern Forest (PCT 3226)

| | Vegetation Community Details |
|---|---|
| **Description:** | A very tall wet sclerophyll open forest of intermediate elevations on moderately fertile, moist sheltered slopes of the moderately high, cool western Blue Mountains and outlying ranges. Distributed from Charbon and the slopes of Nullo Mountain south to Springvale and Hartley Vale and through the western Burragorang catchment to Mares Forest and Joadja. Samples are from elevations of 650-1150 metres asl, with means of 700-1100 mm rainfall and 4-19 frost days annually, commonly associated with sheltered slopes derived from shales and enriched sandstones (Illawarra Coal Measures, Narrabeen Group sandstones below remnant basalt, Lambie Group metasediments) and occasionally ignimbrite and granitic rocks.<br>A very tall, mid-dense to closed canopy commonly contains *Eucalyptus fastigata*, accompanied by *Eucalyptus radiata* and occasionally *Eucalyptus cypellocarpa*. A scattered small tree layer commonly includes *Acacia falciformis* and occasionally *Elaeocarpus reticulatus*. The shrub layer is sparse and very frequently includes scattered *Leucopogon lanceolatus* and occasionally *Coprosma quadrifida* or *Persoonia linearis*. The ground layer is mid-dense to closed and is commonly dominated by ferns including *Pteridium esculentum, Blechnum cartilagineum* and *Calochlaena dubia*, interspersed with tall clumps of *Lomandra longifolia* and *Dianella caerulea*. Other ground layer species include tufted grasses *Microlaena stipoides* and *Poa sieberiana,* small forbs *Viola hederacea, Poranthera microphylla* and *Hydrocotyle laxiflora*, and small vines including *Clematis aristata* and occasional *Geitonoplesium cymosum, Billardiera scandens, Desmodium varians* or *Eustrephus latifolius.*<br>This community tends to occupy deep gullies in the north of its range and moist, sheltered south-facing slopes at higher elevations further south, and may be replaced by PCT 3650 on exposed rocky crests. On more fertile soils on remnant basalt caps it may be replaced by PCT 3305. |
| **Vegetation formation:** | Wet Sclerophyll Forests (Shrubby sub-formation) |
| **PCT lineage:** | Complex split from PCT 1107 and 1615 |
| **Percent cleared:** | 6.74% |
| **Associated TEC:** | No associated TEC |

### 3.2.1.3 Capertee-Wolgan Escarpment Dry Forest (PCT 3480)

| | Vegetation Community Details |
|---|---|
| **Description:** | This placeholder PCT describes a tall to very tall sclerophyll open forest with a mid-stratum of dry shrubs and a ground layer of grasses, graminoids and small climbers. Caution is required with the assignment of plots to this PCT as it is defined by a pool of standard survey plots collected across a range of seasonal extremes by different observers, each with alternate though related taxonomic interpretations. Additional fieldwork is required to resolve data in the area. Based on current data however, this PCT occurs on Permian siltstone and shale escarpment slopes, below the residual sandstone mesas and plateaus above the Capertee Valley, western Blue Mountains. |

| | Vegetation Community Details |
|---|---|
| | The tree canopy very frequently includes a high cover of Eucalyptus fibrosa commonly with *Eucalyptus punctata*, and occasionally one or more species from the stringybark eucalypt group, of which *Eucalyptus macrorhyncha* and *Eucalyptus cannonii* are most frequent. These may be occasionally accompanied or replaced by *Eucalyptus polyanthemos,* rarely *Eucalyptus cypellocarpa* or *Eucalyptus rossii*. The mid-stratum occasionally includes a sparse layer of small trees including eucalypt saplings or *Acacia obtusifolia*. A lower layer of dry shrubs is sparse to mid-dense and almost always includes *Acrotriche rigida*, very frequently with *Bursaria spinosa* and *Persoonia linearis,* commonly with *Astroloma humifusum, Hibbertia obtusifolia, Correa reflexa* and *Indigofera australis.* The ground layer is also sparse to mid-dense, very frequently including *Glycine clandestina*, and commonly tussock grasses including *Poa sieberiana* and *Rytidosperma pallidum, Dianella prunina* and small climbers *Clematis glycinoides* and *Hardenbergia violacea.*<br>This PCT occurs at mid-elevations across all the escarpment aspects that fall below Mount Airly and is likely to extend to unsampled parts of the eastern escarpment below the Wollemi Plateau. It grades into taller forest PCT 3510 on sheltered escarpment aspects or on deeper shale soils. |
| **Vegetation formation:** | Dry Sclerophyll Forests (Shrubby sub-formation) |
| **PCT lineage:** | New vegetation type |
| **Percent cleared:** | 1.96% |
| **Associated TEC:** | No associated TEC |

### 3.2.1.4 Western Blue Mountains Monkey Gum Gully Forest (PCT 3495)

| | Vegetation Community Details |
|---|---|
| **Description:** | A tall to very tall sheltered sclerophyll open forest with dry shrubs and a ground cover of ferns, climbers and graminoids found, in gullies and on steep sheltered escarpment slopes that trace the margins of the sandstone plateau along the western Blue Mountains.<br>The tree canopy is very frequently dominated by *Eucalyptus cypellocarpa*, often with one or more stringybark eucalypts of which *Eucalyptus blaxlandii* and *Eucalyptus globoidea* are most frequent. Other species occasionally include Eucalyptus punctata and rarely Eucalyptus piperita. The mid-stratum is sometimes layered, with a sparse cover of smaller trees that include eucalypts, taller Acacia species, which commonly includes *Acacia obtusifolia* or a sparse cover of *Melaleuca linariifolia* in creek lines. The lower layer of dry shrubs commonly includes *Leucopogon lanceolatus*, *Leptospermum polygalifolium, Acacia obtusifolia* and *Bursaria spinosa*. The ground layer is a mid-dense to dense cover of ferns, climbers, forbs and graminoids. *Lomandra longifolia* is almost always present, very frequently with Pteridium esculentum, Adiantum aethiopicum, *Clematis aristata, Geitonoplesium cymosum, Desmodium varians* and *Dichondra repens.*<br>This PCT is closely associated with sheltered Permian Berry Siltstones on mid to high elevations between Mount Airly in the Capertee Valley and the Megalong and Jamison valleys below the townships of the Upper Blue Mountains. Southern outliers occur in the ranges and valleys around Yerranderie, where Permian sediments are exposed along and below Scotts Main Range. Grades into a wide range of dry and sheltered forest PCTs across its range. It is largely encompassed within the reserve system of the Greater Blue Mountains World Heritage Area. |
| **Vegetation formation:** | Dry Sclerophyll Forests (Shrubby sub-formation) |
| **PCT lineage:** | Previously PCT 941 |
| **Percent cleared:** | 1.73% |
| **Associated TEC:** | No associated TEC |

### 3.2.1.5 Mount Airly Sandstone Forest (PCT 3686)

| | Vegetation Community Details |
|---|---|
| **Description:** | A tall, rarely very tall sclerophyll open forest with a dry shrub layer and very sparse ground layer associated with exposed, rocky high elevation Narrabeen sandstone mesas and ranges on the western rim of the Capertee Valley, Central Tablelands. |

| | Vegetation Community Details |
|---|---|
| | The tree canopy very frequently includes *Eucalyptus sparsifolia*, commonly *Eucalyptus punctata* and/or *Eucalyptus piperita* or occasionally *Eucalyptus mannifera*. The mid-stratum occasionally includes a taller layer of small trees, dominated by *Allocasuarina littoralis*. The lower layer of dry shrubs almost always includes *Acacia obtusifolia*, very frequently with *Persoonia linearis* and commonly with *Leucopogon muticus* and *Podolobium ilicifolium*. The ground layer is dominated by litter and loose stones, and only a very sparse cover of native vegetation, characterised by isolated individuals of graminoids and grasses. Species commonly include Lomandra filicifolia, *Entolasia stricta, Microlaena stipoides* and *Dianella caerulea,* occasionally with *Poa sieberiana.*<br>This PCT is found mainly on the ridgetops of Mount Airly, however occurs patchily on residual sandstones east of Ilford in areas disconnected from the main sandstone ranges to the south and east. It is replaced on the main Ben Bullen range by dry shrub forest PCT 3749 which includes a different set of canopy species, has a lower frequency of *Acacia obtusifolia* and a higher grass cover. |
| **Vegetation formation:** | Dry Sclerophyll Forests (Shrubby sub-formation) |
| **PCT lineage:** | Previously PCT 1248 |
| **Percent cleared:** | 10.01% |
| **Associated TEC:** | No associated TEC |

### 3.2.1.6 Newnes Plateau Peppermint-Ash Tall Forest (PCT 3687)

| | Vegetation Community Details |
|---|---|
| **Description:** | A very tall moist shrubby sclerophyll open forest found on high cool parts of Newnes Plateau in the eastern central tablelands. This PCT is associated with areas of moderately deep or enriched soil, (possibly shale lenses) on Banks Wall Sandstone on the plateau and at its margins with underlying Illawarra Coal Measures sediments. It occurs at elevations of 950-1200 metres asl, with means of 900-1100 mm precipitation and 7-14 frost days annually.<br>A mid-dense tree canopy almost always includes *Eucalyptus radiata, commonly with Eucalyptus dalrympleana* and occasionally *Eucalyptus oreades, Eucalyptus blaxlandii, Eucalyptus fastigata* or *Eucalyptus cypellocarpa.* A complex mid-stratum includes sparse small trees such as occasional *Polyscias sambucifolia* or *Acacia falciformis,* and a mid-dense smaller shrub layer that commonly includes *Leucopogon lanceolatus, Lomatia silaifolia, Amperea xiphoclada, Monotoca scoparia and Olearia myrsinoides,* and occasional patchy *Leptospermum polygalifolium, Banksia spinulosa, Callicoma serratifolia* or *Lomatia myricoides.* The ground layer is mid-dense to sparse and commonly includes tall *Pteridium esculentum, Lomandra longifolia, Dianella caerulea, Dianella tasmanica* and *Senecio pinnatifolius,* twining Billardiera scandens and Clematis aristata, grasses *Microlaena stipoides* and *Poa sieberiana,* and small forbs *Viola sieberiana, Poranthera microphylla, Hydrocotyle laxiflora, Gonocarpus teucrioides, Lomandra filiformis* and *Solenogyne bellioides*. This community commonly grades into PCT 3688 on nearby shallow sandstone soils. |
| **Vegetation formation:** | Dry Sclerophyll Forests (Shrubby sub-formation) |
| **PCT lineage:** | Previously PCT 1247 |
| **Percent cleared:** | 3.11% |
| **Associated TEC:** | No associated TEC |

### 3.2.1.7 Upper Blue Mountains Ridgetop Woodland (PCT 3694)

| | Vegetation Community Details |
|---|---|
| **Description:** | A mid-high to tall, rarely very tall, heathy sclerophyll open forest or woodland found on exposed Narrabeen sandstone ridges and slopes across the upper Blue Mountains.<br>The tree canopy very frequently includes a high cover of *Eucalyptus sieberi* and *Eucalyptus piperita,* occasionally accompanied or replaced by *Eucalyptus sclerophylla, Eucalyptus sparsifolia* or *Eucalyptus oreades*. The mid-dense to dense mid-stratum is characterised by shrubs from the Proteaceae family, very frequently *Banksia spinulosa, Isopogon anemonifolius, Monotoca scoparia* and *Persoonia levis*. Other shrub species frequently include *Leptospermum trinervium* and *Hakea* |

| | Vegetation Community Details |
|---|---|
| | *dactyloides* with the smaller *Platysace linearifolia* almost always present. The ground layer is commonly an open cover of grasses, graminoids, sedges and ferns that very frequently includes *Entolasia stricta, Caustis flexuosa, Lomandra glauca* and commonly *Pteridium esculentum.*<br>This PCT is widespread across sandstone plateaus at elevations above 600 metres asl and within a rainfall range of 920 mm in the western Blue Mountains to 1400 mm per annum in the wettest parts near Katoomba. It extends from the eastern Newnes Plateau to Kings Tableland with outlying examples on elevated parts of Lacys Tableland above Lake Burragorang. |
| **Vegetation formation:** | Dry Sclerophyll Forests (Shrubby sub-formation) |
| **PCT lineage:** | Complex split from PCTs 1248 and 1249 |
| **Percent cleared:** | 6.72% |
| **Associated TEC:** | No associated TEC |

### 3.2.1.8 Western Blue Mountains Peppermint Sheltered Forest (PCT 3695)

| | Vegetation Community Details |
|---|---|
| **Description:** | A tall to very tall dry shrubby sclerophyll open forest found on sheltered Narrabeen sandstone slopes and gullies on the western ranges of Wollemi National Park.<br>The tree canopy almost always includes a high cover of Eucalyptus piperita occasionally with Eucalyptus punctata or rarely Eucalyptus cypellocarpa and stringybarks (*Eucalyptus sparsifolia, Eucalyptus agglomerata, Eucalyptus blaxlandii*). The sparse shrub layer very frequently includes *Leucopogon lanceolatus, Persoonia linearis* and *Acacia obtusifolia* with the latter the most abundant and *Podolobium ilicifolium* is also common. The ground layer consists of a sparse cover of *Pteridium esculentum, Dianella caerulea* and *Entolasia stricta*.<br>This sheltered forest is widespread across the sandstone plateau of the northern Wollangambe and Newnes plateaus north to the Nullo Mountain area. This region marks an area of declining rainfall as the sandstone ranges fall in elevation from high points in the Upper Blue Mountains towards the western flowing Cudgegong River. This community grades into exposed ridgetop woodlands PCT 3623 in the northern extent of the distribution near Nullo Mountain and dry forests PCT 3627 and PCT 3857 elsewhere. |
| **Vegetation formation:** | Dry Sclerophyll Forests (Shrubby sub-formation) |
| **PCT lineage:** | Previously PCT 1630 |
| **Percent cleared:** | 1.86% |
| **Associated TEC:** | No associated TEC |

### 3.2.1.9 Capertee Conglomerate Grey Gum-Stringybark Forest (PCT 3731)

| | Vegetation Community Details |
|---|---|
| **Description:** | A tall, occasionally very tall, sclerophyll open forest with a mid-stratum of dry shrubs and a ground layer of grasses and graminoids. This PCT occurs on dry quartz-rich Permian sediments exposed on foothill ranges of the Capertee and Wolgan valleys, western Blue Mountains.<br>The tree canopy very frequently includes a high cover of *Eucalyptus punctata* and one or more species from the stringybark eucalypt group, of which *Eucalyptus sparsifolia* and *Eucalyptus cannonii* are most frequent. Other eucalypts commonly include *Eucalyptus rossii*, and rarely *Eucalyptus fibrosa, Eucalyptus crebra,* or very localised patches of *Eucalyptus polyanthemos* or Eucalyptus mannifera. The sparse to mid-dense shrub layer commonly includes *Persoonia linearis, Podolobium ilicifolium*, *Hibbertia obtusifolia, Platysace ericoides, Astroloma humifusum* and *Brachyloma daphnoides,* occasionally with a patchy cover of *Leucopogon muticus* and *Acacia decora*. The sparse to mid-dense ground layer is dominated by grasses, very frequently including *Rytidosperma pallidum*, commonly or occasionally with *Dichelachne micrantha*, *Microlaena stipoides* or *Poa sieberiana.* Small forbs almost always include *Goodenia hederacea*, very frequently with graminoids such as *Dianella revoluta* and *Lomandra filiformis*. |

| | Vegetation Community Details |
|---|---|
| | This PCT occurs across a topographically diverse landscape, depending on where the underlying Permian substrate is exposed. This varies from steep, dry and rocky escarpment talus slopes, or on gently sloping crests on plateaus or lower-elevation valley floors. Such areas receive a relatively low mean annual rainfall as they fall in the rain shadow of the Blue Mountains plateau. It occurs at mid to high elevations which experience cool tableland temperatures. This community is replaced by forest PCTs 3480 or 3770 on finer-grained Permian sediments exposed on escarpments and foothills. It has only weak floristic overlap with other PCTs in NSW, and is extensively distributed throughout Gardens of Stone National Park. |
| **Vegetation formation:** | Dry Sclerophyll Forests (Shrubby sub-formation) |
| **PCT lineage:** | Complex split from 889 and 863 |
| **Percent cleared:** | 27.07% |
| **Associated TEC:** | No associated TEC |

### 3.2.1.10 Genowlan Point Heath (PCT 3859)

| | Vegetation Community Details |
|---|---|
| **Description:** | A closed heathland found on rocky Narrabeen sandstone at Genowlan Point on the isolated Mount Airly mesa in the Capertee Valley and surrounding escarpments, western Blue Mountains.<br>Mid-high eucalypts are rarely recorded as emergents, mainly *Eucalyptus blaxlandii* or *Eucalyptus sparsifolia* along with, occasionally, just a few individuals of *Callitris muelleri.* A dense even shrub canopy almost always includes Allocasuarina nana and Leptospermum trinervium and very frequently a sparse cover of Acacia obtusifolia, commonly Brachyloma daphnoides and occasionally *Banksia penicillata*. The ground layer consists of a patchy and sparse cover of graminoids, very frequently including *Lepidosperma viscidum* and *Lomandra glauca* and rarely the larger *Xanthorrhoea johnsonii*.<br>This PCT has a naturally restricted distribution and represents the driest end of the rainfall gradient among all the Sydney Montane Heaths dominated by *Allocasuarina nana*. This community occurs where mean annual rainfall covers a narrow band of 800-860 mm, although the elevation range of 990-1030 metres asl overlaps with other upper Blue Mountains heath PCTs 3862 and 3863. The species richness of these more easterly wetter heaths is almost twice that recorded in this PCT. |
| **Vegetation formation:** | Heathlands |
| **PCT lineage:** | Previously PCT 636 |
| **Percent cleared:** | 32.74% |
| **Associated TEC:** | Relates to the NSW *Genowlan Point Allocasuarina nana Heathland* TEC only where it occurs on Genowlan Point as per paragraph 1 of the Final Determination. |

### 3.2.1.11 Newnes Plateau Rockplate Heath (PCT 3862)

| | Vegetation Community Details |
|---|---|
| **Description:** | A tall heathland or closed heathland, occasionally with eucalypt emergents, found on rocky Narrabeen sandstone on the margins of the Newnes Plateau and headwaters of the Wollangambe catchment, upper Blue Mountains.<br>Low growing eucalypts including the rare mallee *Eucalyptus gregsoniana* are occasionally recorded as an emergent layer. The shrub canopy almost always includes a high cover of A*llocasuarina nan*a broken only by exposed rock plates or pagodas. The shrub layer also very frequently includes *Banksia ericifolia, Petrophile pulchella, Calytrix tetragona* and *Leptospermum arachnoides*. The ground layer is a sparse patchy cover on the skeletal soils however almost always includes *Stylidium lineare* and commonly *Lepidosperma laterale* and *Lomandra glauca*.<br>This PCT is prominent on the rocky ridges that lead to cliffs and escarpments overlooking incised gorges, and forms a continuous even cover or tessellated pattern where the heath grows over extensive areas amongst open exposed pagodas and outcrops. It is restricted to higher elevations, usually exceeding 900 metres asl that receive 900-1160 mm mean annual rainfall. This community |

| | Vegetation Community Details |
|---|---|
| | occurs in colder and drier environments than those that support the similar heath PCT 3863 found in the wetter parts of the upper Blue Mountains near Blackheath and Katoomba. |
| **Vegetation formation:** | Heathlands |
| **PCT lineage:** | Previously PCT 708 |
| **Percent cleared:** | 0.95% |
| **Associated TEC:** | No associated TEC |

### 3.2.1.12 Western Blue Mountains Pagoda Scrub (PCT 3865)

| | Vegetation Community Details |
|---|---|
| **Description:** | A tall open shrubland found on massive residual sandstone outcrops known as pagodas, on clifftops and escarpment edges of the Newnes Plateau and adjoining ranges, western Blue Mountains.<br>The shrub canopy almost always includes *Leptospermum parvifolium* with a high cover and *Leucopogon muticus*, very frequently with *Calytrix tetragona* and *Leptospermum arachnoides*. There is a diverse however inconsistent combination of other heath shrubs that are typically sparse in cover, commonly including *Acacia obtusifolia*, rarely with *Isopogon anethifolius* and *Banksia penicillata.* The shrubland occasionally has a sparse taller layer of small trees that include combinations of pine, most frequently *Callitris rhomboidea*, low stunted eucalypts, most frequently *Eucalyptus rossii* and mallee eucalypts such as *Eucalyptus stricta*. A range of *Allocasuarina* species are also sometimes present, most frequently *Allocasuarina distyla*, either in the small tree layer or as stunted forms in the shrubland. Exposed rock makes up a large proportion of the ground cover and as a result, the mix of ground layer species and their cover is highly variable. An example of the ground layer includes small clumps of sedges such as *Lepidosperma viscidum* that cling to damp skeletal soils in rock crevices.<br>This PCT is common although patchy across the mid to high-elevations between Lithgow and the Wolgan Valley, occurring within Wollemi and Gardens of Stone national parks. It forms part of a mosaic of shrubland, heath and rocky woodland communities in the western Blue Mountains. This PCT is replaced by a floristically related shrubland PCT 3866, found below 750 metres asl in lower annual rainfall zones. Some of the characteristic shrub canopy are shared between the two shrublands, however PCT 3866 includes species common to dry rock plates of the western Hunter region. |
| **Vegetation formation:** | Heathlands |
| **PCT lineage:** | New vegetation type |
| **Percent cleared:** | 0.50% |
| **Associated TEC:** | No associated TEC |

## Legend

N

- Development Consent (SSD_5581)
- MW17-19 EP Area
- CLZ EP Area (ML1814)
- CLZ EP Area (ML1331)

***Vegetation by PCT***

- 1330 - Yellow Box - Blakelys Red Gum grassy woodland on the tablelands, South Eastern Highlands Bioregion
- 1853 - Blue Mountains Gorges Grey Gum Sheltered Forest
- 1876 - Capertee Footslopes Box-Stringybark Forest
- 1877 - Capertee Escarpment Ironbark Forest
- 1881 - Western Hunter Flats Rough-barked Apple Forest
- 1886 - Western Hunter Footslopes Box Woodland
- 1895 - Sydney Hinterland Grey Myrtle Dry Rainforest
- 3110 - Greater Sydney Enriched Grey Myrtle Dry Rainforest
- 3210 - Blue Mountains Cool Wet Eucalypt Forest
- 3226 - Western Blue Mountains Montane Wet Fern Forest
- 3227 - Western Blue Mountains Sheltered Shale Forest
- 3303 - Central Tableland Ribbon Gum Sheltered Forest
- 3376 - Southern Tableland Grassy Box Woodland
- 3396 - Northwest Flats Box-Blakelys Red Gum Forest
- 3406 - Southwest Ranges White Box Woodland
- 3480 - Capertee-Wolgan Escarpment Dry Forest
- 3495 - Western Blue Mountains Monkey Gum Gully Forest
- 3510 - Capertee Slopes Stringybark-Box Forest
- 3516 - Northwest Black Pine-Ironbark Forest
- 3623 - Western Blue Mountains Grey Gum-Stringybark Forest
- 3686 - Mount Airly Sandstone Forest
- 3687 - Newnes Plateau Peppermint-Ash Tall Forest
- 3694 - Upper Blue Mountains Ridgetop Woodland
- 3695 - Western Blue Mountains Peppermint Sheltered Forest
- 3696 - Western Blue Mountains Rocky Scribbly Gum Woodland
- 3731 - Capertee Conglomerate Grey Gum-Stringybark Forest
- 3749 - Western Blue Mountains Scribbly Gum Forest
- 3859 - Genowlan Point Heath
- 3862 - Newnes Plateau Rockplate Heath
- 3865 - Western Blue Mountains Pagoda Scrub
- 4064 - Central Eastern Ranges River Oak Forest
- 32767 - Unattributed
- 0 - Not native vegetation

ML1331

ML1814

**FIGURE 3-5:**
**VEGETATION COMMUNITIES**

LOCATION: **AIRLY**

VERSION: **A**
DATE EXPORTED: **26/09/2022**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m

SCALE 1:30,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial**
PROJ: **PR152229**
PURPOSE: **Baseline Assessment**

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### 3.2.2 Threatened Ecological Communities

PCT 3210 and PCT 3859 may form a part of BC Act listed TECs.

It was concluded that one TEC occurs within the CLZ EP area (see **Table 3-6**).

**Table 3-6: TECs within the EP areas**

| TEC | Listing | Associated PCT | Area (ha) | EP Area |
|---|---|---|---|---|
| Genowlan Point *Allocasuarina nana* Heathland EEC | BC Act | 3895 | 2.21 | CLZ |

Details of these listings and justification of their presence or absence within the study area are provided in the following section.

#### 3.2.2.1 Genowlan Point *Allocasuarina nana* Heathland EEC

PCT 3859 within the study area forms a part of the Genowlan Point *Allocasuarina nana* Heathland EEC listed under the BC Act. PCT 3859 within the study area is consistent with the EEC listing as:

- It occurs on the Genowlan Point, Capertee Valley; and
- It contains *Allocasuarina nana*, as confirmed in floristic plots recently undertaken (**Table 3-7**). These plots also confirmed the presence of *Xanthorrhoea johnsonii, Micromyrtus sessilis, Pseudanthus divaricatissimus* and *Callitris muelleri,* which form a unique combination that typically composes this community (DPE 2019b).

This EEC is geographically restricted to Genowlan Point with the total extent of its occurrence limited to an estimated 15.2 ha area. This TEC is monitored annually by the NPWS.

Two floristic plots were surveyed as part of this Baseline Assessment (**Figure 2-2**). Results are detailed below in **Table 3-7**. Both plots displayed a species diversity of 27 and contained no exotic species.

**Table 3-7: Flora composition and Structure of BAM plots for Genowlan Point *Allocasuarina nana* Heathland EEC**

| BAM Growth Form Group | Scientific Name | Common Name | GEN_PT_02 C | GEN_PT_01 A | GEN_PT_02 C | GEN_PT_02 A |
|---|---|---|---|---|---|---|
| Forb (FG) | *Dampiera stricta* | | 1 | 100 | 0.5 | 50 |
| Forb (FG) | *Goodenia bellidifolia* | | 0.1 | 50 | 0.2 | 30 |
| Forb (FG) | *Patersonia sericea* | Silky Purple-Flag | 0.1 | 1 | | |
| Grass & grasslike (GG) | *Austrostipa pubescens* | | 0.1 | 25 | | |
| Grass & grasslike (GG) | *Lepidosperma viscidum* | | 15 | 25 | 0.1 | 2 |
| Grass & grasslike (GG) | *Lomandra glauca* | Pale Mat-rush | 0.2 | 50 | 1 | 50 |
| Grass & grasslike (GG) | *Rytidosperma spp.* | | | | 0.1 | 2 |
| Grass & grasslike (GG) | *Rytidosperma tenuius* | | 0.1 | 25 | | |
| Grass & grasslike (GG) | *Schoenus spp.* | | 1 | 100 | 0.1 | 5 |
| Grass & grasslike (GG) | *Schoenus villosus* | | | | 1 | 40 |
| Other (OG) | *Marsdenia spp.* | | 0.1 | 1 | | |
| Other (OG) | *Xanthorrhoea johnsonii* | Johnson's Grass Tree | | | 1 | 3 |
| Shrub (SG) | *Acacia obtusifolia* | | 0.1 | 1 | 1 | 1 |
| Shrub (SG) | *Allocasuarina nana* | Dwarf She-oak | 75 | 100 | 70 | 200 |
| Shrub (SG) | *Babingtonia densifolia* | | 0.2 | 25 | | |

| BAM Growth Form Group | Scientific Name | Common Name | GEN_PT_02 C | GEN_PT_01 A | GEN_PT_02 C | GEN_PT_02 A |
|---|---|---|---|---|---|---|
| Shrub (SG) | *Baeckea brevifolia* | | 0.1 | 10 | | |
| Shrub (SG) | *Boronia microphylla* | Small-leaved Boronia | | | 0.2 | 20 |
| Shrub (SG) | *Boronia rigens* | Stiff Boronia | 0.1 | 25 | 0.4 | 20 |
| Shrub (SG) | *Bossiaea heterophylla* | Variable Bossiaea | | | 0.6 | 20 |
| Shrub (SG) | *Brachyloma daphnoides* | Daphne Heath | 0.1 | 5 | 1 | 10 |
| Shrub (SG) | *Cryptandra amara* | Bitter Cryptandra | 0.1 | 20 | 0.5 | 20 |
| Shrub (SG) | *Harmogia densifolia* | | | | 0.2 | 20 |
| Shrub (SG) | *Hibbertia serpyllifolia* | Hairy Guinea Flower | 0.1 | 5 | | |
| Shrub (SG) | *Isopogon anethifolius* | Narrow-leaf Drumsticks | 0.1 | 1 | 0.1 | 1 |
| Shrub (SG) | *Kunzea parvifolia* | Violet Kunzea | 5 | 25 | | |
| Shrub (SG) | *Leptospermum parvifolium* | | 5 | 25 | | |
| Shrub (SG) | *Leptospermum polyanthum* | | | | 2 | 10 |
| Shrub (SG) | *Leptospermum trinervium* | Slender Tea-tree | 1 | 25 | 0.2 | 1 |
| Shrub (SG) | *Leucopogon muticus* | Blunt Beard-heath | 0.1 | 5 | 1 | 8 |
| Shrub (SG) | *Micrantheum ericoides* | | 0.1 | 25 | | |
| Shrub (SG) | *Micromyrtus ciliata* | Fringed Heath-myrtle | | | 0.3 | 30 |
| Shrub (SG) | *Micromyrtus sessilis* | | 1 | 40 | 0.4 | 5 |
| Shrub (SG) | *Persoonia spp.* | | | | 0.1 | 6 |
| Shrub (SG) | *Phyllota phylicoides* | Heath Phyllota | | | 1 | 20 |
| Shrub (SG) | *Platysace lanceolata* | Shrubby Platysace | 0.1 | 5 | | |
| Shrub (SG) | *Pseudanthus divaricatissimus* | | 0.1 | 10 | 1 | 20 |
| Shrub (SG) | *Rhytidosporum procumbens* | | | | 0.1 | 2 |
| Tree (TG) | *Callitris muelleri* | | | | 15 | 25 |
| Tree (TG) | *Eucalyptus piperita* | Sydney Peppermint | 0.1 | 5 | | |
| | **Total** | | | ***27*** | | ***27*** |

## Legend

N

- Development Consent (SSD_5581)
- MW17-19 EP Area
- CLZ EP Area (ML1814)
- CLZ EP Area (ML1331)
- Mining Tenements
- Roads and Tracks

***TEC***

- Genowlan Point Allocasuarina nana Heathland EEC (PCT 3859)
- White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland (PCT1330)

ML 1331
ML 1814
RUSSELLS ROAD
PEARSONS HUT TRAIL
MALCOLMS GULLY TRAIL
HUT TRAIL
MAZE EAST TRAIL
GLEN DAVIS ROAD

**FIGURE 3-6:**
**THREATENED ECOLOGICAL COMMUNITIES**

LOCATION: **AIRLY**

VERSION: **A**
DATE EXPORTED: **26/09/2022**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m

SCALE 1:30,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial**
PROJ: **PR152229**
PURPOSE: **Baseline Assessment**

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### 3.2.3 Groundwater Dependent Ecosystems

No high priority GDEs have been identified within the study area, although there is potential for 'Facultative Ecosystems' existing as moist sheltered gully forests or along creek lines (RPS 2014; GHD 2017).

#### 3.2.3.1 Facultative Ecosystems

Monitoring has shown the water flow in 'The Grotto' to be ephemeral and rainfall dependent. The sheltered environment along with moisture from surface water and seepage of water from the surrounding sandstones promotes the growth of water loving plants such as tree ferns. In general, groundwater flows were considered too deep to have much interaction with potentially occurring GDEs, however, there were areas of alluvium that contain shallow aquifers within surrounding Airly Mine lease area (see **Figure 3-7**). Vegetation communities which occurred within the 'shallow aquifer zone', and hence may have interaction with groundwater, include:

- PCT 3226: Western Blue Mountains Montane Wet Fern Forest;
- PCT 3495: Western Blue Mountains Monkey Gum Gully Forest; and
- PCT 3731: Capertee Conglomerate Grey Gum-Stringybark Forest.

The aforementioned communities were ultimately considered to be 'Facultative Ecosystems' as opposed to GDEs (RPS 2014). These communities are likely to be utilising shallow aquifers and are therefore considered unlikely to be entirely groundwater dependent. This assumption is supported by the fact that the flora species within these vegetation communities are not restricted to alluvial drainage lines; they can occur along moist sheltered gully areas, creek lines, as well as dry slopes. Therefore, they can be termed as Facultative Ecosystems as defined below:

*Facultative Ecosystems – 'A GDE that is not entirely dependent on groundwater, and may rely on groundwater on a seasonal basis or only during extended drought periods. At other times, water requirements may be met by soil or surface water'* (Serov et al 2012).

**Table 3-8** below outlines the extent of these Facultative Ecosystems present within each EP Area.

**Table 3-8: Facultative Ecosystems within the EP Areas**

| Old PCT Code | PCT Code | PCT Description | CLZ (ML1814) Area (ha) [% within EP area)[1] | MW17-19 EP Area (ha) [2] [% within EP area)[1] |
|---|---|---|---|---|
| 1615 | 3226 | Western Blue Mountains Montane Wet Fern Forest | 15.19 [7.18 %] | 1.68 [1.38%] |
| 941 | 3495 | Western Blue Mountains Monkey Gum Gully Forest | 29.21 [13.82%] | 11.55 [9.50%] |
| - | 3731 | Capertee Conglomerate Grey Gum-Stringybark Forest | 2.31 [1.09%] | - |

1. CLZ EP area and MW17-19 EP areas overlap. Percentage is the proportion of this community within the specified EP area.
2. Facultative ecosystems occur only within the 'extended monitoring and management area' and not within the 'principal subsidence management area'.

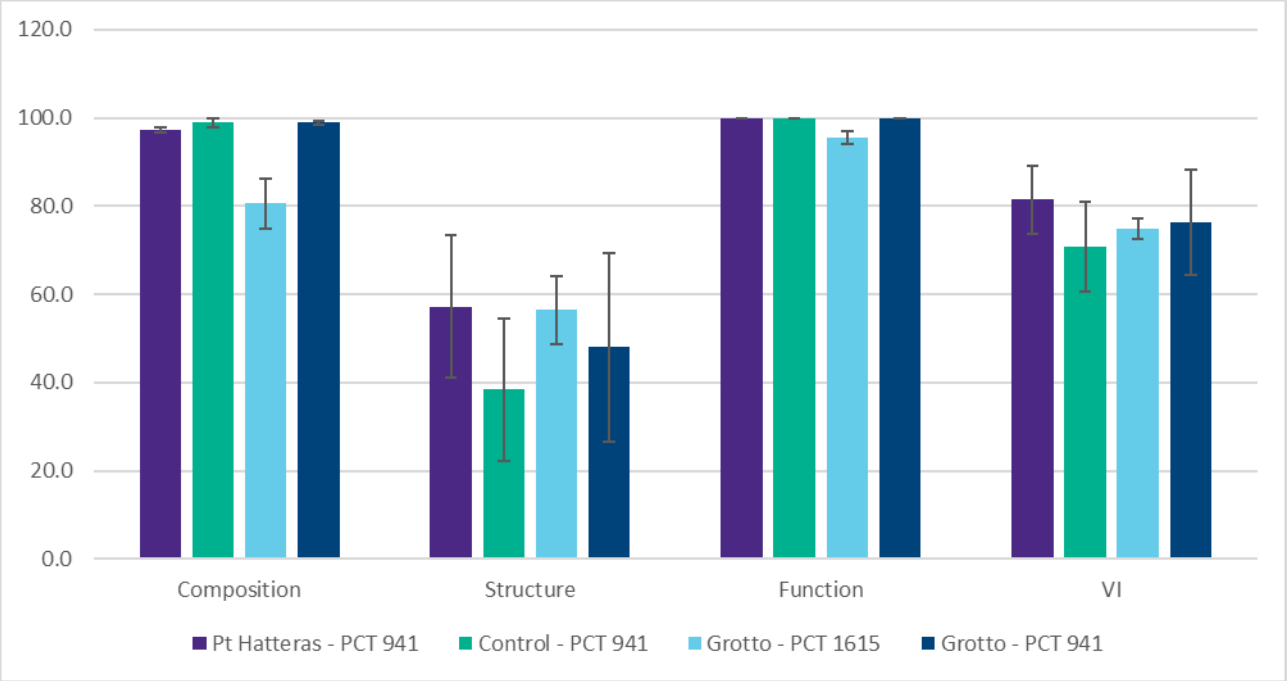
##### 3.2.3.1.1 Monitoring

Ten GDE plots were established utilising BAM in the summer 2022 monitoring period around the base of Pt Hatteras and within the Grotto across two of the PCTs.

**Table 3-9** and **Graph 3-1** displays the 2022 composition, structure, function and vegetation integrity (VI) scores within the GDE plots across monitoring locations. This data will be used for comparison in future monitoring periods.

**Table 3-9: 2022 GDE plots - mean BAM scores across monitoring locations**

| Location - PCT | Composition | Structure | Function | VI |
|---|---|---|---|---|
| Pt Hatteras - PCT 942 | 97.3 | 57.2 | 100.0 | 81.5 |
| Control - PCT 941 | 98.9 | 38.4 | 100.0 | 70.9 |
| Grotto - PCT 1615 | 80.6 | 56.4 | 95.5 | 74.9 |
| Grotto - PCT 941 | 98.9 | 48.1 | 100.0 | 76.2 |




**Graph 3-1: Histogram displaying mean BAM scores (composition, structure, function, VI) and SE across monitoring locations**

RDP analysis for this Baseline Assessment found that PCT 3226/3495 was always dominated by moisture dependant ferns such as *Adiantum aethiopicum*, *Blechnum spp.*, *Calochlaena dubia*, *Cyathea australis* and *Pteridium esculentum.* Furthermore, *Calochlaena dubia* was always present, thus could be used as an indicator species of Facultative Ecosystem health.

PCT 3731 commonly exhibited a groundcover of more generalist species such as *Lomandra longifolia* and *Pteridium esculentum* which are generally indicative of variable soil moisture. *Doodia aspera* was almost always present. Sometimes drier woodland grasses were present (*Echinopogon spp., Aristida spp.)* and sprawling shrub *Pimelea latifolia.* See **Apx Table 3** for the full floristics.

#### 3.2.3.1.1.1 Rapid aquatic assessment

Rapid aquatic assessment occurred along 50 m transects within the Grotto at five locations adjacent streams. **Table 3-10** provide a summary of the stream condition within the Grotto whilst

**Table 3-11** provide a summary of the stream types. This data forms a part of the baseline condition of these monitoring locations.

**Table 3-10: 2022 stream condition**

| Parameter | Score |
|---|---|
| Average flow width (m) | 1.1 |
| Max flow width (m) | 2.0 |
| Min flow width (m) | 0.4 |
| Average soil moisture ±3% VWC | 20.84 |

| | |
|---|---|
| Clarity/sediment load (0 poor - 5 clear) | 4.2 |
| Erosion (0 absent - 5 severe) | 1 |

**Table 3-11: 2022 GDE stream type parameters**

| Parameter | Ratio across locations |
|---|---|
| **Stream flow type** | |
| Pooling | 1 |
| Flowing | 1 |
| Continuous | 0.4 |
| Discontinuous | 0.6 |
| Riffles | 1 |
| **Aquatic vegetation type** | |
| Submerged | 0.4 |
| Floating | 0 |
| Emergent | 0 |
| **Substrate type** | |
| Bedrock | 0.04 |
| Boulder (>256mm) | 0.06 |
| Cobble (64-256mm) | 0.08 |
| Pebble (16-64mm) | 0.082 |
| Gravel (2-16mm) | 0.144 |
| Sand (0.06-2mm) | 0.41 |
| Clay/Silt (<0.06mm) | 0.184 |
| **Bank slope** | |
| Flat <10° | 0 |
| Low 10 - 30° | 0 |
| Moderate 30 - 60° | 0.4 |
| Steep 60 - 80° | 0.6 |
| Vertical 80 - 90° | 0 |

**Plate 3-4 The Grotto surface flow (PCT 3226)**

**Plate 3-5 PCT 3731**

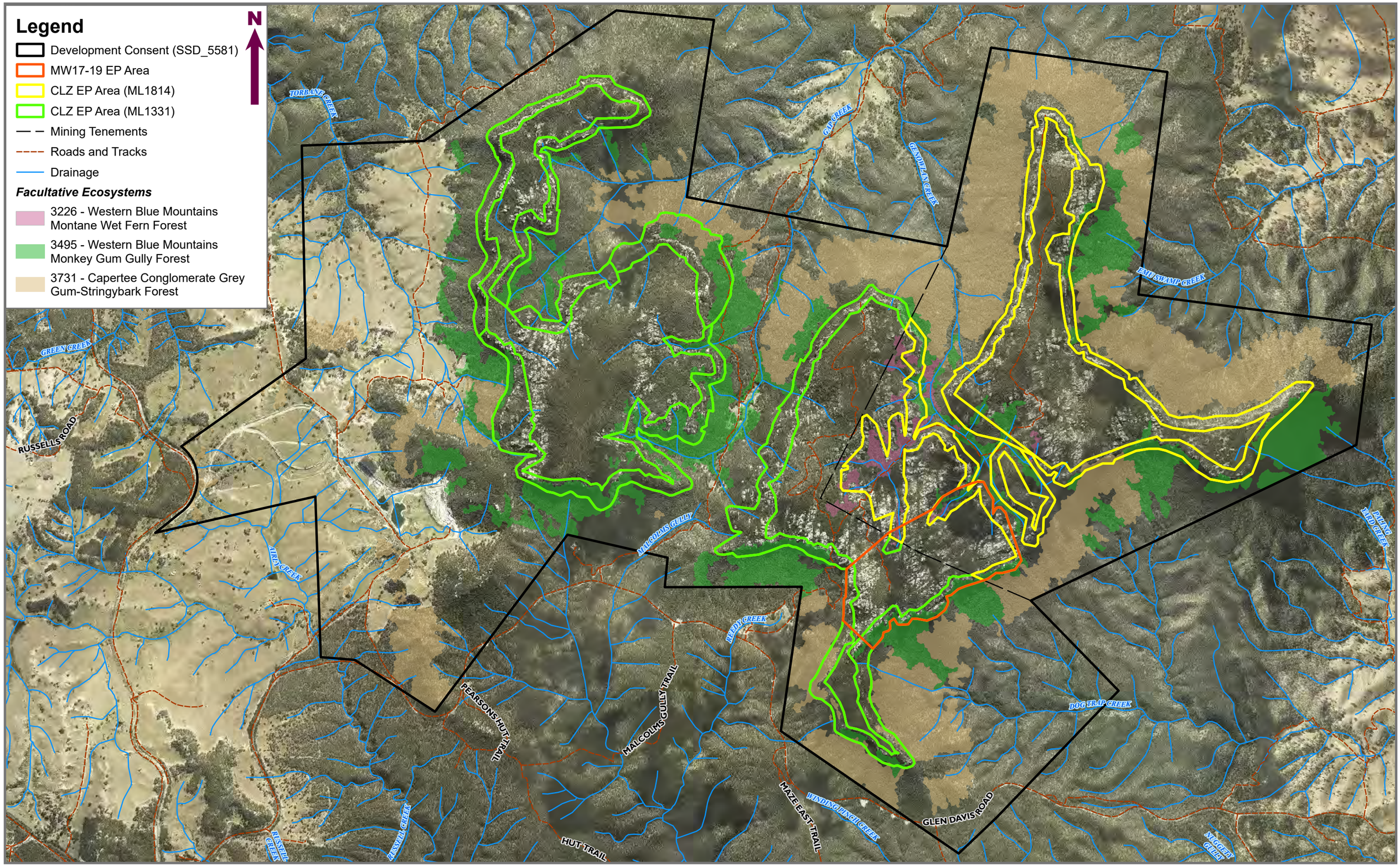



**FIGURE 3-7:**
**GROUNDWATER DEPENDENT ECOSYSTEMS AND HYDROLOGY**

LOCATION: **AIRLY**

VERSION: **A**
DATE EXPORTED: **26/09/2022**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m

SCALE 1:30,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial**
PROJ: **PR152229**
PURPOSE: **Baseline Assessment**

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## 3.3 Flora

### 3.3.1 Threatened flora species

Seven threatened flora species have been recorded within the locality, of these, two threatened flora species occur within the EP areas as summarised in **Table 3-12** and shown in **Figure 3-8**.

**Table 3-12 Threatened flora species**

| Common Name | Scientific | BC Act | EPBC Act | Count | Source | EP Area |
|---|---|---|---|---|---|---|
| *Eucalyptus cannonii* | Capertee Stringybark | V | | 158 | BioNet (DPE 2022b) (RPS 2021) | |
| *Grevillea obtusiflora* | | E | E | 19 | BioNet (DPE 2022b) | |
| *Persoonia marginata* | Clandulla Geebung | V | V | 48 | BioNet (DPE 2022b) | |
| *Phebalium bifidum* | | E | | 248 | BioNet (DPE 2022b) | |
| *Pomaderris brunnea* | Brown Pomaderris | E | V | 1 | BioNet (DPE 2022b) | |
| *Prostanthera cryptandroides subsp. cryptandroides* | Wollemi Mint-bush | V | V | 2 | BioNet (DPE 2022b) | |
| *Prostanthera stricta* | Mount Vincent Mint-bush | V | V | 1000+ | RPS 2022 | MW17-19, CLZ |
| *Pultenaea sp.* Genowlan Point | | CE | CE | 35 | NPWS 2021 | CLZ |
| *Zieria murphyi* | Velvet Zieria | V | V | 1 | BioNet (DPE 2021b) | |

Note: V – Vulnerable; E – Endangered; CE – Critically Endangered; M – Migratory

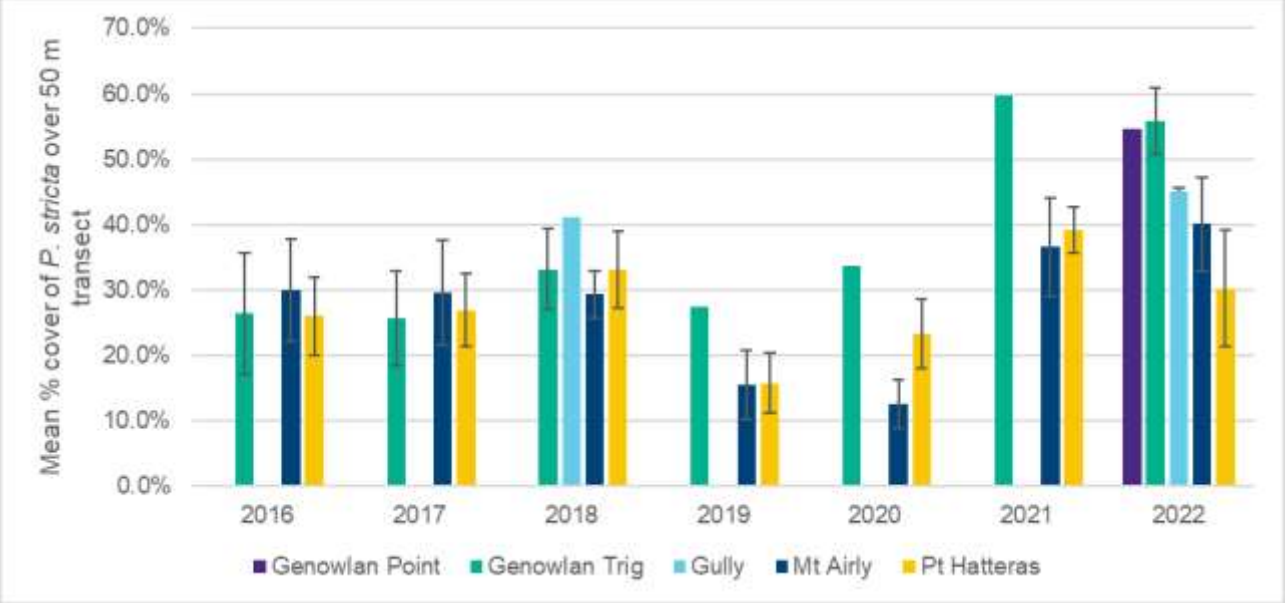
#### 3.3.1.1 *Prostanthera stricta* (Mount Vincent Mint Bush)

*Prostanthera stricta* occurs from Mt Vincent to Genowlan Mountain in the Central Tablelands. *Prostanthera stricta* is often a locally dominant understory shrub species found within heath or scrub communities along cliff edges, or as an understorey species within a range of open forest or tall open forest types and/or adjacent transitional communities. Associated vegetation includes *Eucalyptus blaxlandii, Eucalyptus cannonii* and *Eucalyptus viminalis* with *Acacia implexa* and *Goodenia ovata*. *Prostanthera stricta* grows in areas of both skeletal soil and on deeper, well-drained soil profiles in areas characterised by steep rocky side slopes, cliff lines, sandstone platforms, or gentle slopes with exposed sandstone outcroppings. It has been found that the habitat at Mount Airly, Point Hatteras and Genowlan Point is typically restricted to the gradation from basalt to sandstone, which is frequently abrupt, occupying a narrow band of 5 - 50 m (RPS 2014a).

Within the study area *Prostanthera stricta* is common within areas of the 'Mount Tomah' soil landscape associated with basalt capping on Genowlan Point, however can occur elsewhere in the study area with basalt influence. Some stands of *Prostanthera stricta* are also located near Genowlan Trig (see **Figure 3-8**).

##### 3.3.1.1.1 Monitoring

Eighteen transects were monitored across the 2022 monitoring program, including four plots that were established, and two that were re-established to provide additional baseline and control replication. Monitoring results display an increase in cover of *Prostanthera stricta* across the transects linked to rainfall patterns which were above the historical average for 9 months of the year and population recovery since the controlled burn across Mount Airly in 2018.

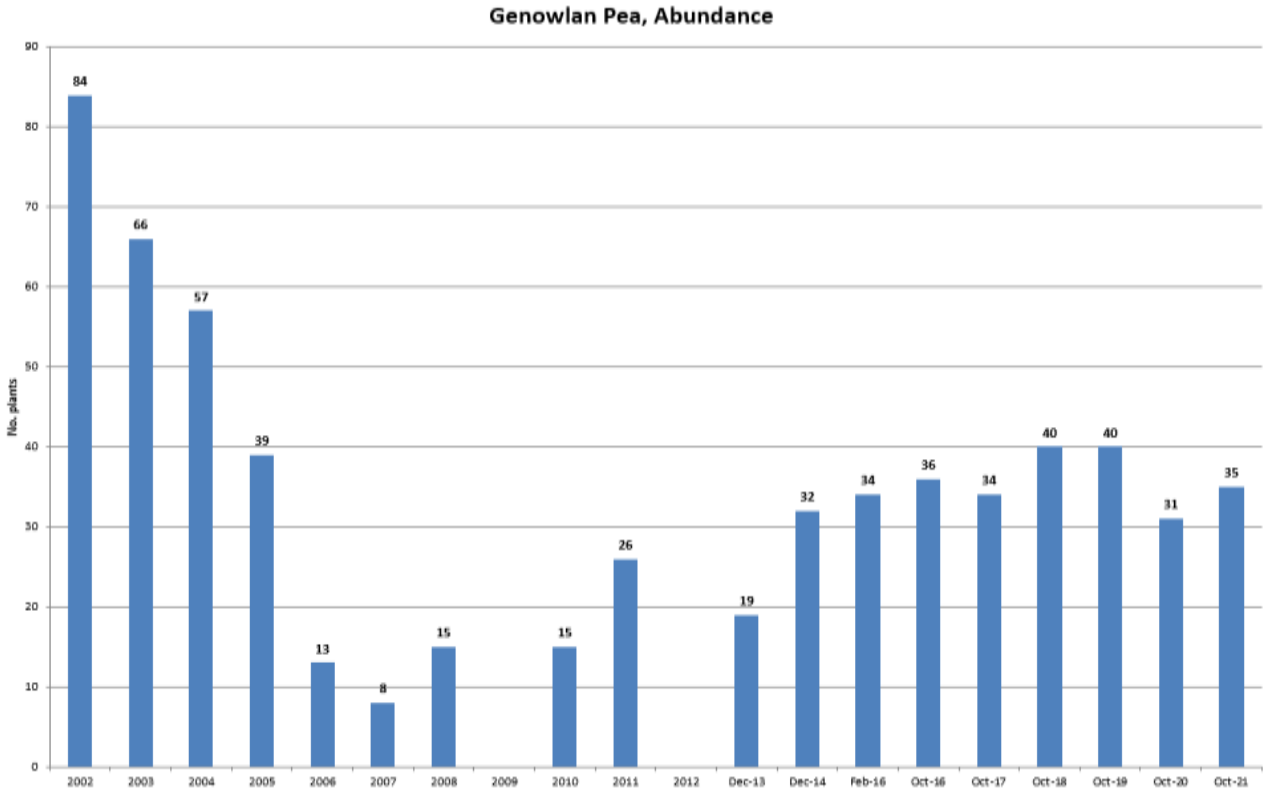



**Graph 3-2: Proportional percent cover of *Prostanthera stricta* over the 50 m plot (RPS 2021)**

**Plate 3-6 Population of *Prostanthera stricta* (Mount Vincent Mint Bush)**

### 3.3.1.2 *Pultenaea sp*. Genowlan Point

*Pultenaea sp.* Genowlan Point is known from a single population in the Mugii Murum-ban State Conservation Area in the Capertee Valley, which is a site-managed species within the Saving Our Species (SOS) program. This population is restricted to a small area of 0.15ha on an exposed rocky area adjacent to a cliff edge within the CLZ EP area (see **Figure 3-8**). All individuals within this population occupy north-westerly aspects on skeletal soils, in some cases on narrow ledges beneath the cliff edge. Associated vegetation includes open *Eucalyptus sparsifolia* forest with an open shrubby understorey including *Persoonia longifolia, Isopogon dawsonii* and *Leucopogon muticus* (DPE 2021c). Monitoring of this species is currently conducted by NPWS.




**Graph 3-3: *Pultenaea sp*. Genowlan Point abundance (NPWS 2021)**

Currently there are 35 individuals o*f Pultenaea sp*. Genowlan Point in the population (NPWS 2021; see **Graph 3-3** and **Figure 3-8**) and the population has been deemed 'stable' (NPWS 2020).

**Plate 3-7** ***Pultenaea sp*. Genowlan Point**

## 3.3.2 Exotic flora

The MW17-19 and CLZ EP areas are predominately weed free due to their isolation, and reduced vehicle access. No weeds were recorded within the Genowlan Point plots, however seven exotic species were recorded within the woodland plot, in relatively low abundance. See **Table 3-13** for a summary of the exotic flora species.

**Table 3-13: Exotic flora species recorded within the EP areas**

| Scientific Name | Common Name | Abundance within plots |
|---|---|---|
| *Cirsium vulgare* | Spear Thistle | 1 |
| *Conyza spp.* | | 3 |
| *Galium divaricatum* | Slender Bedstraw | 100 |
| *Hypochaeris glabra* | Smooth Catsear | 1 |
| *Hypochaeris radicata* | Catsear | 2 |
| *Modiola spp.* | | 2 |
| *Senecio jacobaea* | Ragwort | 2 |

Under the *Biosecurity Act* 2015, plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.

RUSSELLS ROAD

PEARSONS HUT TRAIL

MALCOLMS GULLY TRAIL

HUT TRAIL

MAZE EAST TRAIL

GLEN DAVIS ROAD

## Legend

N

- Development Consent (SSD_5581)
- MW17-19 EP Area
- CLZ EP Area (ML1814)
- CLZ EP Area (ML1331)
- Mining Tenements
- Roads and Tracks

***Threatened Flora Species (RPS and UQ)***

- *Eucalyptus cannonii*
- *Pomaderris brunnea*
- *Pomaderris cotoneaster*
- *Prostanthera stricta*
- *Pultenaea sp. Genowlan Point*

**FIGURE 3-8:**
**THREATENED FLORA**

LOCATION: **AIRLY**

VERSION: **A**
DATE EXPORTED: **26/09/2022**
TECHNICIAN: **Natalie.Wood**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m

SCALE 1:30,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial**
PROJ: **PR152229**
PURPOSE: **Baseline Assessment**

www.rpsgroup.com.au

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g. the accuracy, reliability, suitability or completeness of any approximations or estimates made or referred to by RPS Australia East Pty Ltd in this plan.
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4. The aerial photography used in this plan has not been rectified. This image has been overlaid as a best fit on the boundaries shown and position is approximate only.

**PROJECT PATH: S:\Centennial\All Jobs\5568 - 152229 - Airly Cliff Line Zone EP BMP Update\10 - Drafting\ECO_BMPGeneralFigures_.aprx**

MAKING COMPLEX EASY

# 3.4 Fauna

## 3.4.1 Threatened fauna records

### 3.4.1.1 Birds

A total of 24 threatened birds have been previously recorded within the locality; however, due to the mobility of these species and availability of niche habitat features within the EP areas it is presumed that all threatened bird species may periodically utilise resources in the study area (See **Table 3-14** and **Figure 3-9**). Evidence of Glossy Black-Cockatoo (*Calyptorhynchus lathami;* BC Act: Vulnerable) feeding was present within the EP areas.

**Table 3-14 Threatened bird species**

| Common Name | Scientific Name | BC Act | EPBC Act | Count | Source |
|---|---|---|---|---|---|
| Barking Owl | *Ninox connivens* | V | - | 8 | BioNet (DPE 2022b) |
| Black Falcon | *Falco subniger* | V | - | 1 | BioNet (DPE 2022b) |
| Black-chinned Honeyeater (eastern subspecies) | *Melithreptus gularis gularis* | V | - | 17 | BioNet (DPE 2022b) (UQ 2014) |
| Brown Treecreeper (eastern subspecies) | *Climacteris picumnus victoriae* | V | - | 94 | BioNet (DPE 2022b) (UQ 2014) (RPS 2021) |
| Diamond Firetail | *Stagonopleura guttata* | V | - | 61 | BioNet (DPE 2022b) (UQ 2014) (RPS 2021) |
| Dusky Woodswallow | *Artamus cyanopterus cyanopterus* | V | - | 52 | BioNet (DPE 2022b) (RPS 2021) |
| Flame Robin | *Petroica phoenicea* | V | - | 3 | BioNet (DPE 2022b) (UQ 2014) (RPS 2021) |
| Gang-gang Cockatoo | *Callocephalon fimbriatum* | V | E | 48 | BioNet (DPE 2022b) (UQ 2014) (RPS 2021) |
| Gilbert's Whistler | *Pachycephala inornata* | V | - | 1 | BioNet (DPE 2022b) |
| Glossy Black-Cockatoo | *Calyptorhynchus lathami* | V | - | 55 | BioNet (DPE 2022b) (UQ 2014) (RPS 2021) |
| Grey-crowned Babbler (eastern subspecies) | *Pomatostomus temporalis temporalis* | V | - | 5 | BioNet (DPE 2022b) (RPS 2021) |
| Hooded Robin (south-eastern form) | *Melanodryas cucullata cucullata* | V | - | 25 | BioNet (DPE 2022b) (RPS 2021) |
| Little Eagle | *Hieraaetus morphnoides* | V | - | 15 | BioNet (DPE 2022b) |
| Little Lorikeet | *Glossopsitta pusilla* | V | - | 55 | BioNet (DPE 2022b) (UQ 2017) (RPS 2021) |
| Masked Owl | *Tyto novaehollandiae* | V | - | 1 | BioNet (DPE 2022b) (RPS 2021) |
| Painted Honeyeater | *Grantiella picta* | V | V | 1 | BioNet (DPE 2022b) (UQ 2014) (RPS 2021) |
| Powerful Owl | *Ninox strenua* | V | - | 9 | BioNet (DPE 2022b) (UQ 2014) (RPS 2021) |
| Regent Honeyeater | *Anthochaera phrygia* | CE | CE | 136 | BioNet (DPE 2022b) (UQ 2017) |
| Scarlet Robin | *Petroica boodang* | V | - | 19 | BioNet (DPE 2022b) (UQ 2014) (RPS 2021) |
| Sooty Owl | *Tyto tenebricosa* | V | - | 5 | BioNet (DPE 2022b) (RPS 2021) |
| Speckled Warbler | *Chthonicola sagittata* | V | - | 17 | BioNet (DPE 2022b) |
| Square-tailed Kite | *Lophoictinia isura* | V | - | 2 | BioNet (DPE 2022b) |
| Swift Parrot | *Lathamus discolor* | E | CE | 27 | BioNet (DPE 2022b) |

| Common Name | Scientific Name | BC Act | EPBC Act | Count | Source |
|---|---|---|---|---|---|
| Turquoise Parrot | *Neophema pulchella* | V | - | 21 | BioNet (DPE 2022b) |
| Varied Sittella | *Daphoenositta chrysoptera* | V | - | 14 | BioNet (DPE 2022b) |
| White-bellied Sea-Eagle | *Haliaeetus leucogaster* | V | - | 2 | BioNet (DPE 2022b) |
| White-fronted Chat | *Epthianura albifrons* | V | - | 1 | BioNet (DPE 2022b) |

Note: V – Vulnerable; E – Endangered; CE – Critically Endangered; M – Migratory.

**Plate 3-8 Glossy Black-Cockatoo (*Calyptorhynchus lathami*) feeding on *Allocasuarina sp.***

### 3.4.1.2 Microbats

Eight threatened microbat species have been previously recorded within the locality (see **Figure 3-9**), due to the mobility of these species and availability of niche habitat features (see **Table 3-18**). It is presumed that all threatened microbat species may periodically utilise resources within the EP areas. See **Table 3-15** for threatened microbats recorded nearby the study area.

Other non-threatened microbat species previously observed in the locality include, Gould's Wattled Bat (*Chalinolobus gouldii*), Chocolate Wattled Bat (*Chalinolobus morio*), Eastern Horseshoe Bat (*Rhinolophus megaphyllus*), White-striped Free-tailed Bat (*Austronomus australis*), Large Forest Bat (*Vespadelus darlingtoni*), Eastern Free-tailed Bat (*Mormopterus ridei*), South-eastern Free-tailed Bat (*Mormopterus planiceps*), Southern Forest Bat (*Vespadelus regulus*) and Little Forest Bat (*Vespadelus vulturnus*) (RPS 2016).

**Table 3-15 Threatened microbat species**

| Common Name | Scientific | BC Act | EPBC Act | Count | Source |
|---|---|---|---|---|---|
| Eastern False Pipistrelle | *Falsistrellus tasmaniensis* | V | | 3 | BioNet (DPE 2022b) |
| Eastern Coastal Free-tailed Bat | *Mormopterus norfolkensis* | V | | 0 | BioNet (DPE 2022b) (RPS 2018) |

| Common Name | Scientific | BC Act | EPBC Act | Count | Source |
|---|---|---|---|---|---|
| Large Bent-winged Bat | *Miniopterus orianae oceanensis* | V | | 15 | BioNet (DPE 2022b) (UQ 2014) (RPS 2021) |
| Large-eared Pied Bat | *Chalinolobus dwyeri* | V | V | 15 | BioNet (DPE 2022b) (UQ 2014) (RPS 2021) |
| Little Bent-winged Bat | *Miniopterus australis* | V | | 1 | BioNet (DPE 2022b) |
| Little Pied Bat | *Chalinolobus picatus* | V | | 0 | BioNet (DPE 2022b) (RPS 2018) |
| Greater Broad-nosed Bat | *Scoteanax rueppellii* | V | | 1 | BioNet (DPE 2022b) |
| Yellow-bellied Sheathtail-bat | *Saccolaimus flaviventris* | V | | 1 | BioNet (DPE 2022b) |

Note: V – Vulnerable; E – Endangered; CE – Critically Endangered; M – Migratory.

### 3.4.1.3 Mammals

Five threatened mammal species (excluding microbat species) have been previously recorded in the locality (see **Figure 3-9**). Of significance, the Spotted-tail Quoll (*Dasyurus maculatus maculatus*; BC Act: Vulnerable; EPBC Act: Endangered) was captured on a camera trap in 2013 (RPS 2013) and a Koala (*Phascolarctos cinereus*; BC Act: Vulnerable; EPBC Act: Vulnerable) has recently been observed on the Diamond Mine Trail (DPE 2022b) and calls recorded on songmeters (RPS 2021). The Greater Glider (*Petauroides volans*; EPBC Act: Vulnerable) were also observed during spotlighting in recent surveys (RPS 2020). See **Table 3-16** for a summary of the threatened mammals found within or nearby the study area.

**Table 3-16 Threatened fauna species**

| Common Name | Scientific | BC Act | EPBC Act | Count | Source |
|---|---|---|---|---|---|
| Greater Glider | *Petauroides volans* | | V | 4 | BioNet (DPE 2022b), (RPS 2021) |
| Grey-headed Flying-fox | *Pteropus poliocephalus* | V | V | 2 | BioNet (DPE 2022b) |
| Koala | *Phascolarctos cinereus* | E | E | 2 | BioNet (DPE 2022b) |
| Spotted-tailed Quoll | *Dasyurus maculatus* | V | E | 4 | BioNet (DPE 2022b) (RPS 2013) |
| Squirrel Glider | *Petaurus norfolcensis* | V | | 2 | BioNet (DPE 2022b) (RPS 2021) |

Note: V – Vulnerable; E – Endangered; CE – Critically Endangered; M – Migratory.

**Plate 3-9 Spotted-tail Quoll (*Dasyurus maculatus*) captured on a camera trap in 2013, within the Airly Mine lease area (RPS 2013)**

### 3.4.1.4 Amphibians

No threatened frog species have been previously recorded within the locality, however this may be due to a lack of survey effort, cryptic nature and seasonality of many frog species. Six threatened frog species returned a 'moderate' LoO (see **Table 3-4**) based on habitat suitability. Non-threatened frog species previously recorded in the locality include the Common Eastern Froglet (*Crinia signifera*), Eastern Banjo Frog (*Limnodynastes dumerilii*), Brown-striped Frog (*Limnodynastes peronii*), Spotted Grass Frog (*Limnodynastes tasmaniensis*), Smooth Toadlet (*Uperoleia laevigata*), Green Tree Frog (*Litoria caerulea*), Broad-palmed Frog (*Litoria latopalmata*), Rocket Frog (*Litoria nasuta*) and Peron's Tree Frog (*Litoria peronii*) (RPS 2013a).

Where suitable, frogs should be considered within the existing fauna monitoring survey effort.

### 3.4.1.5 Reptiles

Two threatened reptile species have been previously recorded within the locality (DPE 2022b) (see **Figure 3-9**). The Broad-headed Snake (*Hoplocephalus* bungaroides; BC Act: Endangered; EPBC Act: Vulnerable) has been recorded within the study area, while Rosenburg's Goanna (*Varanus rosenbergi*; BC Act: Vulnerable; EPBC Act: Not Listed) has been recorded on multiple occasions (opportunistically and on camera trap) during previous survey efforts (RPS 2016) within the Airly Mine lease area. See **Table 3-17**.

**Table 3-17 Threatened reptile species**

| Common Name | Scientific | BC Act | EPBC Act | Count | Source | Within EP Area |
|---|---|---|---|---|---|---|
| Broad-headed Snake | *Hoplocephalus bungaroides* | E | V | 1 | BioNet (DPE 2022b) | Neither |
| Rosenberg's Goanna | *Varanus rosenbergi* | V | | 3 | BioNet (DPE 2022b) (RPS 2021) | Neither |

Note: V – Vulnerable; E – Endangered; CE – Critically Endangered; M – Migratory.

**Plate 3-10 Rosenburg's Goanna (*Varanus rosenbergi*) recorded on a camera trap (RPS 2020)**

## 3.4.2 Habitat for threatened fauna

Five broad habitat types occur in the study area; dry sclerophyll forest, wet sclerophyll forest, grassy woodlands, heath and cleared and cleared areas. Specific habitat features particularly associated with threatened fauna within the locality area described in **Table 3-18.**

**Table 3-18 Habitat features for threatened fauna**

| Key habitat feature | Description |
|---|---|
| **Sandstone habitats** | Rugged sandstone habitats are a characteristic feature of the study area, and include the distinctive pagodas, steeps cliffs and escarpments, rocky outcrops or piles of sandstone boulders, caves, crevices and ledges.<br>Several fauna species recorded in the study area are sandstone habitat specialists. The study area supports an abundance and complexity of sandstone caves and overhangs that offer roosting habitat to obligate cave-roosting microbat species recorded in the study area, such as Eastern Horseshoe-bat (*Rhinolophus megaphyllus*) and Large-eared Pied Bat (*Chalinolobus dwyeri*; BC Act: Vulnerable; EPBC Act: Vulnerable).<br>The Common Wallaroo (*Macropus robustus*) may be more abundant than the number of sightings suggests, due to its shy nature and scats not being readily identifiable. Steep escarpments, sandstone outcrops and rocky hills comprise preferred habitat of the species, and such features are common throughout the study area (DEC 2007a).<br>Sandstone outcrops, overhangs, crevices and ledges provide good habitat opportunities for reptile species; many species of lizards and snakes rely heavily on sandstone cracks and crevices for shelter. Lesueur's Velvet Gecko (*Oedura lesueurii*) is a small nocturnal gecko that may shelter beneath sandstone boulders and slabs during the day in the study area, preferring rocks in full sun rather than partial or full shade. (Downes and Shine 1998), The Broad-tailed Gecko (*Phyllurus platurus*) also typically seeks shelter in sandstone crevices. The Broad-headed Snake (*Hoplocephalus bungaroides*; BC Act: Endangered; EPBC Act: Vulnerable) is also likely to associate with rock crevices and under flat sandstone rocks on exposed cliff edges locally. |

| Key habitat feature | Description |
|---|---|

**Plate 3-11 Sandstone habitat in the form of sandstone escarpments and pagoda formations typical of the study area**

| | |
|---|---|
| **Hollow-bearing Trees** | Hollow-bearing trees are known to be common within the study area and surrounds and include a diversity of eucalypt species of various ages. Smaller trees of woodland communities typically support smaller trunk and branch hollows whereas forest communities in sheltered gullies, support large trees and large branch hollows.<br>Characteristics of hollows dictate the suitability of hollows for different fauna groups or species. The abundance and variations in hollows are reflected by the high diversity and abundance of hollow-dependent fauna species previously recorded in the locality. Hollow-dependent fauna are defined as species that rely on tree hollows for shelter, roosting, or nesting at some stage in their life cycle. Several threatened hollow-dependent species occur in the study area, including Gang-gang Cockatoo (*Callocephalon fimbriatum*; BC Act: Vulnerable), Glossy Black-Cockatoo (*Calyptorhynchus lathami;* BC Act: Vulnerable), Little Lorikeet (*Glossopsitta pusilla*; BC Act: Vulnerable), Powerful Owl (*Ninox strenua*; BC Act: Vulnerable), and Brown Treecreeper (*Climacteris picumnus victoriae*; BC Act: Vulnerable).<br>Broad hollow size and examples of fauna species may include:<br>• Small hollow (1-5 cm minimum diameter): Little Forest Bat (*Vespadelus vulturnus*);<br>• Medium hollow (5-10 cm minimum diameter): Gould's Wattled Bat (*Chalinolobus gouldii*), Chocolate Wattled Bat (*Chalinolobus morio*), Lesser Long-eared Bat (*Nyctophilus geoffroyi*), Large Forest Bat (*Vespadelus darlingtoni*), Southern Myotis (*Myosits macropus;* BC Act: Vulnerable), Sugar glider (*Petaurus breviceps*), Striated Pardalote (*Pardalotus striatus*);<br>• Large hollow (10-20 cm minimum diameter): Australian owlet-nightjar (*Aegotheles cristatus*), Australian King-Parrot (*Alisterus scapularis*), Crimson Rosella (*Platycercus elegans*), Eastern Rosella (*Platycercus eximius*), Little Lorikeet (*Glossopsitta pusilla*; BC Act: Vulnerable), Red-rumped Parrot (*Psephotus haematonotus*), Red-browed Treecreeper (*Climacteris erythrops*), Brown Treecreeper (*Climacteris picumnus victoriae*; BC Act: Vulnerable), White-throated Treecreeper (*Cormobates leucophaea*); and<br>• Very large hollow (>20 cm minimum diameter): Sulphur-crested Cockatoo (*Cacatua galerita*), Gang-gang Cockatoo (*Callocephalon fimbriatum*; BC Act: Vulnerable), Glossy Black-Cockatoo (*Calyptorhynchus lathami;* BC Act: Vulnerable), Yellow-tailed Black-Cockatoo (*Calyptorhynchus funereus*), Laughing Kookaburra (*Dacelo novaeguineae*), Powerful Owl (*Ninox strenua*; BC Act: Vulnerable), Southern Boobook (*Ninox novaeseelandiae*), Common Brushtail possum (*Trichosurus vulpecular*), Greater Glider (*Petauroides Volans*; EPBC Act: Vulnerable). |

| Key habitat feature | Description |
|---|---|
| **Flowering and fruiting plants** | The study area supports an abundance of flowering plants including a diversity of myrtaceous species, such as eucalypts, and other flowering species such as banksias and acacias. These species offer foraging resources including nectar, pollen, Eucalypt sap and Acacia gum to arboreal mammals. The study area also supports a diversity of highly mobile nectar-feeding birds including and may provide foraging resources for threatened birds such as Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis* BC Act: Vulnerable), Gang-gang Cockatoo (*Callocephalon fimbriatum*; BC Act: Vulnerable), Little Lorikeet (*Glossopsitta pusilla*; BC Act: Vulnerable), Painted Honeyeater (*Grantiella picta*; BC Act: Vulnerable; EPBC Act: Vulnerable) and Regent Honeyeater (*Anthochaera phrygia*; BC Act: Critically Endangered; EPBC Act: Critically Endangered).<br>Mistletoe was common throughout the study area; the fruits of many mistletoe species show a range of attributes that are attractive to many animals, as they are large, sweet and conspicuous. Species that may utilise mistletoes include Silvereye (*Zosterops lateralis*), Ringtail possum (*Pseudocheirus peregrines*) and thornbills (RPS 2014). |
| **Logs and ground timber** | Large woody debris was common across the study area. The abundance of hollow logs offers potential sheltering and breeding habitat for small terrestrial mammals, reptiles and birds. |
| **Aquatic habitats** | There are several mapped first, second and third order creek lines within the study area. All creeks are ephemeral and flow into the main tributary of Genowlan Creek then on into the Capertee River. These habitats may offer habitat to frogs such as the threatened *Heleioporus australiacus* (Giant Burrowing Frog), *Mixophyes iteratus* (Giant Barred Frog) and *Pseudophryne australis* (Red-crowned Toadlet). |
| **Key Fish Habitat and habitat for threatened fish** | Permanent aquatic habitats are uncommon in the study area and are limited to ephemeral drainage lines.<br>Genowlan Creek has not been deemed as critical habitat under the BC Act or FM Act (Centennial 2016), however is mapped as Key Fish Habitat under the FM Act (DPI 2021).<br>The Capteree River is also mapped as Key Fish Habitat under the FM Act (DPI 2021) and the Capertee River downstream from the study area are mapped as habitat for the Macquarie Perch (*Macquaria australasica;* Threatened species under the FM Act). The closest mapped habitat for the Macquarie Perch is located 25 km east of the study area in Glen Davis. |
| ***Allocasuarina spp.*** | Glossy Black-Cockatoo (BC Act: Vulnerable) have a restrictive diet and feed only on the seeds in cones of She-oak [i.e. *Casuarina* and *Allocasuarina sp*., but specifically *Allocasuarina littoralis* (Black She-oak) within the Airly mining lease] and during foraging, discard chewed cones to the ground. It is these discarded cones (termed 'orts') that can be used to quantify the amount of time that glossy black-cockatoo spend foraging in stands of She-oaks and estimate foraging periods (RPS 2018). |
| **Koala feed trees** | The EP Area is located within the Central and Southern Tablelands Koala management area (DECC 2008). Several key Koala feed trees for this management area occur within the study area across all the PCTs present, with the exception of PCT 3865 heath community. Koala feed trees present on site include:<br>• *E. agglomerata* (Blue-leaved Stringybark);<br>• *E. cypellocarpa* (Monkey Gum);<br>• *E. dalrympleana* (Mountain Gum);<br>• *E. macrorhyncha* (Red Stringybark);<br>• *E. melliodora* (Yellow Box);<br>• *E. piperita* (Sydney Peppermint);<br>• *E. polyanthemos* (Red Box);<br>• *E. punctata* (Grey Gum);<br>• *E. viminalis* (Ribbon Gum). |

### 3.4.3 Feral Species

Four feral fauna species were recorded on camera traps during the 2022 monitoring period including cats on two occasions, feral pigs on two occasions, and foxes on six occasions. Feral species activity has increased since the 2021 monitoring year, however no feral dogs were recorded this year (RPS 2022)

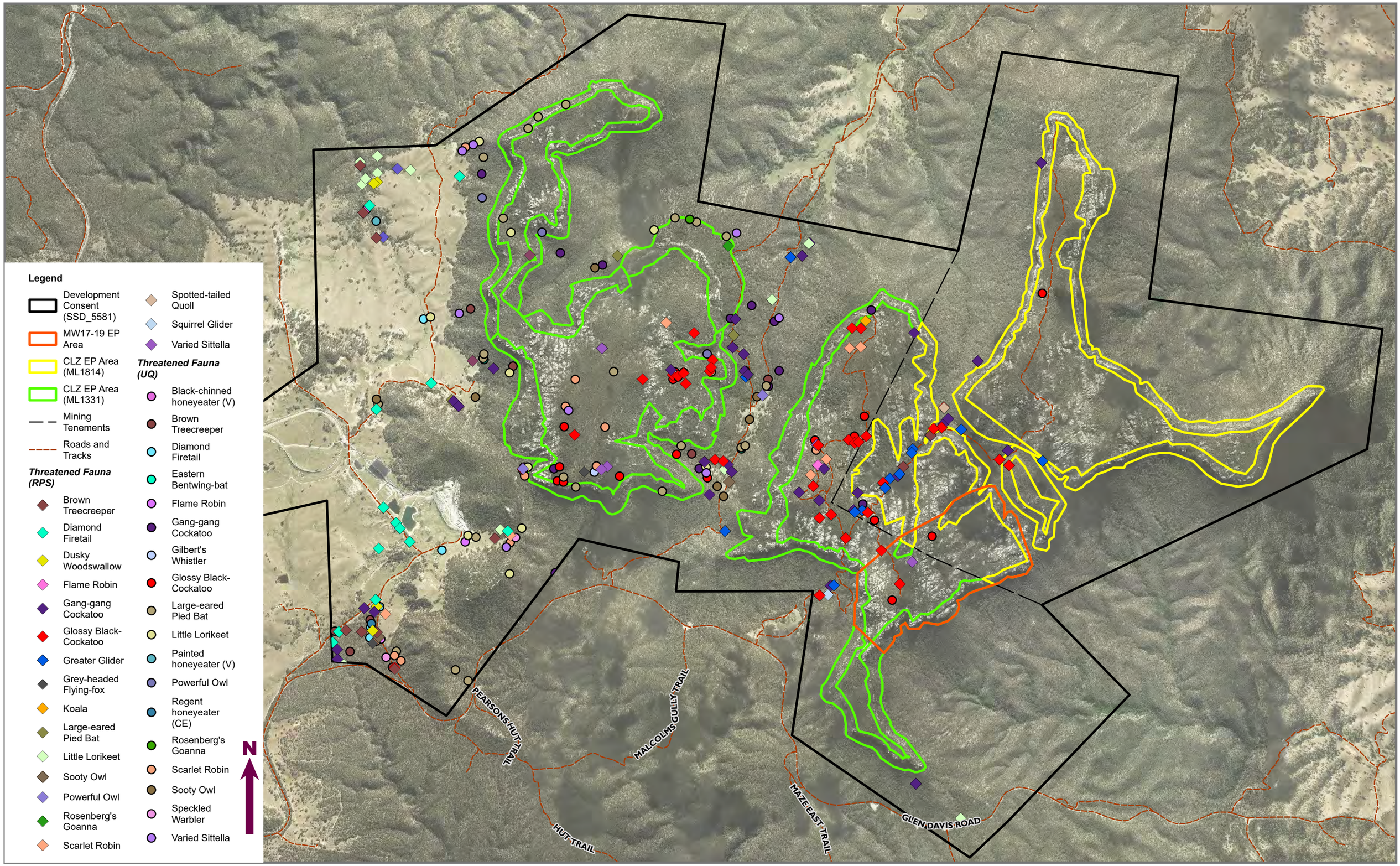


**FIGURE 3-9:**
**THREATENED FAUNA**

LOCATION: **AIRLY**

VERSION: **A**
DATE EXPORTED: **26/09/2022**
TECHNICIAN: **Robert.Suansri**

DATA SOURCES
**Centennial, RPS, NSWSS,**

500 0 500 1,000 1,500 2,000 m

SCALE 1:30,000 AT A3 SIZE / Projection: GDA 1994 MGA Zone 56

CLIENT: **Centennial**
PROJ: **PR152229**
PURPOSE: **Baseline Assessment**

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PROJECT PATH: S:\Centennial\All Jobs\5568 - 152229 - Airly Cliff Line Zone EP BMP Update\10 - Drafting\ECO_BMPGeneralFigures_B.aprx

MAKING COMPLEX EASY

## 3.5 Key Threatening Processes

Existing KTPs are listed under the BC Act, FM Act and EPBC Act within the study area are summarised below in **Table 3-19**.

**Table 3-19 Summary of current KTPs**

| KTP | Status | Impact | Reasons |
|---|---|---|---|
| **Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands** | BC Act | Existing, Low impact | Alteration to the flow regimes and water quality of Genowlan Creek from previous Returns Workings within and adjacent the study area. |
| **Competition and grazing by the feral European rabbit** | BC Act, EPBC Act | Existing, Low impact | Exotic animals have been previously recorded within or adjacent the study area, however, were more frequently observed within cleared areas to the west of the study area (RPS 2014). Pest management has occurred since, with significant reduction in pest species. |
| **Competition and habitat degradation by Feral Goats, *Capra hircus* Linnaeus 1758** | BC Act, EPBC Act | Existing, Low impact | Exotic animals have been previously recorded within or adjacent the study area, however, were more frequently observed within cleared areas to the west of the study area. Small groups of Feral Goats (*Capra hircus*) were frequently found on Mt Airly (RPS 2014). Pest management has occurred since, with significant reduction in pest species. |
| **Predation and hybridisation by Feral Dogs, *Canis lupus familiaris*** | BC Act | Existing, Low impact | Exotic animals have been previously recorded within or adjacent the study area, however, were more frequently observed within cleared areas to the west of the study area. Feral Dogs were seen on several occasions, in cleared areas in proximity to the pit top. Rabbits (*Oryctolagus cuniculus*) were common in cleared, low-lying areas (RPS 2014). Pest management has occurred since, with significant reduction in pest species. |
| **Invasion of native plant communities by exotic perennial grasses** | BC Act, EPBC Act | Existing, Low impact | The areas of vegetation within the study area are predominantly weed free. Minor infestations along 4WD tracks due to spread of seeds via vehicle movement may be present. |
| **Human-caused Climate Change** | BC Act, EPBC Act, FM Act | Existing, Moderate impact | The study area currently is at risk to the rapidly changing climates which disturbs the intricate balance of ecosystems. Whilst the ecosystem in not at the extremes of the climate (i.e. alpine areas) which are highly sensitive to climate change, the study area is at severe risk to extreme weather events, such as frequent wildfires. |

# 4 SUMMARY OF FINDINGS, IMPLICATION FOR MINING AND RECOMENDATIONS

The EP areas are within the Capertee Uplands of the South Eastern Highlands Interim Biogeographic Regionalisation for Australia, and is within the Mugii Murum-ban State Conservation Area. The underlying geology of the study area comprises Narrabeen Group—fine-grained lithic sandstone occasionally interbedded with thin shale lenses. The EP areas encompasses 12 Plant Community Types (PCTs). Broadscale vegetation types include dry sclerophyll forest, wet sclerophyll forest and heath. Sensitive biodiversity features within the EP areas include:

- Sensitive landscape features;
- Threatened Ecological Communities (TECs);
- Facultative Ecosystems;
- Threatened flora; and
- Threatened fauna.

Each of these sensitive biodiversity features is discussed by EP area in the following sections.

## 4.1 MW17-19 EP area

### 4.1.1 Sensitive landscape features

No sensitive landscape features as per the Environmental Impact Statement (EIS; Centennial 2014) occur within the EP area. The EP area is characterised by steep sandstone escarpments and pagoda rock formations.

### 4.1.2 Vegetation communities

The MW17-19 EP area encompasses eight PCTs with none forming part of a listed TEC. The vegetation predominately consists of PCTs 3865, 3686 and 3695 which are heath communities and open forests typical of ridgetops. **Table 3-5** provides a breakdown of these PCTs.

No high priority GDEs have been identified within the study area, although there is potential for Facultative Ecosystems existing as moist sheltered gully forests or along creek lines (RPS 2014; GHD 2017). The MW17-19 EP area supports small areas of PCT 3495 Western Blue Mountains Monkey Gum Gully Forest and PCT 3226 Western Blue Mountains Montane Wet Fern Forest, which are considered to be Facultative Ecosystems. These communities are considered unlikely to be entirely groundwater dependent. This assumption is supported by the fact that the flora species within these vegetation communities are not restricted to alluvial drainage lines; they can occur along moist sheltered gully areas, creek lines, as well as dry slopes.

### 4.1.3 Threatened flora

One threatened flora species is known to occur within this EP area (see **Figure 3-8**). *Prostanthera stricta* (Mount Vincent Mint Bush; BC Act: Vulnerable; EPBC Act: Vulnerable). There are currently 18 monitoring transects for *Prostanthera stricta* within the Lease Area with additional transects established in the 2022 monitoring period directly within the EP area, and to provide additional control locations. Monitoring results display an increase in cover of *Prostanthera stricta* across the transects linked to rainfall patterns which were above the historical average for 9 months of the year and population recovery since the controlled burn across Mount Airly in 2018. (RPS 2022; **Graph 3-2**).

### 4.1.4 Threatened fauna

One threatened fauna species is persistent within the EP area (see **Figure 3-9**). The Glossy Black-Cockatoo (*Calyptorhynchus lathami*; BC Act: Vulnerable), frequents the area feeding on abundant stands of *Allocasuarina* species. A glossy black-cockatoo monitoring was established in this EP area.

Other mobile threatened fauna species particularly woodland birds, microbats, reptiles and arboreal mammals would utilise the habitat features within the area. Key habitat features include:

- Sandstone habitats: pagodas, steeps cliffs and escarpments, rocky outcrops or piles of sandstone boulders, caves, crevices and ledges for microbats and reptiles such as the Broad-headed Snake (*Hoplocephalus bungaroides;* BC Act: Endangered; EPBC Act: Vulnerable) and Rosenburg's Goanna (*Veranus rosenbergi;* BC Act: Vulnerable);
- Flowering and fruiting plants: utilised as foraging habitat for woodland birds and mammals such as the Flame Robin (*Petroica phoenicea*; BC Act: Vulnerable), the Gang-gang Cockatoo (*Callocephalon fimbriatum*; BC Act Vulnerable; EPBC Act: Endangered) and the Greater Gliders (*Petauroides Volans*; EPBC Act: Endangered);
- *Allocasuarina* species: for foraging glossy black-cockatoo (*Calyptorhynchus lathami*; BC Act: Vulnerable); and
- Koala feed trees: within woodland vegetation including *Eucalyptus cypellocarpa, Eucalyptus piperita* and *E. punctata*.

Fauna species diversity will continue to be monitored across the EP areas as part of the collective monitoring programme across the Mining Lease Area.

### 4.1.5 Implications for mining and recommendations

Approvals for Panel and Pillar Mining within MW17-19 EP area are based on predicted surface subsidence levels of up to 100-125mm (Centennial 2021). Void and pillar widths have been specifically designed to support the overburden with minimal subsidence effects at the surface. The final pillars left following panel extraction are specifically designed to provide long term stable support to the surface with no expected surface cracking and minimal ground movement (Centennial 2014). Based on this mine design, the proposed MW17-19 EP area is unlikely to have negative implications on the aforementioned key biodiversity feature.

## 4.2 CLZ EP area

### 4.2.1 Sensitive landscape features

The CLZ EP area contains sensitive landscape features including the deeply incised gorges named the Grotto and Oasis which forms a tributary of the Genowlan Creek.

### 4.2.2 Vegetation communities

The CLZ EP area encompasses 12 PCTs. The vegetation varies from PCT 3686, 3695 and 3865 along ridgetop cliff edges, to PCT 3226 and 3495 within the gullies. **Table 3-5** provides a breakdown of these PCTs. One TEC occurs within this EP area. PCT 3859 within the study area forms a part of the Genowlan Point *Allocasuarina nana* Heathland EEC listed under the BC Act. There is about 2.21 ha of the 15.2 ha extant occurring with the CLZ EP area.

No high priority GDEs have been identified within the study area, although there is potential for Facultative Ecosystems existing as moist sheltered gully forests or along creek lines (RPS 2014; GHD 2017).

The CLZ EP area supports areas of PCT 3226 Western Blue Mountains Montane Wet Fern Forest, PCT 3495 Western Blue Mountains Monkey Gum Gully Forest and PCT 3731 Capertee Conglomerate Grey Gum-Stringybark Forest within gullies and escarpments. During the 2022 monitoring programme across the Mining Lease Area ten GDE plots were established utilising BAM around the base of Pt Hatteras and within the Grotto across two of the PCTs. Composition, structure, function and vegetation integrity (VI) scores were calculated which establish baseline data for this ecosystem. Additionally rapid aquatic assessment occurred along 50 m transects within the Grotto at five locations adjacent streams which provide baseline condition and stream type data.

### 4.2.3 Threatened flora

Two threatened flora species are known to occur within this EP area (**Figure 3-8)**:

- *Prostanthera stricta* (Mount Vincent Mint Bush; BC Act: Vulnerable; EPBC Act: Vulnerable); and
- *Pultenaea sp*. Genowlan Point (BC Act: Critically Endangered; EPBC Act: Critically Endangered).

Eighteen transects for *Prostanthera stricta* occur within the Lease Area with additional transects established in the 2022 monitoring period to provide additional control locations. Monitoring results display an increase in cover of *Prostanthera stricta* across the transects linked to rainfall patterns which were above the historical average for 9 months of the year and population recovery since the controlled burn across Mount Airly in 2018. (RPS 2022; **Graph 3-2**).

*Pultenaea sp.* Genowlan Point is known from a single population that occurs within the CLZ EP area. Monitoring of *Pultenaea sp.* Genowlan Point is currently conducted by NPWS. Currently there are 35 individuals o*f Pultenaea sp*. Genowlan Point in the population (NPWS 2021; see **Graph 3-3**) and the population has been deemed 'stable' (NPWS 2020).

### 4.2.4 Threatened fauna

Threaten fauna utilise the diverse habitats of the CLZ EP area including (**Figure 3-9**):

- Diurnal birds;
- Forest owls;
- Mammals;
- Microbats; and
- Reptiles.

Greater Gliders and Large forest owls such as the Sooty Owl (*Tyto tenebricosa*; BC Act :Vulnerable) are common to gully habitats likely due to abundant hollows, tall timber and coverage. A historical record of the Spotted-tailed Quoll (*Dasyurus maculatus*; BC Act; Vulnerable; EPBC Act: Endangered) is located within the Grotto. The incised gorges and gullies also provide key foraging habitat for microbat species, whilst cliffs and overhangs provide roosting habitat. Diurnal bird species such as the Glossy Black-Cockatoo (*Calyptorhynchus lathami*; BC Act: Vulnerable) frequent the woodland and heath communities.

Whist no threatened amphibians have been detected within the Mining Lease Area, no formal surveys have been undertaken. Amphibian species are cryptic and can only be heard at specific times of the year and in suitable high rainfall conditions, therefore often avoid detection. Amphibian species are especially vulnerable to environmental disturbances and can be used as models of studying environmental change (Hopkins 2007). It is recommended that amphibian surveys are considered within the collective monitoring programme across the Mining Lease Area.

Key habitats for threatened fauna within the CLZ EP area include:

- Sandstone habitats: pagodas, steeps cliffs and escarpments, rocky outcrops or piles of sandstone boulders, caves, crevices and ledges for microbats and reptiles such as the Broad-headed Snake (*Hoplocephalus bungaroides;* BC Act: Endangered; EPBC Act: Vulnerable) and Rosenburg's Goanna (*Veranus rosenbergi;* BC Act: Vulnerable);
- Hollow-bearing Trees: are known to be common within the EP area and surrounds and include a diversity of eucalypt species of various ages. Smaller trees of woodland communities typically support smaller trunk and branch hollows whereas forest communities in sheltered gullies around the Grotto, support large trees and large branch hollows.
- Aquatic habitats: in the form of ephemeral first, second and third order creek lines which flow into the main tributary of Genowlan Creek then on into the Capertee River. These habitats may offer habitat to frogs such as the threatened *Heleioporus australiacus* (Giant Burrowing Frog), *Mixophyes iteratus* (Giant Barred Frog) and *Pseudophryne australis* (Red-crowned Toadlet).
- Flowering and fruiting plants: utilised as foraging habitat for woodland birds and mammals such as the Flame Robin (*Petroica phoenicea*; BC Act: Vulnerable), the Gang-gang Cockatoo (*Callocephalon*

*fimbriatum*; BC Act Vulnerable; EPBC Act: Endangered) and the Greater Gliders (*Petauroides Volans*; EPBC Act: Endangered);

- *Allocasuarina* species: for foraging Glossy Black-Cockatoos (*Calyptorhynchus lathami*; BC Act: Vulnerable); and
- Koala feed trees: within woodland vegetation including *Eucalyptus cypellocarpa, Eucalyptus piperita* and *Eucalyptus punctata*.

### 4.2.5 Implications for mining and recommendations

The CLZ EP area is restricted to first workings only. The subsidence assessment of the CLZ ML1331 Extraction Plan (Centennial 2017) states that “no surface impacts would be expected at these levels of subsidence. Specifically, no surface impacts would be expected to cliff lines, pagodas and steep slopes at these negligeable levels of subsidence”. However, repeatable and measurable monitoring should continue, or be established. It is to note that monitoring of *Pultenaea* sp. Genowlan Point and Genowlan Point *Allocasuarina* nana Heathland EEC is carried out by NPWS.

During the 2022 monitoring programme across the Mining Lease Area, the following baseline monitoring was conducted:

- Continued monitoring of threatened species and their habitats;
- Biodiversity monitoring within facultative ecosystems, with a focus on the Grotto habitat following a Before After Control Impact design where feasible; and
- Additional *Prostanthera stricta* monitoring transects established within the EP Area.

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# Appendix A
# Likelihood of Occurrence Analysis

**Apx Table 1 Likelihood of Occurrence Analysisla**

| Scientific Name (Common Name) | BC Act | EPBC Act | Habitat | Number of Recent Records (DPE 2022b) | LoO |
|---|---|---|---|---|---|
| *Acacia bynoeana (Bynoe's Wattle)* | E | V | Grows mainly in heath and dry sclerophyll forest in sandy soils. Mainly south of Dora Creek-Morisset area to Berrima and the Illawarra region, west to the Blue Mountains, also recorded from near Kurri Kurri in the Hunter Valley and from Morton National Park. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Acacia flocktoniae (Flockton Wattle)* | V | V | Grows in dry sclerophyll forest on sandstone. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Acacia meiantha* | E | E | The Clarence population occurs in open eucalypt forest in association with E. dives and E. sieberi and in an adjacent area of mostly shrubs where the tree overstorey was cleared for powerlines; it is found on sandy soil over sandstone at approx. 1000 m elevation. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |

| Scientific Name (Common Name) | BC Act | EPBC Act | Habitat | Number of Recent Records (DPE 2022b) | LoO |
|---|---|---|---|---|---|
| *Actitis hypoleucos (Common Sandpiper)* | | M | Utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflats. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| *Anthochaera phrygia (Regent Honeyeater)* | CE | CE | The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. The distribution of the species has contracted dramatically in the last 30 years to between north-eastern Victoria and south-eastern Queensland. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and | 30 | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |

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| | | | surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests. | | |
| *Aprasia parapulchella (Pink-tailed Legless Lizard)* | V | V | Inhabits sloping, open woodland areas with predominantly native grassy groundlayers, particularly those dominated by kangaroo grass. Sites are typically well-drained, with rocky outcrops or scattered, partially-buried rocks. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Apus pacificus (Fork-tailed Swift)* | | M,MAR | The Fork-tailed Swift is almost exclusively aerial, flying from less then one metre to at least 300 metres above ground and probably much higher. | | None. Species specific habitat types (i.e. important habitat features) and known vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are absent from the investigation area. The investigation area is also likely located outside the species known 'area of occurrence' and may also occur outside the species 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Species incidence is not expected and, if detected, would likely represent atypical occurrence (e.g. incidence linked with transient activity). Presence unlikely associated with habitat occupancy involving important lifecycle processes. |
| *Ardea ibis (Cattle egret)* | | MAR | 0 | | None. Species specific habitat types (i.e. important habitat features) and known vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are absent from the investigation area. The investigation area is also likely located outside the species known 'area of occurrence' and may also occur outside the species 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Species incidence is not expected and, if detected, would likely represent atypical occurrence (e.g. incidence linked with transient activity). Presence unlikely associated with habitat |

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| | | | | | occupancy involving important lifecycle processes. |
| *Artamus cyanopterus cyanopterus (Dusky Woodswallow)* | V | | The Dusky Woodswallow is widespread in eastern, southern and southwestern Australia. In New South Wales it is widespread from coast to inland, including the western slopes of the Great Dividing Range and farther west. It is sparsely scattered in, or largely absent from, much of the Upper Western region. The Dusky Woodswallow is often reported in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. It has also been recorded in shrublands and heathlands and various modified habitats, including regenerating forests; very occasionally in moist forests or rainforests. At sites where Dusky Woodswallows are recorded the understorey is typically open with sparse eucalypt saplings, acacias and other shrubs, including heath. The ground cover may consist of grasses, sedges or open ground, often with coarse woody debris (Higgins and Peter 2002). Birds are also often observed in farm land, usually at the edges of forest or woodland or in | 8 | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |

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| | | | roadside remnants or wind breaks with dead timber. | | |
| *Astrotricha crassifolia (Thick-leaf Star-hair)* | V | V | Occurs near Patonga (Gosford LGA), and in Royal NP and on the Woronora Plateau (Sutherland and Campbelltown LGAs). There is also a record from near Glen Davis (Lithgow LGA). Also in Victoria. Occurs in dry sclerophyll woodland on sandstone. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Botaurus poiciloptilus (Australasian Bittern)* | E | E | The Australasian Bitterns is widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes and spikerushes. | | None. Species specific habitat types (i.e. important habitat features) and known vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are absent from the investigation area. The investigation area is also likely located outside the species known 'area of occurrence' and may also occur outside the species 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Species incidence is not expected and, if detected, would likely represent atypical occurrence (e.g. incidence linked with transient activity). Presence unlikely associated with habitat occupancy involving important lifecycle processes. |
| *Burhinus grallarius (Bush Stone-curlew)* | E | | The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and in the south-east it is either rare or extinct throughout its former range. Inhabits open forests and woodlands with a sparse grassy | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of |

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| | | | groundlayer and fallen timber. Largely nocturnal, being especially active on moonlit nights. | | active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| *Calidris acuminata (Sharp-tailed Sandpiper)* | | M | Freshwater or saltwater wetlands- the muddy edges of lagoons, swamps, lakes, dams, soaks, sewage dams or temporary floodwaters. | | None. Species specific habitat types (i.e. important habitat features) and known vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are absent from the investigation area. The investigation area is also likely located outside the species known 'area of occurrence' and may also occur outside the species 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Species incidence is not expected and, if detected, would likely represent atypical occurrence (e.g. incidence linked with transient activity). Presence unlikely associated with habitat occupancy involving important lifecycle processes. |
| *Calidris ferruginea (Curlew Sandpiper)* | E | CE,M,MAR | The Curlew Sandpiper is distributed around most of the coastline of Australia. It occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin. It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes the inland | | None. Species specific habitat types (i.e. important habitat features) and known vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are absent from the investigation area. The investigation area is also likely located outside the species known 'area of occurrence' and may also occur outside the species 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Species incidence is not expected and, if detected, would likely represent atypical occurrence (e.g. incidence linked with transient activity). Presence unlikely associated with habitat occupancy involving important lifecycle processes. |
| *Calidris melanotos (Pectoral Sandpiper)* | | M,MAR | Tends to live and feed over shallow coastal waters- the estuaries, lagoons and channels around river and harbour entrances and along the | | None. Species specific habitat types (i.e. important habitat features) and known vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are absent from the investigation area. The investigation area is also likely located outside the species known 'area of occurrence' and may also occur outside the species 'extent of occurrence' [i.e. standard grid size of |

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| | | | shallows close in shore. | | 2x2km (IUCN 2017)]. Species incidence is not expected and, if detected, would likely represent atypical occurrence (e.g. incidence linked with transient activity). Presence unlikely associated with habitat occupancy involving important lifecycle processes. |
| *Callocephalon fimbriatum (Gang-gang Cockatoo)* | V | E | In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. Also occur in subalpine snow gum woodland and occasionally in temperate or regenerating forest. In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas. It requires tree hollows in which to breed. | 6 | Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records). |
| *Calyptorhynchus lathami (Glossy Black-Cockatoo, Riverina population)* | EP | | Inhabits forest with low nutrients, characteristically with key Allocasuarina spp. Tends to prefer drier forest types with a middle stratum of Allocasuarina below Eucalyptus or Angophora. Often confined to remnant patches in hills and gullies. Breed in hollows stumps or limbs, either living or dead. Endangered population in the Riverina. | 2 | Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records). |
| *Cercartetus nanus (Eastern Pygmy-possum)* | V | | Inhabits rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN |

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| | | | favoured food source. Will often nest in tree hollows, but can also construct its own nest . Because of its small size it is able to utilise a range of hollow sizes including very small hollows. Individuals will use a number of different hollows and an individual has been recorded using up to 9 nest sites within a 0.5ha area over a 5 month period . | | 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| *Chalinolobus dwyeri (Large-eared Pied Bat)* | V | V | Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range. Can also be found on the edges of rainforests and in wet sclerophyll forests. This species roosts in caves and mines in groups of between 3 and 37 individuals. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| *Chrysococcyx osculans (Black-eared cuckoo)* | | MAR | 0 | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not |

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| | | | | | recently observed in the locality (NSW BioNet records). |
| *Chthonicola sagittata (Speckled Warbler)* | V | | The Speckled Warbler lives in a wide range of eucalypt dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. | 3 | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| *Climacteris picumnus victoriae (Brown Treecreeper (eastern subspecies))* | V | | Found in eucalypt woodlands (including box-gum woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and river red gum forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains. | 10 | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |

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| *Cynanchum elegans (White-flowered Wax Plant)* | E | E | Recorded from rainforest gullies scrub and scree slopes from the Gloucester district to the Wollongong area and inland to Mt Dangar. | | None. Species specific habitat types (i.e. important habitat features) and known vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are absent from the investigation area. The investigation area is also likely located outside the species known 'area of occurrence' and may also occur outside the species 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Species incidence is not expected and, if detected, would likely represent atypical occurrence (e.g. incidence linked with transient activity). Presence unlikely associated with habitat occupancy involving important lifecycle processes. |
| *Daphoenositta chrysoptera (Varied Sittella)* | V | | Inhabits wide variety of dry eucalypt forests and woodlands, usually with either shrubby under storey or grassy ground cover or both, in all climatic zones of Australia. Usually in areas with rough-barked trees, such as stringybarks or ironbarks, but also in paperbarks or mature Eucalypts with hollows. | 3 | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| *Darwinia peduncularis* | V | | Occurs as local disjunct populations in coastal NSW with a couple of isolated populations in the Blue Mountains. It has been recorded from Brooklyn, Berowra, Galston Gorge, Hornsby, Bargo River, Glen Davis, Mount Boonbourwa and Kings Tableland. Usually grows on or near rocky outcrops on sandy, well drained, low nutrient soil over sandstone. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |

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| *Dasyurus maculatus (Spotted-tailed Quoll)* | V | E | Spotted-tailed Quoll are found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland. Only in Tasmania is it still considered common. Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| *Delma impar (Striped Legless Lizard)* | V | V | Found mainly in natural temperate grassland but has also been captured in grasslands that have a high exotic component. Also found in secondary grassland near natural temperate grassland and occasionally in open box-gum woodland. Sometimes found in grasslands with significant amounts of surface rocks, which are used for shelter. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Dichanthium setosum (Bluegrass)* | V | V | Occurs on the New England Tablelands, North West Slopes and Plains and the Central Western Slopes of NSW, as well as in Queensland and Western Australia. It occurs widely on private property, including in the Inverell, Guyra, Armidale and Glen Innes areas. Often found in moderately disturbed areas such as cleared woodland, grassy roadside remnants | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not |

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| | | | and highly disturbed pasture. | | recently observed in the locality (NSW BioNet records). |
| *Eucalyptus aggregata (Black Gum)* | V | V | Found in the NSW Central and Southern Tablelands, with small isolated populations in Victoria and the ACT. Has a moderately narrow distribution, occurring mainly in the wetter, cooler and higher parts of the tablelands in the lowest parts of the landscape, on alluvial soils, on cold, poorly-drained flats and hollows adjacent to creeks and small rivers. Also occurs as isolated paddock trees in modified native or exotic pastures. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| *Eucalyptus cannonii (Capertee Stringybark)* | V | | Restricted to an area of about 100 by 60 km in the central tablelands of NSW. The western border is approximately marked by a line between Bathurst and Mudgee, while the eastern locations occur approximately on a line between Lithgow and the town of Bylong. Within this area the species is often locally frequent. Recorded from Tablelands Grassy woodland Complex communities and Talus Slope woodland, and in Winburndale Nature Reserve within woodland dominated by Eucalyptus macrorhyncha and | 28 | Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records). |

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| | | | Eucalyptus goniocalyx. | | |
| *Eucalyptus pulverulenta (Silver-leafed Gum)* | V | V | Found in two quite separate areas, the Lithgow to Bathurst area and the Monaro (Bredbo to Bombala).Grows in shallow soils as an understorey plant in open forest, typically dominated by brittle gum, red stringybark, broad-leaved peppermint, silvertop ash and apple box. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| *Euphrasia arguta* | CE | CE | Occur in eucalypt forest with a mixed grass and shrub understorey within Nundle State forest. Sites have either been logged in the last few decades, or appear to have regrown from past clearing. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| *Falco subniger (Black Falcon)* | V | | The Black Falcon is found along tree-lined watercourses and in isolated woodlands, mainly in arid and semi-arid areas. It roosts in trees at night and | 1 | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or |

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| | | | often on power poles by day. | | quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| *Falco hypoleucos (Grey Falcon)* | E | | Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| *Falsistrellus tasmaniensis (Eastern False Pipistrelle)* | V | | Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 m high. Two observations have been made of roosts in stem holes of living eucalypts. There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor . This species also appears to be highly mobile and records showing movements of up to 12 km between roosting and foraging sites . | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Gallinago hardwickii* | | M | Latham's Snipe is a non-breeding migrant to the south east of | | None. Species specific habitat types (i.e. important habitat features) and known vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation |

| Scientific Name (Common Name) | BC Act | EPBC Act | Habitat | Number of Recent Records (DPE 2022b) | LoO |
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| *(Latham's Snipe)* | | | Australia including Tasmania, passing through the north and New Guinea on passage. Latham's Snipe breed in Japan and on the east Asian mainland. seen in small groups or singly in freshwater wetlands on or near the coast, generally among dense cover. They are found in any vegetation around wetlands, in sedges, grasses, lignum, reeds and rushes and also in saltmarsh and creek edges on migration. | | formations) are absent from the investigation area. The investigation area is also likely located outside the species known 'area of occurrence' and may also occur outside the species 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Species incidence is not expected and, if detected, would likely represent atypical occurrence (e.g. incidence linked with transient activity). Presence unlikely associated with habitat occupancy involving important lifecycle processes. |
| *Glossopsitta pusilla (Little Lorikeet)* | V | | Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes. | 3 | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| *Grantiella picta (Painted Honeyeater)* | V | V | The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. |

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| | | | all breeding occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. Inhabits boree, brigalow and box-gum woodlands and box-ironbark forests. | | standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Grevillea divaricata* | E | | Known only from the type collection made in 1823 by Allan Cunningham, from "north of Bathurst". Specimen notes describe the plant as occurring frequently in dry open forest lands and as possibly growing on rocky river margins. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| *Grevillea evansiana (Evans Grevillea)* | V | V | Grows in dry sclerophyll forest or woodland, occasionally in swampy heath, in sandy soils, usually over Hawkesbury sandstone. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |

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| *Grevillea obtusiflora* | E | E | Occurs as scattered groups in the understorey of low open eucalypt forest at an altitude of 730 metres above sea level. Subspecies fecunda occurs in clusters within low, open scrub beneath open, dry sclerophyll forest, on orange, sandy loam soils with sandstone boulders, at an altitude of 570 metres. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Haliaeetus leucogaster (White-bellied Sea-Eagle)* | V | | Inhabits coastal and near coastal areas, building large stick nests, and feeding mostly on marine and estuarine fish and aquatic fauna. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| *Haloragodendron lucasii* | E | E | Occurs on Hawkesbury Sandstone in moist sandy loam soil. The species prefers sheltered aspects and inhabits gentle slopes below cliff lines near creeks in low open woodland or open forest. Its distribution is correlated with high soil moisture and phosphorus levels. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently |

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| | | | | | observed in the locality (NSW BioNet records). |
| *Heleioporus australiacus (Giant Burrowing Frog)* | V | V | The Giant Burrowing Frog has been recorded breeding in a range of water bodies associated with more sandy environments of the coast and adjacent ranges from the Sydney Basin south the eastern Victoria. It breeds in hanging swamps, perennial non-flooding creeks and occasionally permanent pools, but permanent water must be present to allow its large tadpoles time to reach metamorphosis. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Hieraaetus morphnoides (Little Eagle)* | V | | Most abundant in lightly timbered areas with open areas nearby. Often recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. May nest in farmland, woodland and forest in tall trees. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Hirundapus caudacutus (White-throated Needletail)* | | V,M,MAR | An aerial species found in feeding concentrations over cities, hilltops and timbered ranges. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat |

| Scientific Name (Common Name) | BC Act | EPBC Act | Habitat | Number of Recent Records (DPE 2022b) | LoO |
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| | | | | | occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| *Homoranthus darwinioides (Fairy Bells)* | V | V | Grows in various woodland habitats with shrubby understoreys, usually in gravely sandy soils. Landforms the species has been recorded growing on include flat sunny ridge tops with scrubby woodland, sloping ridges, gentle south-facing slopes, and a slight depression on a roadside with loamy sand. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Hoplocephalus bungaroides (Broad-headed Snake)* | E | V | Occurs almost exclusively in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they spend most of the year sheltering in and under rock crevices and exfoliating rock. However, some individuals will migrate to tree hollows to find shelter during hotter parts of summer. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| *Hygrocybe anomala var. ianthinomarginata* | V | | Occurs in gallery warm temperate forests dominated by lilly pilly, grey myrtle, cheese tree and sweet | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a |

| Scientific Name (Common Name) | BC Act | EPBC Act | Habitat | Number of Recent Records (DPE 2022b) | LoO |
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| | | | pittosporum. Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss. | | disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| *Hygrocybe aurantipes* | V | | Occurs in gallery warm temperate forests dominated by lilly pilly, grey myrtle, cheese tree and sweet pittosporum. Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates include soil, humus, or moss. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| *Hygrocybe reesiae* | V | | Occurs in gallery warm temperate forests dominated by lilly pilly, grey myrtle, cheese tree and sweet pittosporum. Associated with alluvial sandy soils of the Hawkesbury Soil Landscapes with naturally low fertility and erodible. Occur as individuals or in groups, terrestrial rarely on wood and only if extremely rotten; substrates | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher |

| Scientific Name (Common Name) | BC Act | EPBC Act | Habitat | Number of Recent Records (DPE 2022b) | LoO |
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| | | | include soil, humus, or moss. | | value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| *Lathamus discolor (Swift Parrot)* | E | CE,MAR | The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects . The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW . This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| *Leionema lachnaeoides* | E | E | Occurs at 10 sites in the upper Blue Mountains, within a 12 km range between Katoomba and Blackheath. Potential habitat occurs in the Megalong and Jamison Valleys. Populations occur on exposed sandstone cliff tops and terraces, at 960 - 1000m altitude and with aspects from south-east to south-west. Habitat vegetation is montane heath and commonly includes Eucalyptus stricta, Allocasuarina nana, Dillwynia retorta, Epacris microphylla and Caustis flexuosa. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Leionema sympetalum* | V | V | Restricted to exposed rocky sandstone formations known | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation |

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| *(Rylstone Bell)* | | | as pagodas. The species occurs in dry sclerophyll forest and probably also occurs in open or closed heathland communities. | | formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Leipoa ocellata (Malleefowl)* | E | V | Predominantly inhabit mallee communities, preferring the tall, dense and floristically-rich mallee found in higher rainfall (300 - 450 mm mean annual rainfall) areas. Utilises mallee with a spinifex understorey, but usually at lower densities than in areas with a shrub understorey. Less frequently found in other eucalypt woodlands, such as inland grey box, ironbark or bimble box woodlands with thick understorey, or in other woodlands such dominated by mulga or native cypress pine species. | | None. Species specific habitat types (i.e. important habitat features) and known vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are absent from the investigation area. The investigation area is also likely located outside the species known 'area of occurrence' and may also occur outside the species 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Species incidence is not expected and, if detected, would likely represent atypical occurrence (e.g. incidence linked with transient activity). Presence unlikely associated with habitat occupancy involving important lifecycle processes. |
| *Leucochrysum albicans var. tricolor (Hoary Sunray)* | | E | Hoary Sunray occurs in a wide variety of grassland, woodland and forest habitats, generally on relatively heavy soils. Plants can be found in natural or semi-natural vegetation and grazed or ungrazed habitat. Bare ground is required | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat |

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| | | | for germination. In NSW, the species is often found in association with yellow box, Blakely's red gum and red box. | | occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| *Litoria aurea (Green and Golden Bell Frog)* | E | V | Inhabits a very wide range of water bodies including marshes, dams and streams, particularly those containing emergent vegetation such as bullrushes or spikerushes. It also inhabits numerous types of man-made water bodies including quarries and sand extraction sites. Optimum habitat includes water-bodies that are un-shaded, free of predatory fish such as Plague Minnow, have a grassy area nearby and diurnal sheltering sites available. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| *Litoria booroolongensis (Booroolong Frog)* | E | E | The Booroolong Frog is found along permanent western flowing streams of the Great Dividing Range through most of NSW and down into northern Victorua. Streams range from small slow-flowing creeks to large rivers and the adults are found on or near cobble banks and other rock structures within stream margins and shelter under rocks or amongst vegetation near the ground on the stream edge. The species occurs along streams in | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |

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| | | | both forested areas and open pasture, but has been affected by the presence of the introduced willow tree. Booroolong Frogs sometimes basks in the sun on exposed rocks near flowing water during summer. | | |
| Litoria littlejohni (Littlejohn's Tree Frog) | V | V | Occurs in wet and dry sclerophyll forests and heathland associated with sandstone outcrops between 280 and 1000 m on the eastern slopes of the Great Dividing Range from the Central Coast down into Victoria. Individuals have been collected from a wide range of water bodies that includes semi-permanent dams, permanent ponds, temporary pools and permanent streams, with calling occurring from fringing vegeation or on the banks. Individuals have been observed sheltering under rocks on high exposed ridges during summer and within deep leaf litter adjacent to the breeding site. Calling occurs in all months of the year, often in association with heavy rains. The tadpoles are distinctive, being large and very dark in colouration. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Lophoictinia isura (Square-tailed Kite) | V | | Typically inhabits coastal forested and wooded lands of tropical and temperate Australia. In NSW it | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may |

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| | | | is often associated with ridge and gully forests dominated by Eucalyptus longifolia, Corymbia maculata, E. elata or E. smithii. Individuals appear to occupy large hunting ranges of more than 100km2. They require large living trees for breeding, particularly near water with surrounding woodland -forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs. | | not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Macquaria australasica (Macquarie Perch) | | E | Macquarie perch are found in the Murray-Darling Basin (particularly upstream reaches) of the Lachlan, Murrumbidgee and Murray rivers, and parts of south-eastern coastal NSW, including the Hawkesbury and Shoalhaven. Macquarie perch are found in both river and lake habitats, especially the upper reaches of rivers and their tributaries | | None. Species specific habitat types (i.e. important habitat features) and known vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are absent from the investigation area. The investigation area is also likely located outside the species known ‘area of occurrence’ and may also occur outside the species 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Species incidence is not expected and, if detected, would likely represent atypical occurrence (e.g. incidence linked with transient activity). Presence unlikely associated with habitat occupancy involving important lifecycle processes. |
| Melanodryas cucullata cucullata (Hooded Robin (south-eastern form)) | V | | Occupy a wide range of eucalypt woodlands, Acacia shrublands and open forests. | 3 | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat |

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| | | | | | occupancy. Species recently observed in the locality (NSW BioNet records). |
| *Melithreptus gularis gularis (Black-chinned Honeyeater (eastern subspecies))* | V | | Eucalypt woodlands within an approximate annual rainfall range of 400-700mm | 1 | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| *Merops ornatus* (Rainbow bee-eater) | | MAR | 0 | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat) | V | | Most records are from dry eucalypt forests and woodlands to the east of the Great Dividing Range. Appears to roost in trees, but little is known of this species' habits. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |

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| *Miniopterus australis* (Little Bent-winged Bat) | V | | Coastal north-eastern NSW and eastern Queensland. Little Bent-wing Bat is an insectivorous bat that roost in caves, in old mines, in tunnels, under bridges, or in similar structures. They breed in large aggregations in a small number of known caves and may travel 100s km from feeding home ranges to breeding sites. Little Bent-wing Bat has a preference for moist eucalypt forest, rainforest or dense coastal banksia scrub where it forages below the canopy for insects. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Miniopterus orianae oceanensis* (Large Bent-winged Bat) | V | | Eastern Bent-wing Bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| *Mixophyes balbus* (Stuttering Frog) | E | V | Associated with streams in dry sclerophyll and wet sclerophyll forests and rainforests of more upland areas of the Great Dividing Range of NSW and down into Victoria. Breeding occurs along forest streams with | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity |

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| | | | permanent water where eggs are deposited within nests excavated in riffle zones by the females and the tadpoles swim free into the stream when large enough to do so. Outside of breeding, individuals range widely across the forest floor and can be found hundres of metres from water | | for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Mixophyes iteratus* (Giant Barred Frog) | E | E | This species is found along larger streams of the coast and adjacent ranges of NSW and SE QLD. It inhabits rainforest and wet sclerophyll forest, but is also found within cleared farmland where fringing vegetation is retained, including lantana beds. Many sites where the Giant Barred Frog is known to occur are the lower reaches of streams which have been affected by major disturbances such as clearing, timber harvesting and urban development in their headwaters. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| *Monarcha melanopsis* (Black-faced Monarch) | | M,MAR | 0 | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently |

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| | | | | | observed in the locality (NSW BioNet records). |
| Motacilla flava (Yellow Wagtail) | | M,MAR | Often seen near water. Listen for high-pitched, piercing call note. Common breeder on Arctic tundra from Alaska to Russia; found in grassy and waterside habitats in Southeast Asian wintering grounds and in migration. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| Myiagra cyanoleuca (Satin Flycatcher) | | M,MAR | 0 | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Myotis macropus (Southern Myotis) | V | | The Large-footed Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently |

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| | | | under bridges and in dense foliage. | | observed in the locality (NSW BioNet records). |
| Neophema chrysostoma (Blue-winged parrot) | | MAR | 0 | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| Neophema pulchella (Turquoise Parrot) | V | | The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust. | 2 | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Ninox connivens (Barking Owl) | V | | Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. |

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| | | | in otherwise open country. | | standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Ninox strenua (Powerful Owl) | V | | Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. It is most commonly recorded within red turpentine in tall open forests and black she-oak within open forests. Large mature trees with hollows at least 0.5 m deep are required for nesting. Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials. Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Numenius madagascariensis (Eastern Curlew) | | CE,M,MAR | The Eastern curlew spends its breeding season in northeastern Asia, including Siberia to Kamchatka, and Mongolia. Its breeding habitat is composed of marshy and swampy wetlands and lakeshores. | | None. Species specific habitat types (i.e. important habitat features) and known vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are absent from the investigation area. The investigation area is also likely located outside the species known ‘area of occurrence’ and may also occur outside the species 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Species incidence is not expected and, if detected, would |

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| | | | Most individuals winter in coastal Australia, with a few heading to South Korea, Thailand, Philippines and New Zealand, where they stay at estuaries, beaches, and salt marshes. It uses its long, decurved bill to probe for invertebrates in the mud. It may feed in solitary but it generally congregates in large flocks to migrate or roost. Its call is a sharp, clear whistle, cuuue-reee, often repeated. | | likely represent atypical occurrence (e.g. incidence linked with transient activity). Presence unlikely associated with habitat occupancy involving important lifecycle processes. |
| Nyctophilus corbeni (Corben's Long-eared Bat) | V | V | The South-eastern Long-eared Bat has a limited distribution that is restricted around the Murray-Darling Basin in south-eastern Australia. Even in this region its distribution is scattered and it is rarely recorded. It occurs in far eastern South Australia, in areas north of the Murray River, east of Canegrass Station and south of the Barrier Highway. These areas include the Riverland Biosphere Reserve, Danggali Conservation Park and the Birds Australia Gluepot Reserve. It is distributed throughout inland NSW except in the north-west area which is dominated by treeless plains. It can be found in | | None. Species specific habitat types (i.e. important habitat features) and known vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are absent from the investigation area. The investigation area is also likely located outside the species known ‘area of occurrence’ and may also occur outside the species 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Species incidence is not expected and, if detected, would likely represent atypical occurrence (e.g. incidence linked with transient activity). Presence unlikely associated with habitat occupancy involving important lifecycle processes. |

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| | | | the Hunter Valley, extending from central NSW to the eastern Hunter Valley coast. Considered Nyctophilus timorensis south eastern form under TSC Act. | | |
| Olearia cordata | V | V | Grows in dry open sclerophyll forest and open shrubland, on sandstone ridges. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Pachycephala inornata (Gilbert's Whistler) | V | | Recorded in mallee shrublands, but also occurs in box-ironbark woodlands, cypress pine and belah woodlands and river red gum forests, though at this stage it is only known to use this habitat along the Murray, Edwards and Wakool Rivers. Within the mallee the species is often found in association with an understorey of spinifex and low shrubs including wattles, hakeas, sennas and hop-bushes. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Paralucia spinifera (Purple Copper Butterfly, Bathurst | E | V | The Copper Butterfly is only found in the Central Tablelands of NSW. Its habitat is restricted to elevations above 900 m where it | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the |

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| Copper Butterfly) | | | feeds exclusively on a form of blackthorn. The butterfly's life cycle relies on a 'mutualistic' relationship with the ant Anonychomyrma itinerans, and on the presence of blackthorn (Bursaria spinosa subsp. lasiophylla). | | known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Persoonia marginata (Clandulla Geebung) | V | V | Grows in dry sclerophyll forest and woodland communities on sandstone. Appears to respond well to disturbance, with greater densities found along the edges of tracks and in areas disturbed by forestry activities. | 38 | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Petauroides volans (Greater Glider) | | V | The Greater Glider occurs in eucalypt forests and woodlands. Utilise tree hollows | | Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records). |
| Petaurus australis (Yellow-bellied Glider) | V | | Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity |

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| | | | gullies and creek flats to tall montane forests in the south. Found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria. | | for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Petaurus norfolcensis (Squirrel Glider) | V | | Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range . Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias . There is only limited information available on den tree use by Squirrel gliders, but it has been observed using both living and dead trees as well as hollow stumps. Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked. Endangered population in the Wagga Wagga LGA. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Petrogale penicillata (Brush-tailed Rock-wallaby) | E | V | Found in rocky areas in a wide variety of habitats including rainforest gullies, wet and dry sclerophyll forest, open woodland and rocky outcrops in semi-arid country. Commonly sites have a northerly aspect with numerous ledges, caves and crevices. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat |

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| | | | | | occupancy. Species recently observed in the locality (NSW BioNet records). |
| Petroica boodang (Scarlet Robin) | V | | The Scarlet Robin is found from SE Queensland to SE South Australia and also in Tasmania and SW Western Australia. In NSW, it occurs from the coast to the inland slopes. The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. | 1 | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Petroica phoenicea (Flame Robin) | V | MAR | Flame Robins are found in a broad coastal band from southern Queensland to just west of the South Australian border. The species is also found in Tasmania. The preferred habitat in summer includes eucalyptus forests and woodland, whilst in winter prefers open woodlands and farmlands. It is considered migratory. The Flame Robin breeds from about August to January. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Phascogale tapoatafa (Brush-tailed Phascogale) | V | | The Brush-tailed Phascogale has a patchy distribution around the coast of Australia. In NSW it is mainly found east of the Great Dividing Range although there are occassional records west ot the divide. Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently |

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| | | | swamps, rainforest and wet sclerophyll forest. | | observed in the locality (NSW BioNet records). |
| Phascolarctos cinereus (Koala) | V | E | Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall . | 2 | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Phebalium bifidum | E | | Phebalium bifidum is restricted to the Capertee Valley, south east of Kandos in the South Eastern Highlands bioregion in NSW. The species is extremely rare, in being known from only four disjunct sites from within the Valley. Phebalium bifidum is not known from any conservation reserve. Occurs in dry sclerophyll woodland or heath on structured loam soil; in most instances plants have been found on relatively flat ground on broad ridges and hill crests. | 514 | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Polytelis swainsonii (Superb Parrot) | V | V | The Superb Parrot is found throughout eastern inland NSW. On the South-western Slopes their core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity |

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| | | | Birds breeding in this region are mainly absent during winter, when they migrate north to the region of the upper Namoi and Gwydir Rivers. Inhabits box-gum, box-cypress-pine and boree woodlands and river red gum forest. | | for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Pomaderris brunnea (Brown Pomaderris) | E | V | The species is expected to live for 10 - 20 years, while the minimum time to produce seed is estimated to be 4 - 6 years. Found in a very limited area around the Colo, Nepean and Hawkesbury Rivers, including the Bargo area. It also occurs at Walcha on the New England Tableland and in far eastern Gippsland in Victoria. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| Pomaderris cotoneaster (Cotoneaster Pomaderris) | E | E | Has been recorded in a range of habitats in predominantly forested country. The habitats include forest with deep, friable soil, amongst rock beside a creek, on rocky forested slopes and in steep gullies between sandstone cliffs. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Pomatostomus temporalis temporalis (Grey-crowned Babbler | V | | In NSW, the eastern sub-species occurs on the western slopes of the Great Dividing Range, and on the western | 1 | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known |

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| (eastern subspecies)) | | | plains reaching as far as Louth and Balranald. It also occurs in woodlands in the Hunter Valley and in several locations on the north coast of NSW. It may be extinct in the southern, central and New England tablelands. Inhabits open box-gum woodlands on the slopes, and box-cypress-pine and open box woodlands on alluvial plains. | | 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Prasophyllum petilum (Tarengo Leek Orchid) | E | E | Grows in open sites within Natural Temperate Grassland at the Boorowa and Delegate sites and in grassy woodland in association with River Tussock Poa labillardieri, Black Gum Eucalyptus aggregata and tea-trees Leptospermum spp. near Queanbeyan and within the grassy groundlayer dominated by Kanagroo Grass under Box-Gum Woodland at Ilford (and Hall, ACT) | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| Prasophyllum sp. Wybong | | CE | Endemic to NSW. It is known from seven populations in eastern NSW near Ilford, Premer, Muswellbrook, Wybong, Yeoval, Inverell and Tenterfield. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with |

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| | | | | | landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| Prostanthera cryptandroides subsp. cryptandroides (Wollemi Mint-bush) | V | V | At Glen Davis, occurs in open forest dominated by Eucalyptus fibrosa. Other eucalypt species may be present as sub-dominants. In the Denman-Gungal and Widden-Baerami Valley areas, occurs on rocky ridgelines on Narrabeen Group Sandstones in association with a range of communities. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Prostanthera stricta (Mount Vincent Mint-bush) | V | V | A locally dominant undershrub in heath or scrub communities along cliff edges, or as an understorey species within a range of open forest or tall open forest types, or in adjacent transitional communities. Grows in areas of both skeletal soil and on deeper, well-drained soil profiles in areas characterised by steep rocky sideslopes, cliff lines, sandstone platforms, or gentle slopes with exposed sandstone outcroppings. | 5 | Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records). |
| Prototroctes maraena (Australian Grayling) | | V | Historically, this species occurred in coastal streams from the Grose River Valley, southwards through NSW, Vic. and Tas. It also occasionally occurred high upstream in the | | None. Species specific habitat types (i.e. important habitat features) and known vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are absent from the investigation area. The investigation area is also likely located outside the species known ‘area of occurrence’ and may also occur outside the species 'extent of occurrence' [i.e. standard grid size of |

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| | | | Snowy R. A single juvenile specimen was collected from Lake Macquarie in 1974 . This species spends only part of its lifecycle in freshwater. The Tambo River population inhabits a clear, gravel-bottomed stream with alternating pools and riffles, and granite outcrops. It has also been associated with clear, gravel-bottomed habitats in the Mitchell & Wonnangatta Rivers but was present in a muddy-bottomed, heavily silted habitat in the Tarwin R. | | 2x2km (IUCN 2017)]. Species incidence is not expected and, if detected, would likely represent atypical occurrence (e.g. incidence linked with transient activity). Presence unlikely associated with habitat occupancy involving important lifecycle processes. |
| Pseudomys novaehollandiae (New Holland Mouse) | | V | The New Holland Mouse currently has a disjunct, fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Pseudophryne australis (Red-crowned Toadlet) | V | | Occurs on wetter ridge tops and upper slopes of sandstone formations on which the predominant vegetation is dry open forests and heaths. This species typically breeds within small ephemeral creeks that feed into larger | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and |

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| | | | semi-perennial streams. After rain these creeks are characterised by a series of shallow pools lined by dense grasses, ferns and low shrubs and usually contain leaf litter for shelter. Eggs are terrestrial and laid under litter, vegetation or rocks where the tadpoles inside will reach a relatively late stage of development before waiting for flooding waters before hatching will occur. | | active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Pteropus poliocephalus (Grey-headed Flying-fox) | V | V | This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost although some individuals may travel up to 70 km. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Pultenaea glabra (Smooth Bush-Pea) | V | V | Grows in swamp margins, hillslopes, gullies and creekbanks and occurs within dry sclerophyll forest and tall damp heath on sandstone. Restricted to the higher Blue Mountains. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Pultenaea sp. Genowlan Point | CE | CE | Occurs on well drained stony soil near a cliff edge. | | Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN |

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| | | | | | 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records). |
| Pultenaea sp. Olinda | E | | Has been found only in a very limited area of pagoda rock formation east of Rylstone. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Pycnoptilus floccosus (Pilotbird) | | V | 0 | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known ‘area of occurrence’ but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Rhipidura rufifrons (Rufous Fantail) | | M,MAR | 0 | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |

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| Rhizanthella slateri (Rhizanthella slateri (Rupp) M.A. Clem. & Cribb in the Great Lakes local government area) | EP | E | Habitat requirements are poorly understood and no particular vegetation type has been associated with the species, although it is known to occur in sclerophyll forest. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Rhodamnia rubescens (Scrub Turpentine) | CE | CE | Found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils. This species is characterised as highly to extremely susceptible to infection by Myrtle Rust. Myrtle Rust affects all plant parts. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Rostratula australis (Australian Painted Snipe) | E | E | In NSW, this species has been recorded at the Paroo wetlands, Lake Cowell, Macquarie Marshes and Hexham Swamp. Most common in the Murray-Darling Basin. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not |

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| | | | | | recently observed in the locality (NSW BioNet records). |
| Saccolaimus flaviventris (Yellow-bellied Sheathtail-bat) | V | | Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Scoteanax rueppellii (Greater Broad-nosed Bat) | V | | Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m. In dense environments they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat. This species roosts in hollow tree trunks and branches. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| Stagonopleura guttata (Diamond Firetail) | V | | Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season). Found in grassy eucalypt woodlands, including box-gum woodlands and snow gum | 4 | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat |

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| | | | woodlands. Also occurs in open forest, mallee, natural temperate grassland, and in secondary grassland derived from other communities. | | occupancy. Species recently observed in the locality (NSW BioNet records). |
| Swainsona recta (Small Purple-pea) | E | E | Before European settlement, this species occurred in the grassy understorey of woodlands and open-forests dominated by Blakely's red gum, yellow box, candlebark gum and long-leaf box. Grows in association with understorey dominants that include kangaroo grass, poa tussocks and spear-grasses. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Tetratheca glandulosa | V | | Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone, with associated soil landscapes such as Lucas Heights, Gymea, Lambert and Faulconbridge. Topographically, the plant occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. Soils are generally shallow, consisting of a yellow, clayey-sandy loam. Stony lateritic fragments are also common in the soil profile on many of these ridgetops. Vegetation structure varies from heaths and scrub to woodlands-open | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |

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| | | | woodlands, and open forest. | | |
| Thesium australe (Austral Toadflax) | V | V | Grows in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Occurs in grassland or grassy woodland. Grows on kangaroo grass tussocks but has also been recorded within the exotic coolatai grass. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known 'area of occurrence' but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| Tyto novaehollandiae (Masked Owl) | V | | Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting. Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead. Nest hollows are usually located within dense forests or woodlands. Masked owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Tyto tenebricosa (Sooty Owl) | V | | Often found in tall old-growth forests, including temperate | | High. Habitat values within the investigation area are generally consistent with descriptions provided in |

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| | | | and subtropical rainforests. In NSW mostly found on escarpments with a mean altitude less than 500 metres. Nests and roosts in hollows of tall emergent trees, mainly eucalypts often located in gullies. Nests have been located in trees 125 to 161 centimetres in diameter. | | the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Varanus rosenbergi (Rosenberg's Goanna) | V | | This species is a Hawkesbury-Narrabeen sandstone outcrop specialist. Occurs in coastal heaths, humid woodlands and both wet and dry sclerophyll forests. | | Known. Species observed and habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is located within known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Habitat occupancy is likely to be associated with important life cycle processes; however, the reliance on this habitat would depend on additional factors (e.g. size and extent of local population, effect of KTPs). Species recently observed in the locality (NSW BioNet records). |
| Velleia perfoliata | V | V | The species is only known from the Hawkesbury District and Upper Hunter Valley in the Central Coast botanical subdivision of NSW. Velleia perfoliata grows in heath on shallow sandy soil over Sandstone. It is currently known to exist in 9 populations. Five of these populations are reserved whilst a further population is partly reserved. Four of the reserved sites are situated adjacent to fire trails. | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| Veronica blakelyi | V | | Restricted to the western Blue Mountains, near Clarence, near Mt Horrible, on Nullo Mountain and in the | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a |

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|---|---|---|---|---|---|
| | | | Coricudgy Range. Occurs at fewer than 20 locations, none of which is in a conservation reserve. Occurs in eucalypt forest, often in moist areas. | | disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| Vespadelus troughtoni (Eastern Cave Bat) | V | | The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT. A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals. | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |
| Wollemia nobilis (Wollemi Pine) | CE | CE | Restricted to remote canyons in the Wollemi National Park, north-west of Sydney. Occurs in warm temperate rainforest and rain forest margins in | | Low. Vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) are present; however, species specific habitat types (i.e. important habitat features) are either absent, in low abundance and/ or in a disturbed state. The investigation area is likely to be located outside the species known ‘area of occurrence’ but may be within the known 'extent of occurrence' |

| Scientific Name (Common Name) | BC Act | EPBC Act | Habitat | Number of Recent Records (DPE 2022b) | LoO |
|---|---|---|---|---|---|
| | | | remote sandstone canyons. | | [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are likely to be negatively influencing the likelihood of habitat occupancy. If detected, species activity is most likely low and associated with landscape scale habitat use such as movement between areas of higher value habitat, the use of supplementary habitat or reflect the negative effects of active/ uncontrolled KTPs. Species not recently observed in the locality (NSW BioNet records). |
| Xanthosia scopulicola | V | | Known only from scattered locations between Kings Tableland (Wentworth Falls) and Boars Head rock (west of Katoomba) in the Blue Mountains. Grows in cracks and crevices of sandstone cliff faces or on rocky outcrops above the cliffs. | | Moderate. Species specific (i.e. important habitat features) and vegetation classification based habitat surrogates (i.e. PCT and/ or vegetation formations) occur within the investigation area. The investigation area may or may not be located within the species known 'area of occurrence' but is within the known 'extent of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality may be influencing the capacity for habitat occupancy. Pre-existing and active KTPs may potentially have a negative influence on species incidence and/ or habitat occupancy. Not recently observed in the locality (NSW BioNet records). |
| Zieria murphyi (Velvet Zieria) | V | V | The species grows in open, dry sclerophyll forest, on sandy soils on sandstone and in sheltered sites, often just below clifflines | | High. Habitat values within the investigation area are generally consistent with descriptions provided in the BCD TSPD. Habitat is likely to be located within the known 'extent of occurrence' and 'area of occurrence' [i.e. standard grid size of 2x2km (IUCN 2017)]. Factors such as connectivity, patch size, habitat quantum and/ or quality are unlikely to adversely influence the capacity of the species to occupy the habitat. Pre-existing and active KTPs are unlikely to be substantially influencing species incidence and/ or habitat occupancy. Species recently observed in the locality (NSW BioNet records). |

# Appendix B
# EPBC Act MNES Search

# Appendix C
# Floristic Plots - Woodland

**Apx Table 2: Full floristic data from Genowlan Point Allocasuarina nana Heathland EEC and Woodland 20 x 20 m plots**

| Scientific Name | Common Name | BC Act | EP BC Act | Exotic | GEN_PT_01 | | GEN_PT_02 | | Woodland_01 | | Woodland_02 | | Woodland_03* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Cover | Abund. | Cover | Abund. | Cover | Abund. | Cover | Abund. | Cover | Abund. |
| *Acacia obtusifolia* | | | | | 0.1 | 1 | 1 | 1 | 2 | 20 | | | 2 | 25 |
| *Acacia terminalis* | Sunshine Wattle | | | | | | | | | | 0.1 | 3 | | |
| *Ajuga australis* | Austral Bugle | | | | | | | | | | | | 0.1 | 25 |
| *Allocasuarina littoralis* | Black She-Oak | | | | | | | | 5 | 2 | 35 | 25 | | |
| *Allocasuarina nana* | Dwarf She-oak | | | | 75 | 100 | 70 | 200 | | | | | | |
| *Austrostipa pubescens* | | | | | 0.1 | 25 | | | | | | | | |
| *Austrostipa spp.* | | | | | | | | | | | | | 0.1 | 5 |
| *Babingtonia densifolia* | | | | | 0.2 | 25 | | | | | | | | |
| *Baeckea brevifolia* | | | | | 0.1 | 10 | | | | | | | | |
| *Billardiera procumbens* | | | | | | | | | | | 0.1 | 2 | | |
| *Boronia microphylla* | Small-leaved Boronia | | | | | | 0.2 | 20 | | | | | | |
| *Boronia rigens* | Stiff Boronia | | | | 0.1 | 25 | 0.4 | 20 | | | | | | |
| *Bossiaea heterophylla* | Variable Bossiaea | | | | | | 0.6 | 20 | | | | | | |
| *Brachyloma daphnoides* | Daphne Heath | | | | 0.1 | 5 | 1 | 10 | | | 0.1 | 1 | | |
| *Callitris muelleri* | | | | | | | 15 | 25 | | | | | | |
| *Cheilanthes sieberi* | Rock Fern | | | | | | | | | | | | 0.1 | 20 |
| *Chrysocephalum spp.* | | | | | | | | | | | | | 0.1 | 1 |
| *Cirsium vulgare* | Spear Thistle | | | YES | | | | | | | | | 0.1 | 1 |
| *Clematis aristata* | Old Man's Beard | | | | | | | | | | | | 0.2 | 50 |
| *Conyza spp.* | | | | YES | | | | | | | | | 0.1 | 3 |
| *Correa reflexa* | Native Fuschia | | | | | | | | | | | | 0.1 | 2 |
| *Cryptandra amara* | Bitter Cryptandra | | | | 0.1 | 20 | 0.5 | 20 | | | | | | |
| *Dampiera stricta* | | | | | 1 | 100 | 0.5 | 50 | | | | | | |
| *Desmodium varians* | Slender Tick-trefoil | | | | | | | | | | | | 0.1 | 10 |
| *Deyeuxia spp.* | | | | | | | | | | | | | 1 | 100 |
| *Dianella caerulea* | Blue Flax-lily | | | | | | | | | | 0.2 | 20 | 0.1 | 4 |
| *Dichondra repens* | Kidney Weed | | | | | | | | | | | | 2 | 500 |
| *Dodonaea multijuga* | | | | | | | | | 0.1 | 4 | | | | |
| *Echinopogon ovatus* | Forest Hedgehog Grass | | | | | | | | | | | | 0.2 | 50 |

| Scientific Name | Common Name | BC Act | EP BC Act | Exotic | GEN_PT_01 | | GEN_PT_02 | | Woodland_01 | | Woodland_02 | | Woodland_03* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Cover | Abund. | Cover | Abund. | Cover | Abund. | Cover | Abund. | Cover | Abund. |
| *Entolasia stricta* | Wiry Panic | | | | | | | | 0.1 | 3 | 0.1 | 10 | | |
| *Epacris spp.* | | | | | | | | | | | 0.1 | 2 | | |
| *Eucalyptus cypellocarpa* | Monkey Gum | | | | | | | | | | | | 20 | 6 |
| *Eucalyptus piperita* | Sydney Peppermint | | | | 0.1 | 5 | | | 5 | 1 | 10 | 4 | 3 | 5 |
| *Eucalyptus punctata* | Grey Gum | | | | | | | | 2 | 1 | | | | |
| *Eucalyptus sparsifolia* | Narrow-leaved Stringybark | | | | | | | | 30 | 10 | 2 | 2 | 10 | 5 |
| *Galium divaricatum* | Slender Bedstraw | | | YES | | | | | | | | | 0.2 | 100 |
| *Galium leiocarpum* | | | | | | | | | | | | | 1 | 500 |
| *Geranium homeanum* | | | | | | | | | | | | | 0.2 | 200 |
| *Glycine microphylla* | Small-leaf Glycine | | | | | | | | | | | | 0.1 | 10 |
| *Glycine tabacina* | Variable Glycine | | | | | | | | | | | | 0.1 | 25 |
| *Gonocarpus elatus* | | | | | | | | | | | 0.2 | 20 | | |
| *Gonocarpus teucrioides* | Germander Raspwort | | | | | | | | | | | | 0.2 | 50 |
| *Goodenia bellidifolia* | | | | | 0.1 | 50 | 0.2 | 30 | | | | | | |
| *Goodenia hederacea* | Ivy Goodenia | | | | | | | | | | 0.1 | 10 | | |
| *Haloragis spp.* | | | | | | | | | | | 0.1 | 1 | | |
| *Harmogia densifolia* | | | | | | | 0.2 | 20 | | | | | | |
| *Hibbertia serpyllifolia* | Hairy Guinea Flower | | | | 0.1 | 5 | | | | | | | | |
| *Hydrocotyle sibthorpioides* | | | | | | | | | | | | | 0.5 | 200 |
| *Hypericum gramineum* | Small St John's Wort | | | | | | | | | | | | 0.1 | 5 |
| *Hypochaeris glabra* | Smooth Catsear | | | YES | | | | | 0.1 | 2 | | | 0.1 | 1 |
| *Hypochaeris radicata* | Catsear | | | YES | | | | | | | | | 0.1 | 2 |
| *Isopogon anethifolius* | Narrow-leaf Drumsticks | | | | 0.1 | 1 | 0.1 | 1 | | | | | | |
| *Juncus spp.* | | | | | | | | | | | | | 0.3 | 30 |
| *Kunzea parvifolia* | Violet Kunzea | | | | 5 | 25 | | | | | | | | |
| *Lepidosperma gunnii* | | | | | | | | | | | 0.2 | 20 | | |
| *Lepidosperma laterale* | Variable Sword-sedge | | | | | | | | | | 0.1 | 2 | | |

| Scientific Name | Common Name | BC Act | EP BC Act | Exotic | GEN_PT_01 | | GEN_PT_02 | | Woodland_01 | | Woodland_02 | | Woodland_03* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Cover | Abund. | Cover | Abund. | Cover | Abund. | Cover | Abund. | Cover | Abund. |
| *Lepidosperma urophorum* | | | | | | | | | 3 | 10 | 15 | 30 | 0.2 | 1 |
| *Lepidosperma viscidum* | | | | | 15 | 25 | 0.1 | 2 | | | | | | |
| *Leptospermum parvifolium* | | | | | 5 | 25 | | | | | | | | |
| *Leptospermum polyanthum* | | | | | | | 2 | 10 | 4 | 5 | 0.1 | 2 | | |
| *Leptospermum trinervium* | Slender Tea-tree | | | | 1 | 25 | 0.2 | 1 | | | | | | |
| *Leucopogon muticus* | Blunt Beard-heath | | | | 0.1 | 5 | 1 | 8 | 0.1 | 2 | | | | |
| *Lomandra filiformis* | Wattle Matt-rush | | | | | | | | 0.1 | 2 | | | | |
| *Lomandra glauca* | Pale Mat-rush | | | | 0.2 | 50 | 1 | 50 | | | 0.2 | 30 | | |
| *Lomandra longifolia* | Spiny-headed Mat-rush | | | | | | | | | | | | 8 | 60 |
| *Lomandra micrantha* | Small-flowered Mat-rush | | | | | | | | 0.3 | 10 | 0.1 | 3 | | |
| *Marsdenia spp.* | | | | | 0.1 | 1 | | | | | | | | |
| *Micrantheum ericoides* | | | | | 0.1 | 25 | | | | | | | | |
| *Microlaena stipoides* | Weeping Grass | | | | | | | | 1 | 40 | 0.1 | 5 | 5 | 2,000 |
| *Micromyrtus ciliata* | Fringed Heath-myrtle | | | | | | 0.3 | 30 | | | | | | |
| *Micromyrtus sessilis* | | | | | 1 | 40 | 0.4 | 5 | | | | | | |
| *Modiola spp.* | | | | YES | | | | | | | | | 0.1 | 2 |
| *Monotoca scoparia* | | | | | | | | | | | | | 0.1 | 5 |
| *Opercularia hispida* | Hairy Stinkweed | | | | | | | | | | | | 0.1 | 5 |
| *Patersonia sericea* | Silky Purple-Flag | | | | 0.1 | 1 | | | | | 0.1 | 1 | | |
| *Persoonia linearis* | Narrow-leaved Geebung | | | | | | | | 2.0 | 3 | 0.1 | 1 | 0.1 | 2 |
| *Persoonia spp.* | | | | | | | 0.1 | 6 | | | | | | |
| *Phyllanthus hirtellus* | Thyme Spurge | | | | | | | | | | 0.1 | 1 | | |
| *Phyllota phylicoides* | Heath Phyllota | | | | | | 1 | 20 | | | | | | |
| *Platysace lanceolata* | Shrubby Platysace | | | | 0.1 | 5 | | | | | 0.2 | 20 | | |
| *Poa sieberiana* | Snowgrass | | | | | | | | 0.1 | 5 | | | | |
| *Pomaderris andromedifolia* | | | | | | | | | | | 0.1 | 3 | | |
| *Pomax umbellata* | Pomax | | | | | | | | 0.1 | 2 | 0.1 | 10 | 0.1 | 25 |

| Scientific Name | Common Name | BC Act | EP BC Act | Exotic | GEN_PT_01 | | GEN_PT_02 | | Woodland_01 | | Woodland_02 | | Woodland_03* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Cover | Abund. | Cover | Abund. | Cover | Abund. | Cover | Abund. | Cover | Abund. |
| *Poranthera microphylla* | Small Poranthera | | | | | | | | 0.1 | 5 | 0.1 | 20 | | |
| *Pseudanthus divaricatissimus* | | | | | 0.1 | 10 | 1 | 20 | | | | | | |
| *Pteridium esculentum* | Bracken | | | | | | | | | | | | 0.2 | 10 |
| *Rhytidosporum procumbens* | | | | | | | 0.1 | 2 | | | | | | |
| *Rytidosperma spp.* | | | | | | | 0.1 | 2 | | | | | | |
| *Rytidosperma tenuius* | | | | | 0.1 | 25 | | | | | | | | |
| *Schoenus spp.* | | | | | 1 | 100 | 0.1 | 5 | | | | | | |
| *Schoenus villosus* | | | | | | | 1 | 40 | | | | | | |
| *Senecio jacobaea* | Ragwort | | | YES | | | | | | | | | 0.1 | 2 |
| *Solanum spp.* | | | | | | | | | | | | | 0.1 | 3 |
| *Stellaria pungens* | Prickly Starwort | | | | | | | | | | | | 0.1 | 25 |
| *Stypandra glauca* | Nodding Blue Lily | | | | | | | | 1 | 20 | 0.1 | 2 | | |
| *Veronica plebeia* | Trailing Speedwell | | | | | | | | | | | | 0.5 | 100 |
| *Viola hederacea* | Ivy-leaved Violet | | | | | | | | | | | | 10 | 1,000 |
| *Wahlenbergia spp.* | Bluebell | | | | | | | | | | | | 0.1 | 5 |
| *Wahlenbergia stricta* | Tall Bluebell | | | | | | | | | | | | 0.1 | 2 |
| *Xanthorrhoea arborea* | | | | | | | | | 0.2 | 2 | | | | |
| *Xanthorrhoea johnsonii* | Johnson's Grass Tree | | | | | | 1 | 3 | | | | | | |

# Appendix D
# Floristic Plots - GDE

**Apx Table 3: Dominant floristics of the Facultative Ecosystems PCT 3731 (EX plots) and PCT 3495 (GDE plots).**

| Scientific Name | Common Name | BC Act | EPBC Act | EX01 | EX02 | EX03 | EX04 | EX05 | GDE01 | GDE02 | GDE03 | GDE04 | GDE05 | GDE06 | GDE07 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fern** | | | | | | | | | | | | | | | |
| *Adiantum aethiopicum* | Common Maidenhair | | | | | | | | | | X | | | | |
| *Blechnum ambiguum* | | | | | | | | | | X | | | | | |
| *Blechnum cartilagineum* | Gristle Fern | | | | | | | | | | X | X | | X | X |
| *Calochlaena dubia* | Rainbow Fern | | | | | | | | XX | XX | X | XX | X | X | X |
| *Cyathea australis* | Rough Treefern | | | | | | | | X | X | X | X | X | X | |
| *Doodia aspera* | | | | X | X | | X | X | | | | | | | |
| *Pteridium esculentum* | Bracken | | | X | X | | X | X | XX | XX | X | X | X | X | X |
| **Forb** | | | | | | | | | | | | | | | |
| *Calomeria amaranthoides* | Incense Plant | | | | | | | | | | X | | | | X |
| *Dichondra repens* | Kidney Weed | | | | X | | | X | | | | | | | |
| *Galium leiocarpum* | | | | X | | | | | | X | X | X | | | |
| *Geranium spp.* | | | | X | | | | | | | X | | | | |
| *Hydrocotyle peduncularis* | | | | | X | | X | | | | | | | | |
| *Hydrocotyle sibthorpioides* | | | | | | | | X | | | X | | | | |
| *Veronica plebeia* | Trailing Speedwell | | | X | | | | | | | | | | | |
| *Viola hederacea* | Ivy-leaved Violet | | | | X | | X | | | X | X | X | | | |
| **Grass & Grass-like** | | | | | | | | | | | | | | | |
| *Aristida ramosa* | Purple Wiregrass | | | | | X | | | | | | | | | |
| *Aristida spp.* | | | | X | | | | | | | | | | | |
| *Echinopogon caespitosus* | Bushy Hedgehog-grass | | | X | | | | X | | | | | | | |
| *Echinopogon ovatus* | Forest Hedgehog Grass | | | | X | | | | | | | | | | |
| *Lomandra longifolia* | Spiny-headed Mat-rush | | | XX | X | | XX | X | XX | | | | X | | |

| Scientific Name | Common Name | BC Act | EPBC Act | EX01 | EX02 | EX03 | EX04 | EX05 | GDE01 | GDE02 | GDE03 | GDE04 | GDE05 | GDE06 | GDE07 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Microlaena stipoides* | Weeping Grass | | | X | X | | | X | | X | X | X | | | |
| *Oplismenus aemulus* | | | | X | X | | | X | | | | | | | |
| *Rytidosperma spp.* | | | | | | X | X | | | | | | | | |
| **Shrub** | | | | | | | | | | | | | | | |
| *Acacia falcata* | | | | X | | | | | | | | | | | |
| *Acacia longifolia* | | | | | | X | X | | | | | | | | |
| *Acacia obtusifolia* | | | | | | | | | X | | | X | | X | |
| *Acacia penninervis* | Mountain Hickory | | | | | | XX | | | | | | | | |
| *Acacia terminalis* | Sunshine Wattle | | | | | X | | | | | | | | | |
| *Bursaria longisepala* | | | | | | X | X | | | | | | | | |
| *Elaeocarpus reticulatus* | Blueberry Ash | | | | X | | | | X | | | X | | X | X |
| *Hibbertia aspera* | Rough Guinea Flower | | | | | | X | | | | | | | | |
| *Indigofera australis* | Australian Indigo | | | X | X | X | | | | | | X | | | |
| *Leptospermum polyanthum* | | | | | | | | | X | X | | | | | |
| *Leptospermum polygalifolium* | Tantoon | | | | | | | X | | | | | X | X | X |
| *Lomatia myricoides* | River Lomatia | | | | | | | | | X | | | | | |
| *Pimelea latifolia subsp. hirsuta* | | | | X | X | XX | X | | | | | | | | |
| **Tree** | | | | | | | | | | | | | | | |
| *Brachychiton populneus* | Kurrajong | | | X | | | | | | | | | | | |
| *Eucalyptus cypellocarpa* | Monkey Gum | | | X | X | | X | XX | XX | | X | XX | X | X | |
| *Eucalyptus fastigata* | Brown Barrel | | | | | | | X | | | XX | | X | X | X |
| *Eucalyptus macrorhyncha* | Red Stringybark | | | | | XX | | | | | | | | | |
| *Eucalyptus melliodora* | Yellow Box | | | | | X | | | | | | | | | |
| *Eucalyptus piperita* | Sydney Peppermint | | | | | | | X | X | | XX | X | X | X | |
| *Eucalyptus polyanthemos* | Red Box | | | | | XX | | | | | | | | | |

**Apx Table 4: GDE BAM plot flora list**

| Scientific Name | Exotic | Common Name | 1 Cover | 1 Abundance | 2 Cover | 2 Abundance | 3 Cover | 3 Abundance | 4 Cover | 4 Abundance | 5 Cover | 5 Abundance | 6 Cover | 6 Abundance | 7 Cover | 7 Abundance | 8 Cover | 8 Abundance | 9 Cover | 9 Abundance | 10 Cover | 10 Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Acacia melanoxylon* | | Blackwood | 4 | 7 | 8 | 4 | 1 | 3 | | | | | | | | | | | | | | |
| *Acacia obtusifolia* | | | 4 | 10 | 3 | 3 | 6 | 20 | 2 | 5 | 4 | 10 | 0.5 | 10 | 0.1 | 1 | | 0.5 | 1 | | | |
| *Acaena novae-zelandiae* | | Bidgee-widgee | | | 0.1 | 5 | 0.1 | 2 | 0.1 | 4 | | | | | | | | | | 0.2 | 10 | |
| *Acrotriche rigida* | | | | | | | | | 0.2 | 1 | | | | | | | | | | | | |
| *Adiantum aethiopicum* | | Common Maidenhair | | | | | | | | | 0.3 | 30 | 0.3 | 20 | | | | 0.5 | 100 | 0.2 | 20 | |
| *Ajuga australis* | | Austral Bugle | | | 0.1 | 6 | 1 | 30 | | | | | | | | | | 0.2 | 40 | 0.3 | 10 | |
| *Allocasuarina littoralis* | | Black She-Oak | | | | | 0.5 | 1 | | | | | | | | | | | | | | |
| *Amperea xiphoclada* | | | | | | | | | | | 0.3 | 20 | | | | | | | | | | |
| *Amyema spp.* | | Mistletoe | | | | | | | 0.1 | 2 | | | | | | | | 0.1 | 1 | | | |
| *Asplenium flabellifolium* | | Necklace Fern | | | | | | | | | 0.2 | 20 | | | | | | | | 0.1 | 5 | |
| *Asplenium flaccidum* | | Weeping Spleenwort | | | | | | | | | | | 0.1 | 2 | 0.1 | 10 | | | | | | |
| *Billardiera scandens* | | Hairy Apple Berry | 0.2 | 20 | | | 0.1 | 5 | 0.1 | 5 | | | | | 0.1 | 2 | | | | | | |
| *Blechnum cartilagineum* | | Gristle Fern | | | | | | | | | 15 | 50 | 0.1 | 4 | 40.5 | 310 | | 25 | 75 | 8 | 30 | |
| *Blechnum nudum* | | Fishbone Water Fern | | | | | | | | | | | | | 0.1 | 2 | | | | | | |
| *Brachychiton populneus* | | Kurrajong | 0.1 | 1 | | | | | | | | | | | | | | | | | | |
| *Bursaria spinosa* | | Native Blackthorn | | | 7 | 20 | 6 | 20 | 1 | 5 | | | | | | | | | | 0.2 | 2 | |
| *Calochlaena dubia* | | Rainbow Fern | | | | | | | | | 25 | 100 | 4 | 20 | 60 | 500 | | | | 2 | 20 | |
| *Calotis hispidula* | | Bogan Flea | | | | | 0.1 | 20 | | | | | | | | | | | | | | |
| *Cassinia spp.* | | | 0.1 | 2 | | | 0.1 | 2 | | | | | 0.1 | 2 | | | | | | | | |

| Scientific Name | Exotic | Common Name | 1 Cover | 1 Abundance | 2 Cover | 2 Abundance | 3 Cover | 3 Abundance | 4 Cover | 4 Abundance | 5 Cover | 5 Abundance | 6 Cover | 6 Abundance | 7 Cover | 7 Abundance | 8 Cover | 8 Abundance | 9 Cover | 9 Abundance | 10 Cover | 10 Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Cassinia uncata* | | Sticky Cassinia | | | | | | | | | | | | | | | | | | 0.1 | | 1 |
| *Centaurium spp.* | * | | | | 0.1 | 4 | | | | | | | | | | | | 0.1 | | 2 | | |
| *Cheilanthes sieberi* | | Rock Fern | 0.1 | 4 | 0.1 | 6 | 0.1 | 2 | 0.1 | 10 | | | | | | | | | | | | |
| *Cirsium vulgare* | * | Spear Thistle | | | 0.1 | 6 | 0.1 | 3 | 0.1 | 1 | | 0.1 | 1 | | | | | | | 0.1 | | 3 |
| *Clematis aristata* | | Old Man's Beard | 7 | 50 | 8 | 60 | 2 | 30 | 2 | 50 | 0.1 | 5 | 0.1 | 5 | 2.1 | 65 | | | 0.2 | 30 | 0.5 | 20 |
| *Clematis glycinoides* | | Headache Vine | | | | | | | 0.2 | 10 | | | | | | | | | 2 | 50 | | |
| *Conyza bonariensis* | * | Flaxleaf Fleabane | | | | | | | 0.1 | 2 | | | | | | | | | | | | |
| *Conyza spp.* | * | | 0.1 | 1 | 0.1 | 5 | 0.2 | 10 | | | 0.1 | 2 | 0.1 | 2 | | | | | | | | |
| *Coprosma quadrifida* | | Prickly Currant Bush | | | | | | | | | | | | | | | | | | 2 | | 9 |
| *Coronidium spp.* | | | | | | | | | 0.1 | 1 | | | | | | | | | | | | |
| *Correa reflexa* | | Native Fuschia | | | | | | | 0.1 | 2 | | | | | | | | 0.1 | 2 | | | |
| *Correa reflexa var. reflexa* | | Native Fuschia | | | | | 0.2 | 3 | | | | | | | | | | | | | | |
| *Crassula Sieberiana* | | Australian Stonecrop | | | | | | | | | | 0.1 | 4 | | | | | | | | | |
| *Cyathea australis* | | Rough Treefern | | | | | | | | | 1 | 4 | | | 22 | 30 | | | | 1 | | 2 |
| *Cynoglossum australe* | | | | | | | | | 2 | 50 | | | | | | | | | | | | |
| *Cyperus spp.* | | | | | | | | | | | 0.1 | 1 | 0.1 | 1 | | | | | | | | |
| *Dendrobium spp.* | | | | | | | | | | | 1 | 20 | | | | | | | | | | |
| *Desmodium varians* | | Slender Tick-trefoil | 0.3 | 40 | 0.2 | 30 | 0.2 | 20 | | | | | | | | | | 0.1 | 50 | | | |
| *Dianella caerulea* | | Blue Flax-lily | | | | | | | | | | | | | 0.3 | 10 | | | | | | |

| Scientific Name | Exotic | Common Name | 1 Cover | 1 Abundance | 2 Cover | 2 Abundance | 3 Cover | 3 Abundance | 4 Cover | 4 Abundance | 5 Cover | 5 Abundance | 6 Cover | 6 Abundance | 7 Cover | 7 Abundance | 8 Cover | 8 Abundance | 9 Cover | 9 Abundance | 10 Cover | 10 Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Dianella caerulea var. caerulea* | | | | | | | | 0.2 | 20 | | 0.5 | 20 | | | | | | | | | | |
| *Dianella caerulea var. producta* | | | 1 | 15 | 1 | 10 | 0.5 | 20 | 1 | 20 | 3 | 70 | 1 | 30 | 0.3 | 5 | | 2 | 50 | 0.1 | 3 | |
| *Dichelachne spp.* | | | 7 | 60 | 1 | 10 | 10 | 100 | 1 | 40 | 0.5 | 20 | | | 0.1 | 3 | | | | 0.1 | 7 | |
| *Dichondra repens* | | Kidney Weed | 3 | 100 | 3 | 80 | 3 | 100 | 5 | 200 | | | | | 3 | 100 | | 0.1 | 100 | 2 | 100 | |
| *Doodia aspera* | | | | | | | | | | | 0.5 | 50 | | | | | | 0.2 | 40 | 0.5 | 20 | |
| *Doodia spp.* | | | | | | | | | | | | | 2 | 80 | | | | | | | | |
| *Echinopogon caespitosus* | | Bushy Hedgehog-grass | 0.1 | 4 | 1 | 30 | | | | | 0.1 | 10 | 1 | 40 | | | | | | 0.2 | 30 | |
| *Echinopogon ovatus* | | Forest Hedgehog Grass | | | | | | 1 | 50 | | | | | | | | | 0.1 | 50 | 0.1 | 8 | |
| *Echium plantagineum* | * | Patterson's Curse | | | 0.1 | 1 | | | | | | | | | | | | | | | | |
| *Einadia hastata* | | Berry Saltbush | 0.1 | 2 | | | | | | | | | | | | | | | | | | |
| *Elaeocarpus reticulatus* | | Blueberry Ash | | | | | 0.1 | 1 | | 0.7 | 3 | 4 | 6 | 15.1 | 10 | | | 0.1 | 1 | 4 | 5 | |
| *Entolasia marginata* | | Bordered Panic | 3 | 100 | 2 | 60 | | | 0.5 | 30 | | 25 | 1000 | 2 | 90 | | | | | 0.1 | 10 | |
| *Entolasia stricta* | | Wiry Panic | | | | | | | | | | | 0.2 | 10 | | | | 0.1 | 30 | | | |
| *Epacris microphylla* | | Coral Heath | | | | | | | | 0.1 | 3 | | | | | | | | | | | |
| *Epacris spp.* | | | | | | | 0.1 | 1 | | | | | | | | | | | | | | |
| *Eucalyptus blaxlandii* | | Blaxland's Stringybark | | | | | | | | | | 6 | 4 | | | | | | | | | |
| *Eucalyptus cannonii* | | Capertee Stringybark | | | | | 15 | 3 | 7 | 2 | | | | | | | | | | | | |
| *Eucalyptus cypellocarpa* | | Monkey Gum | 25 | 10 | 50 | 11 | 10 | 3 | 25 | 5 | 15 | 4 | | | 25 | 4 | 10 | 1 | | 35 | 5 | 10 | 3 |

| Scientific Name | Exotic | Common Name | 1 Cover | 1 Abundance | 2 Cover | 2 Abundance | 3 Cover | 3 Abundance | 4 Cover | 4 Abundance | 5 Cover | 5 Abundance | 6 Cover | 6 Abundance | 7 Cover | 7 Abundance | 8 Cover | 8 Abundance | 9 Cover | 9 Abundance | 10 Cover | 10 Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Eucalyptus fastigata* | | Brown Barrel | | | | | | | | | | | 25 | 4 | | | | | | | | |
| *Eucalyptus macrorhyncha* | | Red Stringybark | 2 | 3 | | | | 3 | 1 | 15 | 2 | | | | | | | | | | | |
| *Eucalyptus piperita* | | Sydney Peppermint | | | | | | | | 25 | 8 | 3 | 2 | | | | | 15 | 3 | 15 | 5 | |
| *Eucalyptus polyanthemos* | | Red Box | 2 | 2 | | 15 | 7 | | | | | | | | | | | | | | | |
| *Eucalyptus punctata* | | Grey Gum | | | | | | | | | | | 0.5 | 1 | | | | 3 | 1 | | | |
| *Eucalyptus spp.* | | | | | 0.1 | 1 | | | | | | | 0.1 | 1 | | | | | | | | |
| *Euchiton involucratus* | | Star Cudweed | | | 0.2 | 20 | 0.2 | 50 | | | | | | | | | | | | | | |
| *Euchiton spp.* | | | 0.1 | 3 | | | | 0.1 | 5 | | | | | | | | | | | 0.1 | 10 | |
| *Eustrephus latifolius* | | Wombat Berry | 0.1 | 10 | | | | | | | | | | | | | | | | | | |
| *Gahnia spp.* | | | | | | | | | | 0.2 | 1 | | | | | | | | | | | |
| *Galium gaudichaudii* | | Rough Bedstraw | | | | | | | | | | 0.1 | 5 | 0.1 | 20 | | | 0.1 | 20 | | | |
| *Galium leiocarpum* | | | 0.1 | 20 | 4 | 100 | 0.3 | 40 | 1 | 100 | 0.4 | 50 | 0.1 | 10 | 0.5 | 50 | | 1 | 400 | 0.1 | 20 | |
| *Galium propinquum* | | Maori Bedstraw | | | | | | | | | | | 1 | 100 | | | | | | 0.1 | 10 | |
| *Galium spp.* | | | | | | | | 0.1 | 5 | | | | | | | | | | | | | |
| *Geitonoplesium cymosum* | | Scrambling Lily | 1 | 40 | 0.2 | 20 | 0.1 | 3 | 0.1 | 2 | 0.1 | 2 | 0.3 | 10 | 0.5 | 40 | | | | 0.1 | 10 | |
| *Geranium homeanum* | | | | | | | | | | | | 0.1 | 10 | 0.1 | 5 | | | 0.1 | 20 | | | |
| *Geranium solanderi* | | Native Geranium | 0.1 | 3 | 1 | 20 | 0.1 | 4 | | | | | 2 | 80 | | | | | | | | |
| *Geranium spp.* | | | | | | | | | | | | | | | | | | 0.3 | 30 | 1 | 50 | |
| *Glycine clandestina* | | Twining glycine | | | | | | 0.3 | 30 | | | | | | | | | 0.2 | 50 | | | |
| *Glycine microphylla* | | Small-leaf Glycine | | | | | | 0.2 | 30 | | | | | | | | | | | | | |
| *Glycine spp.* | | | 0.1 | 10 | 0.1 | 3 | 0.1 | 30 | | | | | | | | | | | | | | |

| Scientific Name | Exotic | Common Name | 1 Cover | 1 Abundance | 2 Cover | 2 Abundance | 3 Cover | 3 Abundance | 4 Cover | 4 Abundance | 5 Cover | 5 Abundance | 6 Cover | 6 Abundance | 7 Cover | 7 Abundance | 8 Cover | 8 Abundance | 9 Cover | 9 Abundance | 10 Cover | 10 Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Glycine tabacina* | | Variable Glycine | | | | | | 0.1 | 20 | | | | 0.1 | 30 | | | | | | 0.2 | | 40 |
| *Gonocarpus tetragynus* | | Poverty Raspwort | | | | 0.3 | 30 | | | | | | | | | | | | | 0.1 | | 20 |
| *Gonocarpus teucrioides* | | Germander Raspwort | 0.3 | 2 | | 0.1 | 3 | | | 0.1 | 2 | 1 | 25 | 0.1 | 2 | | | 0.3 | 15 | 0.2 | | 10 |
| *Goodenia bellidifolia* | | | | | | 0.1 | 3 | | | | | | | | | | | | | | | |
| *Goodenia ovata* | | Hop Goodenia | 7 | 50 | | | | | | | | | | | | | | | | | | |
| *Grevillea speciosa* | | Red Spider Flower | | | | | | | | 0.1 | 2 | | | | | | | | | | | |
| *Hardenbergia violacea* | | False Sarsaparilla | | | | 0.1 | 3 | | | | | | | | | | | | | | | |
| *Hedycarya angustifolia* | | Native Mulberry | | | | | | | | | | 2 | 20 | | | | | | | | | |
| *Helichrysum elatum* | | | | | | | | | | | | | | | | | | | | 0.2 | | 1 |
| *Hibbertia empetrifolia* | | | | | | | | | | | | | | | | | | 1 | 10 | 0.3 | | 6 |
| *Hibbertia obtusifolia* | | Hoary Guinea Flower | | | | 0.1 | 2 | | | | | | | | | | | | | | | |
| *Hibbertia spp.* | | | 0.1 | 4 | | | | | | | | | | | | | | | | | | |
| *Hydrocotyle laxiflora* | | Stinking Pennywort | | | 5 | 100 | 1 | 50 | 3 | 200 | | 0.2 | 20 | 3.3 | 220 | | | 1 | 200 | 2 | | 100 |
| *Hydrocotyle sibthorpioides* | | | | | | | | | | | | 0.2 | 40 | | | | | | | | | |
| *Hypericum gramineum* | | Small St John's Wort | | | 0.1 | 10 | 0.1 | 10 | | | | | | | | | | | | 0.1 | | 3 |
| *Hypericum spp.* | | | | | | | | 0.1 | 1 | | | | | | | | | | | | | |
| *Hypochaeris glabra* | * | Smooth Catsear | | | | | | 0.1 | 5 | | | | | | | | | | | | | |
| *Hypochaeris radicata* | * | Catsear | | | 0.1 | 6 | 0.1 | 3 | | 0.1 | 2 | | | 0.1 | 2 | | | | | | | |
| *Indigofera australis* | | Australian Indigo | 1 | 10 | 0.1 | 1 | 3 | 10 | 0.1 | 2 | | 0.1 | 2 | 1 | 4 | | | 0.5 | 5 | 0.2 | | 5 |

| Scientific Name | Exotic | Common Name | 1 Cover | 1 Abundance | 2 Cover | 2 Abundance | 3 Cover | 3 Abundance | 4 Cover | 4 Abundance | 5 Cover | 5 Abundance | 6 Cover | 6 Abundance | 7 Cover | 7 Abundance | 8 Cover | 8 Abundance | 9 Cover | 9 Abundance | 10 Cover | 10 Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Isolepis inundata* | | Club-rush | | | | | | | | | 4 | 200 | | | | | | | | | | |
| *Juncus spp.* | | | | | | | | | | 0.1 1 | | | | | | | | | | | | |
| *Lagenifera stipitata* | | Blue Bottle-daisy | | | 0.1 | 10 1 | | 40 | 0.1 | 20 | | | 0.1 | 10 | 0.1 | 10 | | | 0.1 | 20 | 0.3 | 30 |
| *Lepidium spp.* | | | 0.2 | 20 | 0.3 | 20 0.1 | | 3 | | | | | | | | | | | | | | |
| *Lepidosperma laterale* | | Variable Sword-sedge | | | 0.1 | 1 | | | | 0.2 3 | | | | | | | | | | | | |
| *Lepidosperma spp.* | | | | | | | | | | | 0.4 | 15 | 0.2 | 10 | | | | | | | | |
| *Leptospermum morrisonii* | | | | | | | | | | 25 20 | | | | | | | | 0.1 | 1 | 30 | 30 | |
| *Leptospermum polygalifolium* | | Tantoon | | | | | | | | | 10 | 30 | 9 | 12 | | | | | | | | |
| *Leucopogon juniperinus* | | Prickly Beard-heath | | | | | | | | | | | 0.1 | 1 | | | | | | | | |
| *Leucopogon lanceolatus* | | | | | | | | | | 0.5 3 | | | 0.5 | 5 | | | | 1 | 1 | 0.3 | 1 | |
| *Lissanthe strigosa* | | Peach Heath | | | 0.2 | 5 | | | | 0.1 1 | | | | | | | | | | | | |
| *Lomandra confertifolia* | | Matrush | | | | 0.1 | 2 | | | | 0.1 | 5 | | | | | | | | | | |
| *Lomandra longifolia* | | Spiny-headed Mat-rush | 4 | 30 | 10 | 20 20 | 90 | 4 | 30 | 1 6 | 2 | 15 | 4.2 | 20 | | | | 4 | 100 | 3 | 30 | |
| *Lomandra multiflora* | | Many-flowered Mat-rush | | | | 0.2 | 10 | | | | | | | | | | | | | | | |
| *Lomandra spp.* | | Mat-rush | | | | | | | | 0.5 5 | | | | | | | | | | | | |
| *Marsdenia spp.* | | | 0.1 | 1 | | | | | | | | | 0.1 | 2 | | | | | | | | |
| *Medicago spp.* | * | | | | 0.1 | 3 | | | | | | | | | | | | | | | | |
| *Microlaena stipoides* | | Weeping Grass | 10 | 200 | 30 | 200 1 | 50 | 2 | 100 | 0.2 10 | 2 | 100 | 5 | 140 | | | | 7 | 1000 | 30 | 300 | |
| *Notodanthonia longifolia* | | Long-leaved | | | | | | | | | 0.1 | 3 | | | | | | 0.1 | 10 | | | |

| Scientific Name | Exotic | Common Name | 1 Cover | 1 Abundance | 2 Cover | 2 Abundance | 3 Cover | 3 Abundance | 4 Cover | 4 Abundance | 5 Cover | 5 Abundance | 6 Cover | 6 Abundance | 7 Cover | 7 Abundance | 8 Cover | 8 Abundance | 9 Cover | 9 Abundance | 10 Cover | 10 Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Wallaby Grass | | | | | | | | | | | | | | | | | | | | |
| *Opercularia hispida* | | Hairy Stinkweed | 0.1 | 2 | | 0.1 | 3 | 0.3 | 20 | | | | | | | | | | | | | |
| *Oplismenus aemulus* | | | 0.1 | 4 | | | | 0.1 | 10 | | | | 3 | 100 | | | | 5 | 750 | 5 | | 200 |
| *Oplismenus imbecillis* | | | | | | | | | | | 0.1 | 10 | | | | | | | | | | |
| *Oxalis spp.* | | | | | | | | | | | | | | | | | | 0.1 | 20 | | | |
| *Pandorea pandorana* | | Wonga Wonga Vine | 0.1 | 3 | | | | | | | | | | | | | | | | | | |
| *Panicum spp.* | | Panicum | | | | | | | | | | | | | | | | | | 4 | | 80 |
| *Persoonia linearis* | | Narrow-leaved Geebung | 0.1 | 2 | | 0.1 | 2 | 1 | 2 | 0.7 | 2 | 0.1 | 4 | 0.1 | 2 | | | | | | | |
| *Phyllanthus hirtellus* | | Thyme Spurge | 0.2 | 15 | | | | | | | | | | | | | | | | | | |
| *Pimelea latifolia subsp. hirsuta* | | | 0.1 | 1 | | | | | | | | | | | | | | 1 | 15 | 0.2 | | 2 |
| *Plantago debilis* | | Shade Plantain | | | 0.1 | 2 | 1 | 30 | | | | | | | | | | | | | | |
| *Platysace lanceolata* | | Shrubby Platysace | | | | | | | | | | 0.1 | 1 | | | | | | | | | |
| *Poa sieberiana* | | Snowgrass | | | | | | 0.2 | 10 | | | | | | | | | 1 | 20 | | | |
| *Poa spp.* | | | | | 1 | 10 | 2 | 40 | | | | | | | | | | | | | | |
| *Poaceae indeterminate* | * | Grasses, reeds and bamboos | | | | | | | | 0.1 | 10 | | | | | | | | | | | |
| *Podolobium ilicifolium* | | Prickly Shaggy Pea | | | | 0.2 | 3 | | | | | | | | | | | | | | | |
| *Polyscias sambucifolia* | | Elderberry Panax | | | | | | | | | | 0.1 | 5 | 0.1 | 1 | | | | | | | |
| *Pomaderris spp.* | | | | | | | | | | | | 25 | 30 | | | | | | | | | |
| *Poranthera microphylla* | | Small Poranthera | | | 0.1 | 8 | 0.1 | 20 | | 0.2 | 10 | | | 0.1 | 4 | 0.1 | 20 | | | | | |

| Scientific Name | Exotic | Common Name | 1 Cover | 1 Abundance | 2 Cover | 2 Abundance | 3 Cover | 3 Abundance | 4 Cover | 4 Abundance | 5 Cover | 5 Abundance | 6 Cover | 6 Abundance | 7 Cover | 7 Abundance | 8 Cover | 8 Abundance | 9 Cover | 9 Abundance | 10 Cover | 10 Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Prunella vulgaris* | * | Self-heal | | | | | | 0.1 | 5 | | | | | | | | | | | | | |
| *Pteridium esculentum* | | Bracken | 3 | 60 | | 1 | 10 | 999 | 999 | 1 | 10 | 3 | 20 | 1.1 | 22 | | | 2 | 30 | 3 | 20 | |
| *Pyrrosia rupestris* | | Rock Felt Fern | | | | | | | | | | 0.2 | 40 | | | | | | | | | |
| *Rhytidosporum spp.* | | | | | 0.2 | 20 | | | | | | | | | | | | | | | | |
| *Rosa rubiginosa* | * | Sweet Briar | | | 0.1 | 1 | | | | | | | | | | | | | | | | |
| *Rubus fruticosus sp. agg.* | * | Blackberry complex | | | 0.1 | 1 | | | | | | | | | | | | | | | | |
| *Rubus parvifolius* | | Native Raspberry | | | 0.1 | 2 | | | | | | | | 0.7 | 30 | | | 0.1 | 3 | 0.1 | 8 | |
| *Rytidosperma pallidum* | | Redanther Wallaby Grass; Silvertop Wallaby Grass | | | | | | 0.2 | 5 | | | | | | | | | | | | | |
| *Rytidosperma racemosum* | | Wallaby Grass | | | | | | 0.1 | 5 | | | | | | | | | | | | | |
| *Rytidosperma spp.* | | | | | | | | 0.5 | 20 | | | | | | | | | | | | | |
| *Schoenus apogon* | | Fluke Bogrush | | | | | | | | | 0.1 | 15 | | | | | | | | | | |
| *Senecio diaschides* | | | | | 0.1 | 10 | 0.1 | 4 | | | | | | | | | | | | | | |
| *Senecio jacobaea* | * | Ragwort | | | 0.1 | 20 | 0.1 | 6 | 0.1 | 1 | | | | | | | | | | | | |
| *Senecio minimus* | | | | | | | | 1 | 25 | | | 0.1 | 5 | | | | | | | | | |
| *Senecio quadridentatus* | | Cotton Fireweed | | | 0.1 | 2 | 0.1 | 6 | | | | | | | | | | | | | | |
| *Sigesbeckia orientalis* | | Indian Weed | 1 | 30 | 1 | 30 | | | | | | | | | | | | | | | | |
| *Solanum aviculare* | | Kangaroo Apple | | | 0.3 | 5 | | | | | | | | | | | | | | | | |

| Scientific Name | Exotic | Common Name | 1 Cover | 1 Abundance | 2 Cover | 2 Abundance | 3 Cover | 3 Abundance | 4 Cover | 4 Abundance | 5 Cover | 5 Abundance | 6 Cover | 6 Abundance | 7 Cover | 7 Abundance | 8 Cover | 8 Abundance | 9 Cover | 9 Abundance | 10 Cover | 10 Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Solanum brownii* | | Violet Nightshade | 0.5 | 8 | 0.2 | 20 | | | | | | | | | | | | | | | | |
| *Solanum nigrum* | * | Black-berry Nightshade | | | 0.1 | 3 | | | | | | | | | | | | | | | | |
| *Solanum prinophyllum* | | Forest Nightshade | 0.1 | 10 | | | 0.1 | 3 | 0.1 | 5 | | | 0.1 | 5 | | | 0.1 | 20 | 0.1 | 3 | | |
| *Solanum stelligerum* | | Devil's Needles | | | | | | | 0.1 | 2 | | | | | | | | | | | | |
| *Sonchus spp.* | | Sowthistle | | | | | 0.1 | 1 | | | | | | | | | | | | 0.1 | 1 | |
| *Stellaria pungens* | | Prickly Starwort | | | | | 0.1 | 3 | | | | | 0.2 | 7 | | | 0.1 | 15 | | | | |
| *Stylidium graminifolium* | | Grass Triggerplant | | | | | | | 0.1 | 2 | | | | | | | | | | | | |
| *Styphelia triflora* | | Pink Five-Corners | | | | | 2 | 20 | 0.1 | 4 | 0.1 | 2 | | | | | | | | | | |
| *Teucrium spp.* | | | | | | | | | | | | | | | | | 1 | 50 | 0.1 | 8 | | |
| *Thysanotus juncifolius* | | | | | | | 0.1 | 20 | | | | | | | | | | | | | | |
| *Todea barbara* | | King Fern | | | | | | | | | 0.4 | 5 | 1 | 6 | | | | | | | | |
| *Urtica incisa* | | Stinging Nettle | | | 0.1 | 3 | | | | | | | | | | | | | | | | |
| *Verbena bonariensis* | * | Purpletop | | | 0.1 | 2 | | | | | | | | | | | | | | | | |
| *Vernonia cinerea* | | | | | | | | | 0.1 | 5 | | | | | | | | | | | | |
| *Veronica plebeia* | | Trailing Speedwell | 0.2 | 20 | 0.1 | 10 | 0.1 | 3 | 0.1 | 5 | 0.1 | 1 | 0.1 | 5 | 0.1 | 8 | | | 0.1 | 50 | 0.1 | 7 |
| *Viola hederacea* | | Ivy-leaved Violet | 15 | 300 | | | 9 | 200 | 25 | 800 | 0.2 | 20 | | | 5 | 300 | | | | | 20 | 300 |
| *Viola sieberana* | | | | | | | | | | | | | 0.2 | 40 | 1 | 60 | | | 5 | 1000 | | |
| *Vittadinia cuneata* | | | | | | | 0.1 | 5 | | | | | | | | | | | | | | |
| *Wahlenbergia communis* | | Tufted Bluebell | | | | | | | 0.2 | 50 | | | | | | | | | | | 0.1 | 10 |
| *Wahlenbergia gracilis* | | Sprawling Bluebell | 0.1 | 4 | 0.1 | 3 | | | | | | | | | | | | | | | | |

| Scientific Name | Exotic | Common Name | 1 Cover | 1 Abundance | 2 Cover | 2 Abundance | 3 Cover | 3 Abundance | 4 Cover | 4 Abundance | 5 Cover | 5 Abundance | 6 Cover | 6 Abundance | 7 Cover | 7 Abundance | 8 Cover | 8 Abundance | 9 Cover | 9 Abundance | 10 Cover | 10 Abundance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Wahlenbergia spp.* | | Bluebell | | | | | | | | | 0.1 | 2 | | | | | | | | | | |
| *Wahlenbergia stricta* | | Tall Bluebell | | | 0.1 | 20 | 0.2 | 30 | | | | | | | | | | | | | | |
| *Wilkiea spp.* | | | | | | | | | | | | | | | 3 | 1 | | | | 2 | 2 | |
| *Xylomelum pyriforme* | | Woody Pear | | | | | | | 0.3 | 999 | | | | | | | | | | | | |

# Appendix E
# Photographs

**Apx Table 5: Monitoring photographs for Facultative Ecosystems PCT 3731 (EX plots) and PCT 3495 (GDE plots)**

| | |
|---|---|
| **EX01** | |
| **EX02** | |

**EX03**

**EX04**

**EX05**

**GDE01**

**GDE02**

**GDE03**

**GDE04**

**GDE05**

**GDE06**

**GDE07**

**Apx Table 6: Baseline photographs of Genowlan Point Allocasuarina nana Heathland EEC and Woodland 20 x 20 m plots**

| | |
|---|---|
| **GEN_PT_01** | <br>Start<br> <br>End |

**GEN_PT_02**

Start

End

**Woodland_01**

Start

End

**Woodland_02**

Start

End

**Woodland_03**

Start

End

# AIRLY EXTRACTION PLAN FOR THE CLIFF LINE ZONE ML1814 AND MW17-19 EXTRACTION PLAN AREA

## Historical Heritage Management Plan Update & Phase 1 Baseline Historical Heritage Assessment

PR152234-1
Version 1.0
14 December 2022

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S. Kennedy 14 December 2022

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**Prepared by:**

**RPS**

Dr Gary P. Marriner
Senior Heritage Consultant

Unit 2A, 45 Fitzroy Street
Carrington NSW 2294

T +61 2 4940 4200
E gary.marriner@rpsgroup.com.au

**Prepared for:**

**Centennial Coal**

Sam Price
Environment and Community Coordinator

319 Glen Davis Road
Capertee NSW 2846

T +61 2 6359 2108
E sam.price@centennialcoal.com.au

# Glossary and Abbreviations

| Term/Acronym | Definition |
|---|---|
| **AA** | Archaeological Assessment |
| **AKO&M** | Australian Kerosene Oil and Mineral Company |
| **ASS** | Australian Shale syndicate |
| **CHL** | Commonwealth Heritage List |
| **COC** | Commonwealth Oil Corporation |
| **EP** | Extraction Plan |
| **GSC** | Genowlan Shale Company |
| **HHIMS** | Historic Heritage Information Management System |
| **HHMP** | Historical heritage management plan |
| **HLRV** | Historical Land Records Viewer |
| **LEP** | Local Environment Plan |
| **LithMer** | Lithgow Mercury |
| **ML** | Mining Lease |
| **NHL** | National Heritage List |
| **NSWS&O** | New South Wales Shale and Oil |
| **RNE** | Register of the National Estate |
| **SHR** | State Heritage Register |
| **SLNSW** | State Library of New South Wales |
| **SLV** | State Library of Victoria |
| **SydGaz** | Sydney Gazette |
| **UNESCO** | United Nations Educational, Scientific and Cultural Organization |
| **WHL** | World Heritage List |

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# 1 INTRODUCTION

## 1.1 Background

RPS have been assisting Centennial Coal with the heritage management of the Airly Mine since 2013 and during this time have produced numerous documents regarding Aboriginal and Historical heritage and archaeology. In 2016 RPS produced an overarching Historical Heritage Management Plan (HHMP) for all of Centennial's Western Holdings which, in addition to Airly, includes Springvale Holdings, Western Coal Services, Lidsdale Siding, Angus Place Lease, Clarence Lease and Charbon (RPS, 2016). The purpose of the HHMP is to provide Centennial with a consistent approach to the identification, recording and management of historical heritage and ensure compliance with the *Heritage Act 1977 (NSW)*. Since its initial production in 2016, the HHMP has been updated once in November 2020.

In 2022 Centennial began planning for an extension to the Airly Mine to incorporate Cliff Line Zone ML1814 which was not assessed in the original HHMP, and the MW17-19 Extraction Plan, which was partially included. RPS were subsequently commissioned by Centennial to update the HHMP to incorporate these areas. This addendum to the HHMP has been written to record the process and results of the update to the HHMP for the new area. As part of this work, a Baseline Historical Heritage Assessment of the areas was also undertaken and is integrated in this document.

## 1.2 Study area

The study area is 5.5km long, 3.2km wide area located within the Lithgow LGA in the Central Tablelands of NSW on the western slopes of the Blue Mountains. It is largely within Mugii Murum-ban State Conservation Area on the north side of Glen Davis Road, around 8km east of Capertee. It is dominated by the mesa of Genowlan Mountain which is separated from the adjacent Mount Airly by Gap Creek. Genowlan Mountain is roughly 'Y' shaped with a central trunk measuring around 2.8 km long southwest to northeast. From the northeastern end, two arms branch off, a north to south ridge that runs for 3.1km and an east to west ridge which is around 3km long. The mesa is characterised by very steep cliffs on all sides. To the northeast of the Mountain is the headwaters of Emu Swamp Creek (Figure 1-1).

## 1.3 Methodology

This report documents the stages of work undertaken to update the HHMP for Airly Mine and a Historical Heritage Baseline Assessment of the areas.

For the HHMP to be updated to include the study area the following sections require additional information.

- Section 3 – Historic Heritage Context for Western Region
- Section 4 – Historic Heritage Sites within Western Region
- Section 5 – Historic Heritage Assessment

This document should be read as an addendum to the HHMP. Section 2 of this report provides further historical context for the study area and should be read in collaboration with Section 3 of the HHMP. Section 3 of this report is a Gap Analysis which seeks to identify if any historical heritage sites are within the study area. This analysis found no sites and as a result a field survey was undertaken to confirm these findings. This collectively address Section 4 of the HHMP. Section 4 of this report provides a Historical Heritage Baseline Assessment for the study area and updates Section 5 of the HHMP.

## 1.4 Authorship

This report was written by Dr Gary Marriner (Senior Heritage Consultant) who also undertook the field survey. Kristen Tola (Heritage Consultant) provided assistance with the background research and database searches, and Natalie Wood (Senior GIS Consultant) provided the figures. Susan Kennedy (Practice Leader, Heritage – NSW) has reviewed this report.

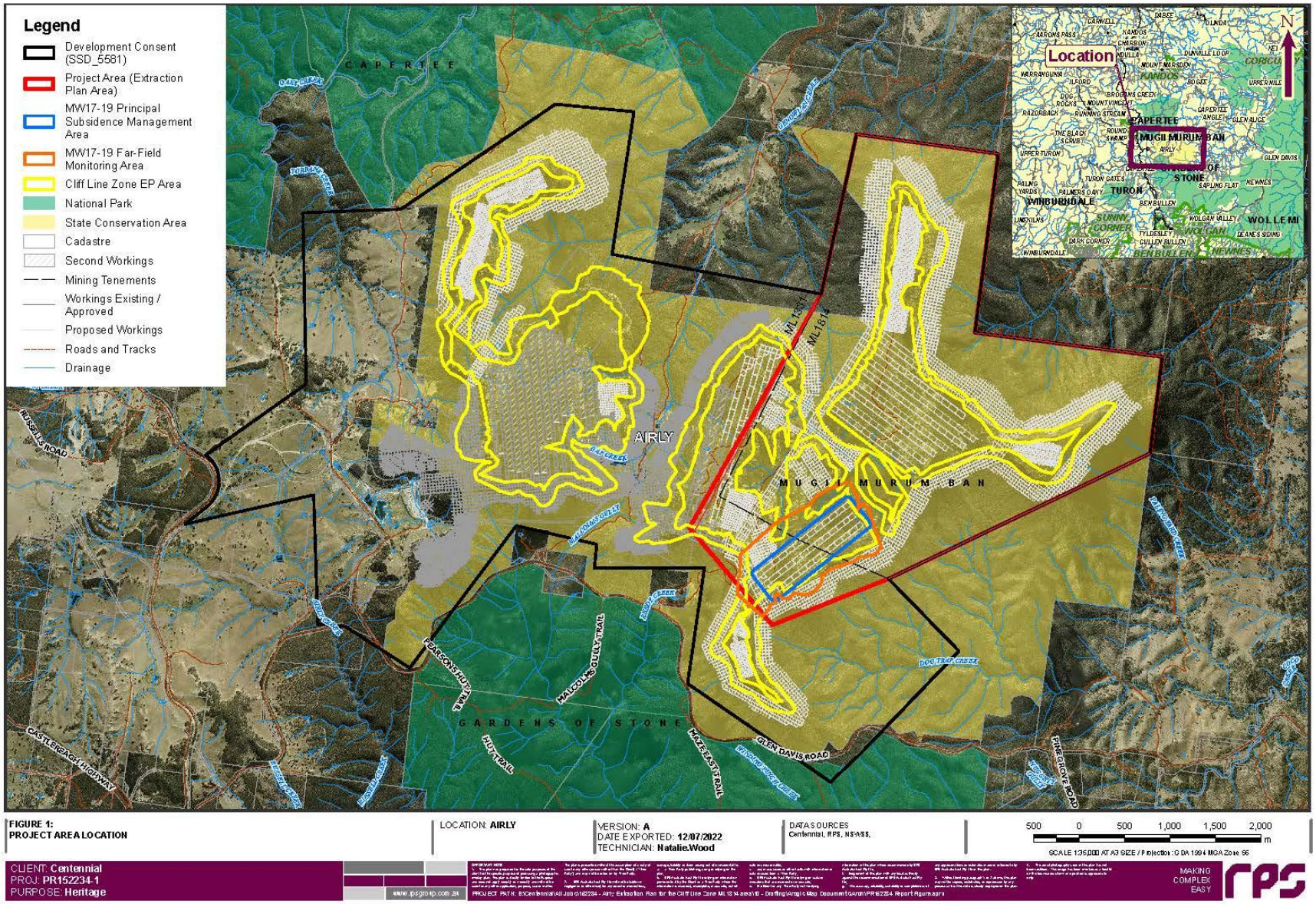


**Figure 1-1: Location of the study area within the State Conservation area**

# 2 HISTORICAL CONTEXT

## 2.1 Overview

A comprehensive historical context as already been produced for Airly (RPS, 2013). The following surmises that context with additional research salient to the specific study areas. The following summary is based on previously prepared histories.

The Aboriginal history of the area is extensive and complex and is not the focus of this document. The Aboriginal use and occupation of the Airly region is addressed in the broader 2013 report which should also be referred to.

## 2.2 Aboriginal history after 1788

The site is on the traditional lands of the Dharuk People who were known to be specialist toolmakers. the first recorded contact between the Dharuk people and British colonialists occurred in 1791 when Governor Philip led a part to the Hawksbury River. By the mid 1790s British settlement of the Hawksbury began to put pressure on the food supplies of the Dharuk people. Initial exploration into the Blue Mountains by Barrallier in 1802 observed Aboriginal people in the Wollondilly Valley (RPS 2013).

## 2.3 Early explorations

European presence in the region around Airly commenced in 1821 when James Blackman travelled from Wallerawang towards Mudgee. Blackman was one of ten farms selected by Governor Macquarie to settle the Bathurst area in 1818 where he was granted 50 acres of farmland and a town lot of two acres. His 1821 journey saw his team travel from Bathurst to Burrundulla Swamps, south of Mudgee via the Cudgegong River (Greaves, 1966). This route would have taken him in the vicinity of Capertee, west of Airly. Blackman continued to explore the area into 1822 along with William Lawson (Selkirk, 1920).

By the 1820s Sir John Jamison had amassed 18,000 acres of land in the area around Capertee which was one of his numerous estates (Lawrence and Davies, 2011 p. 122). Jamison came to NSW in 1814, having inherited land from his father, Thomas Jamison, the surgeon of the First Fleet. Over the ensuing decades Jamison became one of the largest landowners in the colony and was a well-known public figure, constitutional reformer, and member of the Legislative Council from 1837 to 1843 (Walsh, 1967). He was a two time, and inaugural, President of the Agricultural Society of New South Wales, and at one point considered to be the second wealthiest person in the colony (Connah, 1986). He used his land at Capertee, which he named Capita, as a horse farm (Binney, 2005 p.116). In 1829 Capertee was used as a named place for the demarcation of county boundaries, with it being included within the County of Roxburgh at this time (*SydGaz* 17 Oct 1829).

The discovery of gold in 1851 drastically changed the fortunes of Capertee and the surrounding area which by 1883 had a railway, school, and police station. This growth was further enhanced by the discover of coal, limestone, and oil shale in the 1870s. It was during the boom period in the late 19$^{th}$ century that Airly was established as a satellite settlement of Capertee (*SMH* 08 Feb 2004).

## 2.4 Mining

One of the earliest European settlers into the Airly region was James Galagher who took up a selection at Round Swamp in 1842 (Galagher, 2010). In 1854 he purchased 50 acres at Airly Flat, where he built a slab hut and in the ensuing years, he purchased land at Excelsior and also Meadow Flat. Once established, James Galagher built two substantial houses, Airly House and Wallah Tappee (Galagher, 2010 p.10).

In 1883 the first Oil shale seams at Airly were identified by S. Nicholson and J. Larkin who, along with J. Connel, P. Wallace and R. Fryer took out a lease on the southern portion of the area. They were unable to meet the labour conditions for the site however and the lease lapsed around 1888. The area was split into separate mines: Genowlan to the south, Airly/New Hartley to the north, and King's Mine. The village of Airly was nestled approximately between the mines.

Following the failure of the initial lease, the Genowlan mine was taken up by a German syndicate known as the Genowlan Shale Company (GSC) who began exporting immediately. It was during this lease, in 1884,

that a private railway line was built right across Galagher's Airly property connecting the newly discovered oil shale deposits with Torbane Rail Siding and on to the main Mudgee railway line (Galagher, 2010 p.12). Financial difficulties in 1894 led to the largest shareholder in GSC, Andrew Anderson, forming a new company, the Australian Shale syndicate (ASS) which subsequently purchased the mine. The ASS controlled the lease until 1896 when it was contracted out to the Australian Kerosene Oil and Mineral Company (AKO&M). AKO&M had extensive experience in mining shale having run the Joadja mine (Jack, 1995) and were offered purchase on the mine, however they declined indicating it may not have been sufficiently lucrative (Mills, 1998).

The King's mine lease was taken up by Francis William King, and his brother, R.J. King in 1893 who were able to produce a moderate output of shale for export. The continued to work the mine until 1896 at which time it was taken over by New South Wales Shale and Oil (NSWS&O). the NSWS&O also took over the Airly/New Hartley mine at this time having exhausted the resource at Hartley Vale (Rigby, 2004). They renamed the mine New Hartley and commenced production under manager William Hall. Accessibility issues led to significant infrastructure being constructed to link the mine to the government railway at Torbane Station. This consisted of a light rail that went through a tunnel which was completed in 1898. A telephone line was installed alongside the rail to facilitate communications (Mills, 1998). The mine was subsequently acquired by the Commonwealth Oil Corporation in 1906.

## 2.5 Airly Village

Airly Village was surveyed on 28th June 1897 by James Dawson and officially proclaimed 0n the 4th of September 1897. As demonstrated on parish maps of the time, the planned village consisted of a central street – Tramway Avenue – than ran north to south or around 500m with Hill Street running parallel to the west, and Genowlan Street and then Cliff Street parallel to the east. Short Street, Ilford Street and South Street linked these.

Although some buildings were constructed on the planned subdivision including the school, church and post office, many of the residents lived beyond the planned village closer to their work areas and wherever level ground could be found or created (Rigby, 2004). The propensity towards ignoring the formalised settlement was related to the cost of construction and the location of usable water supplies. In June 1898 it was commented, "...The people do not seem disposed to settle in the prescribed area...another drawback in the surveyed township is the absence of good water" (*LithMer* 24 Jun 1898)

Typical dwellings ranged from freestanding sandstone huts to cave houses which utilised the natural sandstone overhangs supplemented with dry stone walls and other materials. Many of the dwellings would have been very makeshift in nature with clay or dirt floors and constructed from materials which could be easily and cheaply obtained and reused. This included bark, galvanised iron, wattle and daub and brattice cloth. Building materials would have been carried into the remote mountain location, presumably in many cases reused from previous use on another mine site and in turn, everything that could be taken would have been moved on to the next site.

## 2.6 Decline of mining

The early 20th century saw numerous industrial disputes as prices for shale fluctuated and resources dwindled. The mine workers at both the New Hartley and Genowlan mines formed a combined union in August 1900 and affiliated it with the Federal Labour Association of Australia. This unionisation occurred during a period of sustained economic depression in Australia when the demand for oil shale fell, prices became unstable and the demands of mine managers upon the workforce became increasingly impractical (Rigby, 2004). The first major strike occurred in September 1900 with demand for an 8-hour day. The miners' demands were met reasonably easily; however, the subsequent reduction in working hours led to a reduction in wages such that the miners were forced to request that the manager increase the hewing rate (Mead, 1986). The request was declined by the A.K.O&M board, and during October 1900 at least a quarter of the workforce left because they were not earning a living wage. A new rate was finally agreed in mid-November 1900. Further strikes occurred over pay and working conditions through the early years of the 20th century including at New Hartley in July 1902 where a 21 week strike took place over hewing rates and another 5 week strike in 1906.

Disputes over pay and conditions continued at New Hartley mine from 1904 to 1907 with a five week strike in 1906 leading to an agreed increase in the hewing rate. Negotiations to reach this agreement were made

difficult by the fact that local managers now had to refer to the new London-based directors of the Commonwealth Oil Corporation (COC) for all major decisions.

In 1907, with a marked increase in share prices, the miners requested a 25% increase in the hewing rate, which was refused by COC, which again led to strike action. At least sixty men saw the strike through, receiving support from unionists throughout the state. The strike was eventually ended on the 16th of May 1908 by a specially established Arbitration Court that met at Torbane. The judgment favoured the miners and the strike eventually contribute to the implementation of the *Industrial Disputes Act 1908*. The settlement led to a three-year deal between miners and management which was honoured by both parties with no further action after 1908. It has been argued (Mead, 1986) that the continual process of strikes and concessions over the first decade of the 20th century was a deliberate management strategy by companies to prevent over mining of the resources. With Mead noting that rather than laying off staff to reduce production and risk skill workers leaving “A carefully created and orchestrated strike, such as the lockout of June to December, 1902 and the pay renegotiation of 1907, would have been a much more satisfactory way of running down reserves”. (Mead *ibid* p.393).

In June 1912 the COC announced their plan to close New Hartley and after it went into liquidation in 1913 its mining interests in the area were purchased by Commonwealth Oil Federation (COF) (Mills, 1998). COF ran the mines for a few years; apparent exhaustion of the resource led to the pit being closed entirely in 1918 (Simpson, 1982).

# 3 GAP ANALYSIS

## 3.1 Introduction

The aim of this gap analysis is to identify if any historical sites are known within the study area and indicate areas where historical sites and archaeological deposits may be located. It includes a search of all relevant Local, State, Federal and World registers and databases, an overview of previous heritage and archaeological research undertaken for the study area and surrounding environment, and an analysis of historical plans including maps and photographs.

## 3.2 Listed Sites

Multiple registers and lists exist for items of historical heritage in Australia. The following databases and registers were searched to identify statutory and non-statutory heritage items within and adjacent to the study area. In some instances, the same heritage item, place, or complex is registered on multiple registers. The listed sites in proximity to the study area are shown in Figure 3-1.

### 3.2.1 UNESCO World heritage list

The study area is not within any UNESCO World heritage listed site. It is adjacent to Greater Blue Mountains Area (WHL 917).

### 3.2.2 Environment Protection and Biodiversity Conservation Act (Cth) 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the principal environmental Act at a Commonwealth level. It provides for the protection and management of nine matters of national environmental significance as defined in the EPBC Act. Matters of national environmental significance include but are not limited to flora, fauna, ecological communities, and heritage places of national and international importance.

In addition, the EPBC Act applies to actions with a significant impact on the environment where the actions affect, or are taken on, Commonwealth land, or are carried out by a Commonwealth agency (even if that significant impact is not on one of the nine matters of 'national environmental significance').

The EPBC Act requires approval from the Minister for actions with a significant impact on places included on the National Heritage List (NHL) or Commonwealth Heritage List (CHL).

#### 3.2.2.1 National Heritage List

The National Heritage List was established under the EPBC Act to protect places of outstanding significance to Australia.

The study area is within one area currently listed as being an ‘Area under assessment’ on the NHL (Table 3-1:).

**Table 3-1: NHL listed sites that relate to the study area.**

| Name | Class | Legal Status | Place ID | Place File Number |
|---|---|---|---|---|
| *The Greater Blue Mountains Area – Additional Values* | Natural | Nominated Place | 105696 | 1/14/006/0061 |

#### 3.2.2.2 Commonwealth Heritage List

The Commonwealth Heritage List was established under the EPBC Act to protect places owned and managed by Commonwealth agencies.

There are no items on the CHL within or adjacent to the study area.

### 3.2.3 Register of the National Estate

The Register of the National Estate (RNE) was originally established under the *Australian Heritage Commission Act 1975* (repealed). In 1997 the Council of Australian Governments agreed that heritage listing, and protection should be the responsibility of the level of government best placed to deliver agreed outcomes. It was agreed that the Commonwealth's involvement in environmental matters should focus on matters of national environmental significance, including World Heritage properties and places of national significance. Each state, territory and local government has a similar responsibility for its own heritage.

The expiration or repeal of parts of the EPBC Act and the *Australian Heritage Council Act 2003* relating to the RNE does not diminish protection of Commonwealth heritage places. Places listed on the Commonwealth Heritage Register remain protected under the EPBC Act. The RNE is now an archive of information about more than 13,000 places throughout Australia.

The study area is within the items in Table 3-2. An indicative place is not considered to be on the RNE, but its details have been entered into the register. As the RNE is now a non-statutory archive of places, the is no process for the item to be added to the register.

**Table 3-2: RNE listed sites that relate to the study area**

| Name | Class | Legal Status | Place ID | Place File Number |
|---|---|---|---|---|
| *The Pagoda Country* | *Natural* | Indicative Place | 18258 | 1/07/232/0033 |

### 3.2.4 Heritage Act 1977 (NSW)

The NSW *Heritage Act 1977* (the Heritage Act) is the principal Act for the management of NSW's environmental heritage. It establishes the State Heritage Register (SHR) and includes provisions for Interim Heritage Orders, Orders to Stop Work and archaeological relics (both on land and underwater within the limits of the State). It also requires government agencies to maintain a Heritage and Conservation Register.

To assist management of NSW's environmental heritage, the Heritage Act distinguishes between assets of State and local significance:

- State significance refers to significance to the state in relation to the historical, archaeological, architectural, cultural, social, natural or aesthetic value of an item
- local significance refers to significance to an area in relation to the historical, archaeological, architectural, cultural, social, natural or aesthetic value of an item.

#### 3.2.4.1 NSW State Heritage Register

Section 31 of the Heritage Act requires the Heritage Council to keep the SHR. The SHR identifies places and objects of importance to the whole of NSW.

There are no items on the SHR in or adjacent to the present study area.

#### 3.2.4.2 HHIMS s170 register National Parks

Section 170 of the Heritage Act requires government agencies to establish a Heritage and Conservation Register that identifies all assets of environmental heritage that it owns or occupies. Government agencies are required to provide the NSW Heritage Council notice of any intention to remove an asset from a Section 170 Heritage and Conservation Register, transfer ownership of an asset included on a Section 170 Heritage and Conservation Register, cease to occupy an asset on a Section 170 Heritage and Conservation Register or demolish an item included on a Section 170 Heritage and Conservation Register and assets must be maintained with due diligence in accordance with the *State Agency Heritage Guide* (Heritage Council 2005).

NSW National Parks & Wildlife Service maintains s170 Register information in the Historic Heritage Information Management System (HHIMS). This is a database that contains records for heritage sites and items that exist on the New South Wales national parks system. HHIMS replaced the previous NSW National Parks and Wildlife Service Historic Places Register in August 2002.

The items in Table 3-3 are adjacent to the study area. There are no items on the National Parks s170 register within the present study area.

**Table 3-3: HHIMS s170 listed sites adjacent the study area**

| Item | State Heritage Inventory ID | Item name | Item type |
|---|---|---|---|
| 12421 | 3917651 | Airly Village Ruins | Complex |
| 13455 | 3917573 | Bakery; Airly Village | Element |
| 13456 | 3917574 | Site of Church; Airly Village | Element |
| 13457 | 3917575 | Spring Shaft and Stone House; Airly Village | Element |
| 13458 | 3917576 | Big Rock Cave Dwellings; Airly Village | Element |
| 13459 | 3917577 | Potts Point Dwelling Precinct; Airly Village | Element |
| 13461 | 3917579 | Magazine, Spring and Stone Cave Dwelling; Airly Village | Element |
| 13462 | 3917580 | Stone Dwelling Precinct; Airly Village | Element |
| 13463 | 3917581 | Gorrms House; Airly Village | Element |
| 13464 | 3917582 | Skipway, stone retaining wall; Airly Village | Element |
| 13465 | 3917583 | Martins Tunnel, ventilation tunnel and Chimney; Airly Village | Element |
| 13466 | 3917584 | Ventilation Chimney; Airly Village | Element |
| 13467 | 3917585 | Boiler and winding house; Airly Village | Element |
| 13468 | 3917586 | Flying Fox Ropeway; Airly Village | Element |
| 13469 | 3917587 | Ventilation shaft, dwelling, skipway; Airly Village | Element |

### 3.2.5 Lithgow Local Environmental Plan 2014

The *Lithgow Local Environmental Plan (LEP) 2014* sets out various planning, development and environmental controls for the Local Government Area (LGA) of Lithgow. Schedule 5 of the LEP identifies heritage items important to the LGA. The LEP differentiates between Heritage Items, Heritage conservation areas and Archaeological sites (Table 3-4).

There are no Heritage Items, Heritage conservation areas or Archaeological sites listed on the Lithgow LEP within the study area. The items in Table 3-4 are archaeological sites adjacent to the study area.

**Table 3-4: Lithgow LEP 2014 listed sites that relate to the study area**

| Locality | LEP Site name | Significance | LEP Item No. |
|---|---|---|---|
| Airly | *Airly Bakery* | Local | A149 |
| Airly | *Airly Big Rock Cave Dwellings* | Local | A148 |
| Airly | *Airly, Torbane and Genowlan oil shale sites* | Local | A144 |
| Airly | *Airly Township and Mines Group* | Local | A145 |
| Airly | *Airly Village Church site* | Local | A146 |
| Airly | *Boiler and winding house* | Local | A158 |
| Airly | *Flying Fox rope way* | Local | A159 |
| Airly | *Gorrms House* | Local | A155 |
| Airly | *Magazine, spring, stone cave dwelling* | Local | A152 |
| Airly | *Managers Residence* | Local | A151 |
| Airly | *Martins Tunnel, ventilation tunnel and chimney* | Local | A156 |
| Airly | *Potts Point Dwelling Complex* | Local | A150 |
| Airly | *Skipway, stone retaining wall* | Local | A154 |
| Airly | *Spring shaft and stone house* | Local | A147 |
| Airly | *Stone dwelling complex* | Local | A153 |
| Airly | *Torbane railway cutting* | Local | A161 |
| Airly | *Torbane retort complex* | Local | A162 |
| Airly | *Ventilation chimney* | Local | A157 |
| Airly | *Ventilation shaft, dwelling, skipway* | Local | A160 |

### 3.2.6 Summary

Analysis of all statutory and non-statutory lists show that at present there are no listed heritage sites or archaeological areas within the study area, however the study area includes part one item currently under assessment for inclusion on the NHL.

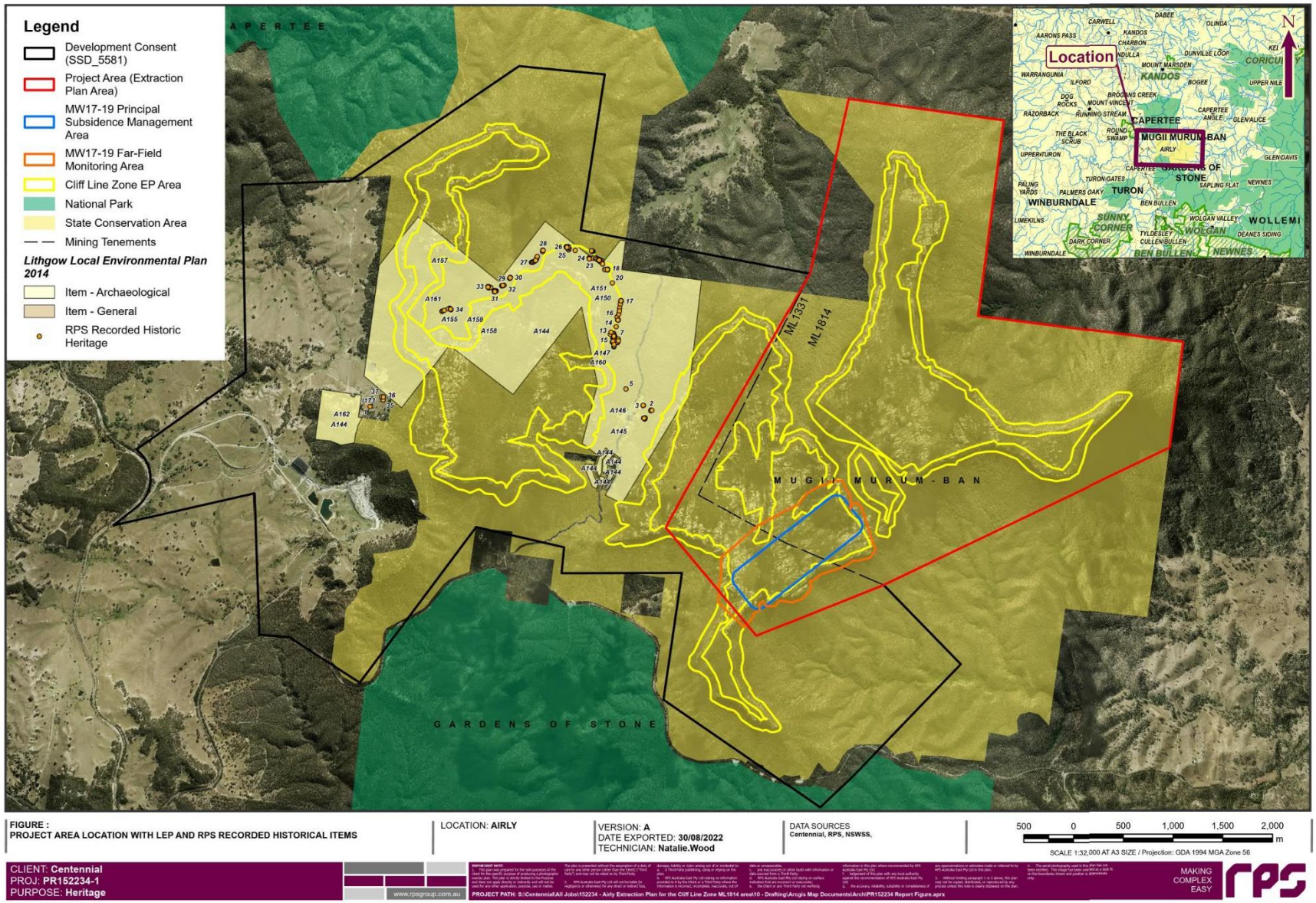


**Figure 3-1: All listed historical heritage sites in relation to the study area**

## 3.3 Previous Reports

### 3.3.1 Mugii Murum-ban State Conservation Area Draft Plan of Management, NSW National Parks and Wildlife Service, September 2015

Much of the study area falls within the Mugii Murum-ban State Conservation Area which covers a total of 3650 Hectares bounded by Glen Davis Road, the Gardens of Stone National Park and Capertee National Park. NSW NPWS produced a Plan of Management for the Area in 2015 (NSW National Parks and Wildlife Service, 2015).The historical background and discussion of historical heritage value within this report focuses on the Oil Shale mining industry and Airly Village west of the study area. It does also indicate that the Ribaux family mined for gold and diamonds on the Genowlan mesa which is within the present area. Many of the tracks established by the Ribaux family remain in use to the present day.

This indicates that if the Ribaux families mining operations included areas within the present study area they are likely to be along these established tracks.

### 3.3.2 Baseline Historic Heritage Assessment – Airly Mine, Capertee, RPS, 2013.

In 2013 a baseline heritage assessment was conducted for the Airly shale mining complex in order to identify evidence of historic mining activity at Mount Airly and Torbane (RPS, 2013).

The survey identified a total of 37 sites forming the Airly shale mining complex with remains comprising working areas, habitation sites and transportation systems.

The Airly shale mining complex was assessed against the NSW heritage significance criteria and in line with the Burra Charter. The assessment concluded the complex is of local significance based upon the 2013 research and investigations of the area.

This complex is well documented in historical records and is located west of the present study area. It is assessed as being of local significance.

### 3.3.3 Airly Mine Extension Project, Cultural Heritage Impact Assessment, RPS 2014

This extensive assessment covered both Aboriginal Cultural Heritage and Historical heritage items across the entire of the ML1331 and ML1814 areas (RPS, 2014). As part of this assessment survey was carried out for Aboriginal heritage within the ML1814 and MW17-19 area. Although not specifically targeting historical items, were they located by the team they were noted. Table 3-5 provides the conditions and results of this survey. No items of historical heritage were identified during this survey. Likewise, no items of Aboriginal heritage were identified within the present study area during this survey, although items outside of the present study area but within the survey units were identified and recorded at that time.

**Table 3-5: Summary of the results of the relevant 2012 survey units**

| Survey Unit (SU) | Location | Landform/s | Visibility - ground surface exposure | Aboriginal Archaeology | Historical Archaeology |
|---|---|---|---|---|---|
| 8A | steep slopes and gullies near pit top/ admin area | steep slope and associated gullies | Not recorded | Y | N |

| Survey Unit (SU) | Location | Landform/s | Visibility - ground surface exposure | Aboriginal Archaeology | Historical Archaeology |
|---|---|---|---|---|---|
| 12A | Grotto and carpark; tracks from Nissen hut to lookout (Chennas) | upper, mid and lower slopes, but mostly undulating slopes in drainage lines between pagodas of Mt Genowlan, west through the grotto to the northern portion | Not recorded | Y | N |
| 13A | near Genowlan trig point; along ridgeline, sandstone pagaodas and steep cliffs | difficult terrain | Low - due to fog | N | N |
| 14A | lower, mid & upper slopes SE of Nissen hut | sandstone pagodas, steep | 20%-30% | N | N |
| 16A | short track taken through the grotto to NE side & continue NE from track | Not recorded | Very low | N | N |
| 17A | existing access track along creek | creek, surrounded by outcrops and pinnacles | 60%-80% | N | N |
| 27A | forest flats E of SUB1 | Top crest area to 1000m elevation, E on Genowlan | Low | Y | N |
| 28A | Eastern arm of Mt Genowlan - elevation 940m | Eroded sandstone formation with iron leeching noted; undulating landform | 0-5% to 80% in clearings (low, heavy leaf litter) - low-medium GS exposure | N | N |
| 1B | From crest, walked in SE direction towards SS pagodas at 950m elevation | Heavily eroded pagodas | Poor - leaf litter | N | N |
| 2B | North arm of plateau, followed track along Mt Genowlan to point | large extensive complex of eroded sandstone | GSV-90% on road; 0-5% due to low shrubs GSE-limited to road | N | N |
| 3B | view of sandstone overhang & from lookout | rock shelter with depth of shelter floor 80-20cm | 0-10% in areas of dense vegetation; 80-95% in exposed sandstone areas | N | N |
| 4B | Steep hills, cave area, | Sandstone outcrops, cave area, | GSV- 90%(track); 0-5%(vegetated areas) | N | N |

| Survey Unit (SU) | Location | Landform/s | Visibility - ground surface exposure | Aboriginal Archaeology | Historical Archaeology |
|---|---|---|---|---|---|
| 5B | Base of Chennas lookout | High rising sandstone cliffs | 0-2% | N | N |
| 6B | East facing toward rock cavity near drainage line | steep hills and dense shrubs; two overhangs | GSE-limited due to pagodas; GSV-poor due to dense fern/leaf litter | N | N |
| 7B | Large track cavity with water source - NW facing | sloped floor and water source | Not recorded | N | N |

### 3.3.4 Historic Heritage management Plan for Cliff Line Zone of First Workings Extraction Plan within ML1331 – Airly Mine RPS, 2017

A Historic Heritage Management Plan (HHMP) for the inclusion in the Airly Mine Extraction Plan (EP) for the Cliff Line Zone of First Workings was produced in 2017 (RPS, 2017). Twelve (12) historic heritage items were identified within the EP area.

Cliff Line Zone consists of first workings only comprising roadways and cut-throughs for mine development and are considered long term stable and therefore monitoring was not deemed a requirement for these works. This work relates to the items identified in the 2013 Baseline Assessment

### 3.3.5 Historic Heritage management Plan (EP-HHMP) for the Splitting and Quartering Extraction Plan (ML1331), RPS, 2018

A HHMP was produced in 2018 for the Splitting and Quartering (SQ) area within ML1331 at Airly . Four items of historic heritage were identified within the SQ area (Site 1, Site 2, Site 31 and Site 33), these sites were originally recorded in the 2013 report. Recommendations were for three of these items, Site 1, Site 2 and Site 31 are to undergo phased monitoring under the Centennial's Western Region HHMP.

### 3.3.6 Archaeological Assessment and Baseline Recording of Sites 1, 2 ,3 and 4 at Airly Village RPS, 2019

In December 2018, a baseline recording and groundtruthing of four items (Site 1, Site 2, Site 3 and Site 4) was conducted under Centennial's Western Region HHMP . The four sites were originally recorded during the 2013 historic heritage assessment. The inspection confirmed the location of these four sites and conducted a full recording including photogrammetry and survey points.

### 3.3.7 Summary

Review of previous reports that relate to the region including the study area indicate that there are no known areas of historical heritage within the study area. Survey undertaken in 2013 (RPS 2014) visited the area and no sites were noted. That said, this survey was expressly for the purposes of locating Aboriginal sites.

The review does provide an indication of the types of historically significant activities that occurred in the wider vicinity and a suggestion of what the physical remains of shale mining activities would look like. The evidence relating to shale mining activity at Airly mine has been established as being locally significant.

## 3.4 Historical Imagery

### 3.4.1 Parish Maps

The study area falls within the Parish of Morundurey, County of Roxburgh (Figure 3-2). The earliest Parish Map located that includes the study area was created in 1894. At this time the area of Genowlan Mountain had been divided into Mining Permit areas largely of 640 acres and applied for under Section 28 of the 1874 mining Act. The plan provides a snapshot of some of the people who had interest in mining the area at the time. The numerous issuing and cancelling of permits likely relates to the relative difficulty individuals would have in accessing and exploiting the land (Table 3-6). The 1902 Parish Map shows the same divisions but lists far fewer applicants with only W.M. Hall making an application for MP3, MP4 and MP5 all of which were cancelled on the 30th of June 1905. An area of 1086 acres at the head of Emu Swamp Creek is shown as being demarked as a Crown Lease Area on the 14th of January 1914, valued at £543, and leased to Robert Hardy for a rent of £6 15s 9d. This included small parts of MP7 and MP8 The area west of Genowlan Mountain was also demarked and leased to John Galagher. This included most of MP11 and a part MP7 and MP3. Robert Hardy is shown as still being in possession of his land on the 1916 Parish Map but Galagher's land is in the possession of Christopher Bottrell at this time and has been demarked as Crown Lease Area 2658 listed as being 1011 acres. At some time between 1902 and 1916 many of the 'Mining Permit' areas were reclassified as 'Mineral Leases', with MP7 becoming ML5 and MP8 becoming ML4. The 1931 Parish Map shows Bottrell and Hardy both still in possession of their grants, as does the 1953 Parish Map. This later map also shows Col Ribaux in possession of MP4.

Research into the various grant holders was undertaken to establish whether any could be considered persons of historical significance. No individuals are likely to be so.

J.E. Tonkin is likely to be James Ebenezer Tonkin (1835 - 1906) who was the Alderman of Bathurst from c.1879 and served as Member of the NSW Legislative Assembly for East Macquarie from 1887 to 1895. In 1894, Tonkin and Patrick Joseph Dorahy founded the Giandarra Gold-mining company along with John Robyns, with the company successfully mining for gold at Kiandra, Kosciuszko.

In May 1896 James Ebenezer Tonkin of Sydney with Patrick Joseph Dorahy and John Robyns of Kiandra, were registered as the owners of a 15-year lease over GL31 (Lease 518), GL34 (Lease 519), GL37 (Lease 520) and GL38 (Lease 521), Parish of Kiandra. Operations are recorded as commencing with two men from mid-June. (Registered Leases #517-521, Mines Dept)

Col Ribaux was interviewed as part of the Baseline Historic Heritage Assessment (RPS 2013) for Airly Mine. He used his grant to mine for diamonds without the use of major mine infrastructure

**Table 3-6: Summary of mining grants given for some parcels of land within the study area. Information taken from Parish Maps.**

| Area | Size | Grants | | |
|---|---|---|---|---|
| MP 1 | 640a | J.E. Tonkin 29/12/1896, cancelled 18/01/1898 | P.J. Dorahy 22/01/1898, cancelled 29/07/1898 | G. Anderson 29/07/1898, cancelled 20/10/1899 |
| MP 3 | 640 | Walter L. Younger, 27/02/1895, cancelled 10/01/1896 | L.D Younger, 04/01/1896, cancelled 11/09/1896 | |
| MP 4 | 640 | Walter L. Younger, 27/02/1895, cancelled 10/01/1896 | L.D Younger, 04/01/1896, cancelled 11/09/1896 | |
| MP 5 | 640 | James E. Tonkin, 03/06/1896, cancelled 08/12/1896 | | |

| Area | Size | Grants | |
|---|---|---|---|
| MP 7 | 640 | Walter L. Younger, 27/02/1895, cancelled 10/01/1896 | L.D Younger, 04/01/1896, cancelled 11/09/1896 |
| MP 8 | 640a | John Marden, 29/04/1895, cancelled 10/01/1896 | Jas Foley 03/08/1897, cancelled 20/010/1899 |
| MP 9 | 640a | | Jas Foley 03/08/1897, cancelled 20/010/1899 |

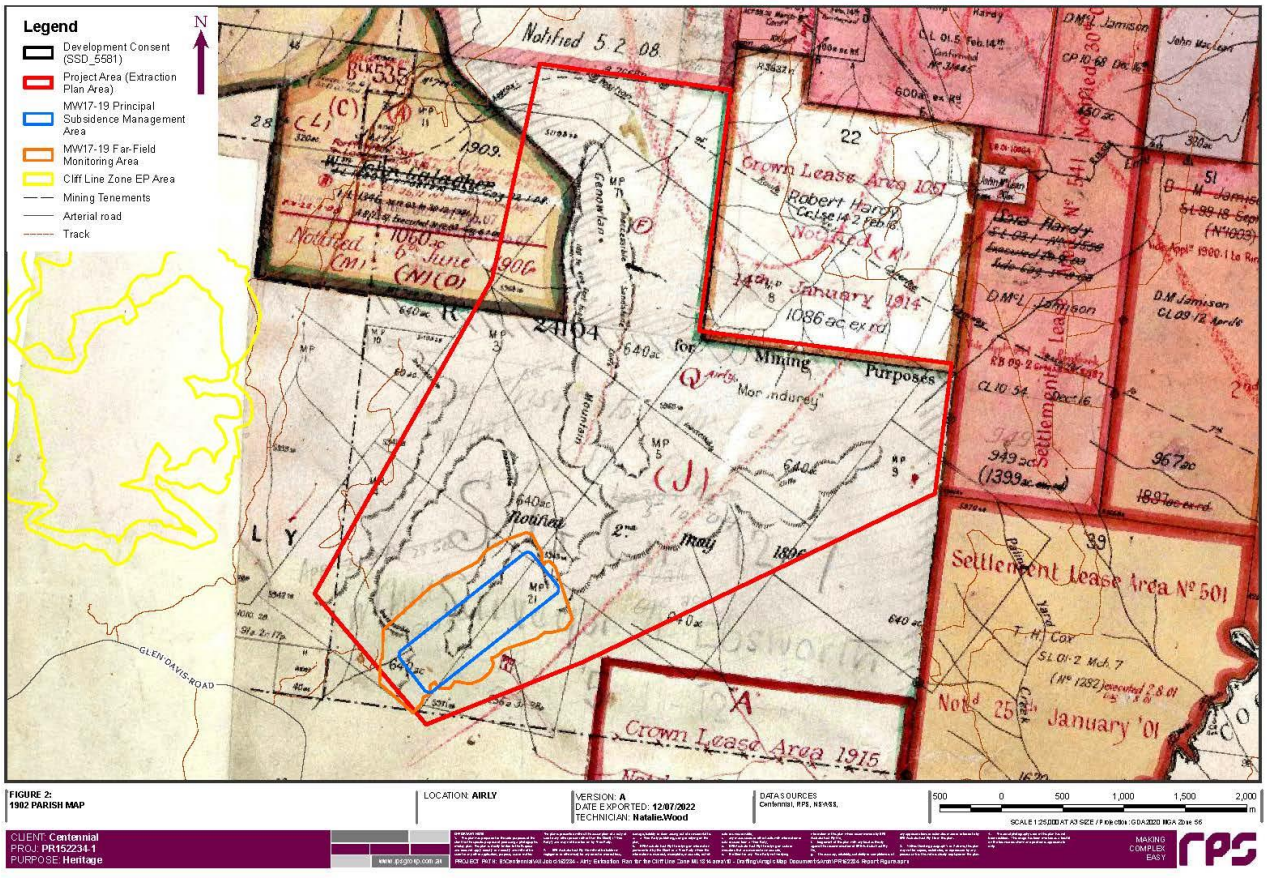


**Figure 3-2: Extract from the 1902 Parish Maps showing the mining grants divisions discussed in Table 3-6 at that time. HLRV, Parish of Morundurey, Historical Parish Maps, Sheet ref 1, Ed. 2, 11297601.jp2**

## 3.4.2 Geological Maps

A geological map, produced in 1900 for the Department of Mines and Agriculture prominently features Genowlan Mountain and demonstrates well the inhospitable and rugged nature of the terrain as well as clearly demonstrating the location of each Mining Permit Area (Figure 3-3). There is no indication of any sites of historical heritage within the study area.

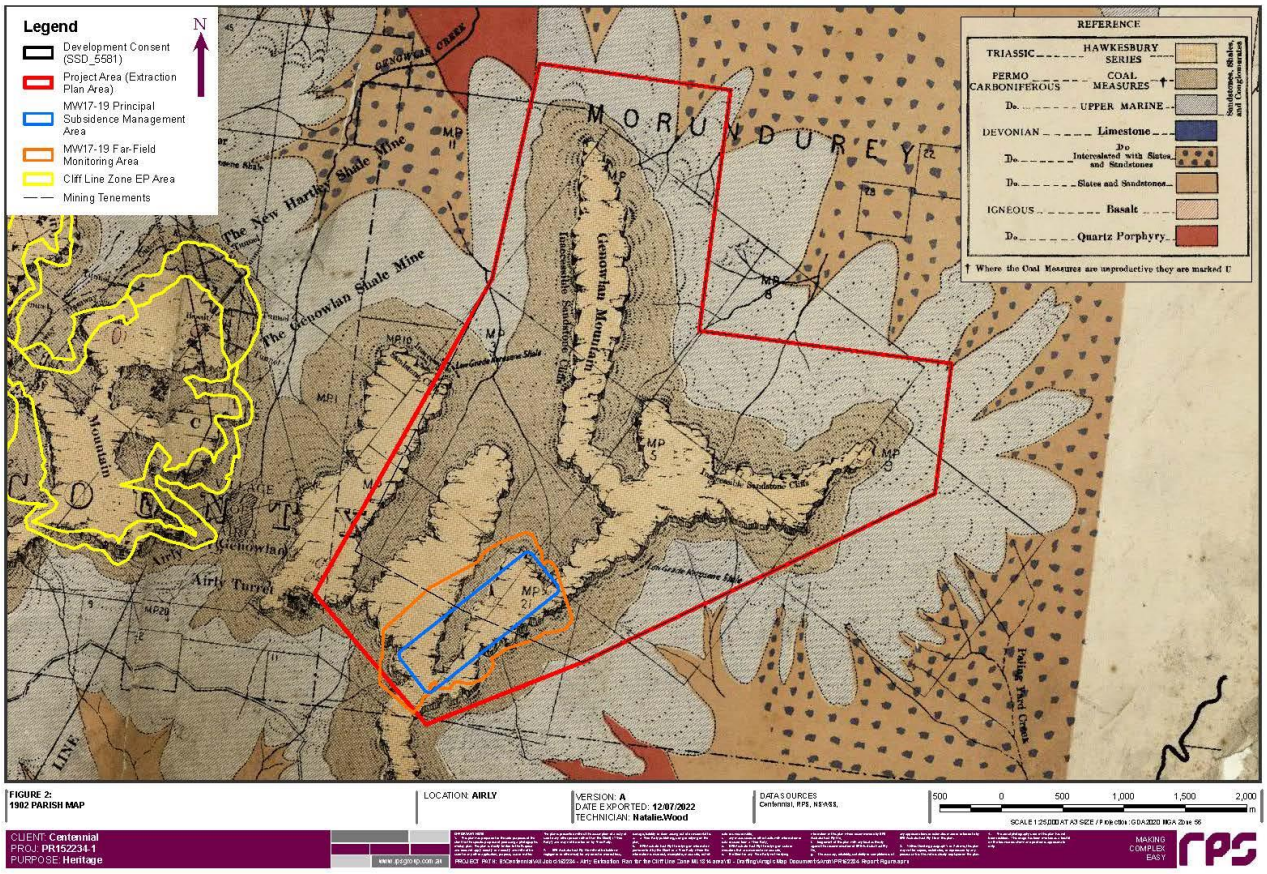


**Figure 3-3: Extract from a 1900 Geological map of the area showing the present study area. The rugged nature of the terrain is evident, and no signs of land use are present. SLNSW, Z/M3 812.23caq/1900/1, FL16343911**

### 3.4.3 Photographs

Historical photographs can rarely be positively located unless they feature well known areas that have retained some degree of intactness. They can however provide a visual indicator of the kinds of historical activities that occurred in the area and help in identifying features on the ground.

Figure 3-4 shows a bush hut, nicknamed the Genowlan Hotel. The photograph was taken by John Henry Harvey, an industrious architect an amateur photographer. The structure shown is single-story with a gable roof and is primarily constructed of wood with a plastered front wall. The front and rear of the structure both have a basic verandah with wooden posts supporting the extending roof. The roof is primarily timber shingles with possible corrugated iron at one end. The end with iron roofing also features a chimney which has been plastered. The front wall of the structure has two doorways and three windows, two of which are glazed 12-panelled sash windows. The photograph provides an indication of the kinds of habitation used by the inhabitants of the area. Remaining evidence of structures similar to this would include posts, collapsed walls with areas of plaster, glass and iron sheeting.

**Figure 3-4: A bush hut (Genowlan Hotel) Capertee Valley N.S.W. SLV, H91.300/478**

### 3.4.4 Summary

Analysis of the Parish maps confirms that the area was desirable for mining purposes and that numerous individuals were in possession of mining leases. None of these individuals are figures of historical significance and the parish maps do not provide any indication of items of historical heritage in the study area.

The study area was demarked into various areas and leased as mining permits throughout the later 19th and early 20th century, which raises the possibility of occupation and use of the land during this period which may have generated an archaeological resource that meets the threshold of significance. No visual evidence of the kinds of activity undertaken has been located within the study area.

## 3.5 Conclusions

The study area is:

- **Included** in one are currently being assessed for inclusion on the *National Heritage List* (The Greater Blue Mountains Area – Additional Values, Place ID 105696)
- **Listed** as an Indicative Place on the *Register of the National Estate* (The Pagoda Country Place ID 18258)
- **Adjacent** to a number of other sited sites including those on the National Parks s170 Register, Lithgow LEP 2014, and the UNESCO WHL.

Previous studies in the vicinity of the study area have demonstrated that there is considerable material culture relating to shale mining practices in the wider area. This includes the 37 sites that form the Airly Shale mining complex and Torbane. The Ribaux family continued to mine the area into the late 20th century.

Analysis of historical imagery demonstrates that much of the study area was divided into individual mining grants under Section 28 of the *Mining Act 1874*. These grants were held by various individuals throughout the late 19th and early 20th centuries.

None of the people identified are of historical significance. No indication of any activities that may have left archaeological evidence have been located in the historical imagery

# 4 HISTORICAL HERITAGE BASELINE ASSESSMENT

## 4.1 Archaeological Potential

Archaeological potential is an assessment of how likely it is for evidence of past activity to have survived into the present day considering the whole life history of a site including recent impacts. It is not an appraisal of the significance of any potential evidence, although it does have implications for significance. The assessment of potential for the project was informed by reviewing historical land use (Section 2) and an investigation of sites in the vicinity (Section 3). Several assumptions and principles were used to assess historical archaeological potential.

Two key questions inform all assessments of archaeological potential:

- has the area been used in the past in such a way that will have left a recognisable archaeological resource?
- have subsequent activities on the site removed any or all traces of these past activities?

This assessment assumes that structural evidence such as postholes, wall footings, pads, wells, cisterns, and cesspits etc. that can be identified on historical plans and in historical images, are likely to survive in the ground if no later activity has impacted upon them. The interrogation of this assumption primarily relies on examining the history of the site as a guide to how it has been used over time. It also assumes that later phases of landscape use are likely to have impacted on previous evidence including the possibility of total removal. This includes, but is not limited to, the erection of buildings that have foundations, the excavation of basements, and trenching for utilities. When available, the blueprints of existing or previously constructed buildings can be consulted. Where possible, the present-day site can also be visited to provide further information not recorded in more formal documents.

The assessment also recognised that many landscape features may not be recorded in any formal or informal way. This means they may not appear in the historic record in general. Additionally, when features are marked on plans or maps it may only be indicative and not a precise representation of the form of the feature. This may include:

- plough marks and other associated early farming features
- cesspits, wells, cisterns, rubbish pits and other dug features
- fence-lines, channels, gullies, and other landscape markers
- paths, gardens, orchards, vines, yards, and other external features.

These features are archaeological evidence in themselves and can help to preserve other kinds of archaeological data. This includes pollen and macrofossils within plough marks and cesspits, as well as artefacts within wells and rubbish pits.

The potential of the site is graded according to the levels outlined in Table 4-1.

**Table 4-1: Grades of archaeological potential used in this assessment**

| Grade of Potential | Events that determine grading |
|---|---|
| **Nil** | Past activity left no discernible impact on the landscape and caused practically no material culture to be deposited<br>Later activity has removed wholesale any indication of previous use of the site<br>There is no indication in historical accounts of activity at the site. |
| **Low** | Past activity left only minor impacts to the landscape and only minimal amounts of material culture to be deposited,<br>Later activity has caused widespread damage to the archaeological resource<br>Historical accounts indicate activity in the general area but are unclear or imprecise. |
| **Medium** | Past activity left a moderate impact on the landscape and caused some material culture to be deposited |

| Grade of Potential | Events that determine grading |
|---|---|
| | Later activity has impacted the landscape but in isolated areas or to depths that have only removed some of the resource<br>Historical accounts provide some precision and clarity on the activity undertaken at the site. |
| **High** | Past activity left a large impact on the landscape and caused plentiful amounts of material culture to be deposited<br>Later activity has had virtually no impact on the resource<br>There are clear and precise historical accounts of where activity occurred within the site. |

## 4.2 Heritage Significance

Once the potential for archaeological evidence to be present has been established, it is necessary to assess whether that evidence has any cultural significance as only evidence with significance is protected. This assessment of significance has been guided by the principles of the *Burra Charter* and legislation in the *Heritage Act 1977*. It is supported by relevant Guidelines produced by the Heritage Council of NSW/Heritage NSW including, but not limited to, *Archaeological Assessment Guidelines* and *Assessing Significance for Historical Archaeological Sites and 'Relics'*.

The ICOMOS Charter for the Conservation of Places of Significance, also known as The Burra Charter, defines cultural significance as meaning

> *Aesthetic, historic, scientific, and social value for past, present and future generations.*

Section 4 of the *Heritage Act 1977* defines two levels of significance: local and State, noting that an item of State significance can also be of local significance however an item that is primarily of local significance may not necessarily be of State significance. In the Act heritage significance means significance to either the State or area in relation to the historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic value of a place, building, work, relic, moveable object or precinct.

Heritage NSW has defined a series of specific criteria for the assessment of heritage which have been used here. They are as follows:

- Criterion (a) an item is important in the course, or pattern, of NSW's cultural or natural history (or the local area)
- Criterion (b) an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the local area)
- Criterion (c) an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area)
- Criterion (d) an item has strong or special association with a particular community or cultural group in NSW for social, cultural or spiritual reasons (or the local area)
- Criterion (e) an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the local area)
- Criterion (f) an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the local area)
- Criterion (g) an item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places or cultural or natural environments (or the local area).

The significance of an archaeological resource is tied directly to events that have occurred on a site in the past. This means that various human activities can occur in the same vicinity at the different periods in time and that leave behind archaeology of varying levels of significance. A key consideration of significance is research potential (Criterion (e)) which is the most relevant criterion for assessing archaeological sites. Included within assessment of this criterion is the question of whether the study of the material recovered would contribute to answering research questions (Heritage Office 1996).

In addition to the clearly established criteria outlined above, other factors including intactness, site history and potential have been considered when assessing significance to ensure a broader approach to

archaeological significance (Heritage Branch 2009). This includes an acknowledgement that the significance of an archaeological resource can change prior to, during, and following excavation based on these attributes.

## 4.3 Assessment

The assessment undertaken of the wider Airly Mine area (RPS 2013) surmised that evidence of shale mining was of **local** significance with the structures contained in Airly village contributing the most to this level of significance. The archaeological potential was considered **high** largely due to the volume of extant features.

Based on the information outlined in the Gap Analysis including examination of the historical context the archaeological potential of the study area is **very low**. Primarily this is due to a low likelihood past activity occurring in the area and the lack of clear evidence of activities taking place. The only potential activities to have occurred in the study area are all related to mining, either as part of larger scale commercial operations by companies such as the GSC, ASS, or AKO&M, or as part of smaller scale individual operations.

Based on the criteria outlined above archaeological evidence of shale mining by larger companies may have significance under the following criterion

- Criterion (c) – evidence of the kinds of technologies used in mining may be significant especially if they demonstrate rare or innovative qualities and signs of adaptation to a unique and inhospitable environment.
- Criterion (d) – the Airly mining complex generally has significance to the local community and to groups such as bushwalkers who are believed to frequent the area. There is also possible significance to the present mining community and the descendants of the original workers in the area.
- Criterion (e) – Given the remoteness of the area, if activity occurred evidence of it is likely to be relatively intact. This provides the possibility for a large corpus of physical evidence to remain. If intact sites are found then they would likely contain unique evidence of how mining was undertaken in the area.
- Criterion (f) – Multiple shale mining sites are known throughout NSW including some, such as Joadja, that are well studied. Shale mining sites are not therefore considered rare generally. That said, each site contains unique adaptations of a common technological background and as such each site could be considered uncommon.
- Criterion (g) – The Airly mining complex is considered to be a good representation of the type because it contains an abundance of clear evidence. Any further sites could readily contribute to this representativeness

Based on this, any evidence of commercial shale mining is likely to be of **local significance,** but any other activity is unlikely to meet the threshold of significance.

# 5 FIELD SURVEY

## 5.1 Introduction

The results of the Gap Analysis did not indicate the locations of any potential historical archaeological sites within the study area. However, research indicates that unrecorded, informal sites may exist in various locations across the area. If these sites related to shale mining, then they would be of local significance.

## 5.2 Methodology

### 5.2.1 Aims

The survey aimed to ascertain whether any items of potential historical heritage were present in the ML1814 area. If any items were located the survey aimed to map their extent and record sufficient information to make a preliminary assessment of the item's significance as per HNSW guidelines. The survey also aimed to identify any areas where further survey was required and identify any areas that may have archaeological potential.

### 5.2.2 Sampling Strategy & rationale

Given the remote and partially inaccessible nature of the terrain, survey was limited to areas that were safely accessible on foot. This also reflects the areas that are most likely to contain historical heritage items. Landforms that had the potential for at least temporary occupation were targeted meaning areas such as cliff faces were avoided. Where possible tracks were followed with the area surrounding the track examined.

It is possible that all areas of the mountain were accessed in the past but only the areas that were subjected to prolonged habitation are likely to have generated an archaeological resource. This likely means at least some kind of structural remains but may also include rubbish dumps. These would not have been built in areas that were not readily accessible by people in the past who would also require nearby water.

### 5.2.3 Field methods

The survey was undertaken fully on foot (pedestrian) and consisted of walking the landscape along established paths and examining any features which appeared to be potential sites of historical heritage. A Garmin GPSMAP 64st was used to record tracks and waypoints on the survey with an accuracy of no less than 3m. Photographic recording was undertaken using a 64mp digital camera and saved in .jpg format. The fieldwork was assigned the code AIR22 with each site identified assigned a sequential numerical identifier prefixed with HHA (Historical Heritage Assessment).

The survey lasted two days. Dr Gary Marriner undertook both days of survey. Day one focused on the north-south arm of mount Genowlan heading to Genowlan Point. Day two focused on the east-west arm heading towards Mugii Dhudungura Point (Figure 5-1).

## 5.3 Results

Day one of the survey aimed to cover the entirety of the north-south arm, which was achieved. The survey largely followed the well establish trackway. The area around the trackway was most likely to have historical heritage items. Areas adjacent to the trackway were also examined if they were largely clear of scrub and safely accessible. A distance of 3.1km was covered and in that time one potential historical site was encountered – AIR22 HAA01.

Day two of the survey aimed to cover the east-west arm. Unlike day 1 there was no clear trackway to follow in this part of the study are and the terrain generally was more challenging. This prevented the full arm from being investigated as no safe route could be found in the time given. The inaccessibility and challenging nature of the terrain makes the presence of intact and identifiable historical items highly unlikely in this area. It would not have been a suitable location for prolonged habitation and would have required substantial engineering and mechanical equipment to be mined. No sites were identified during the survey on day 2.

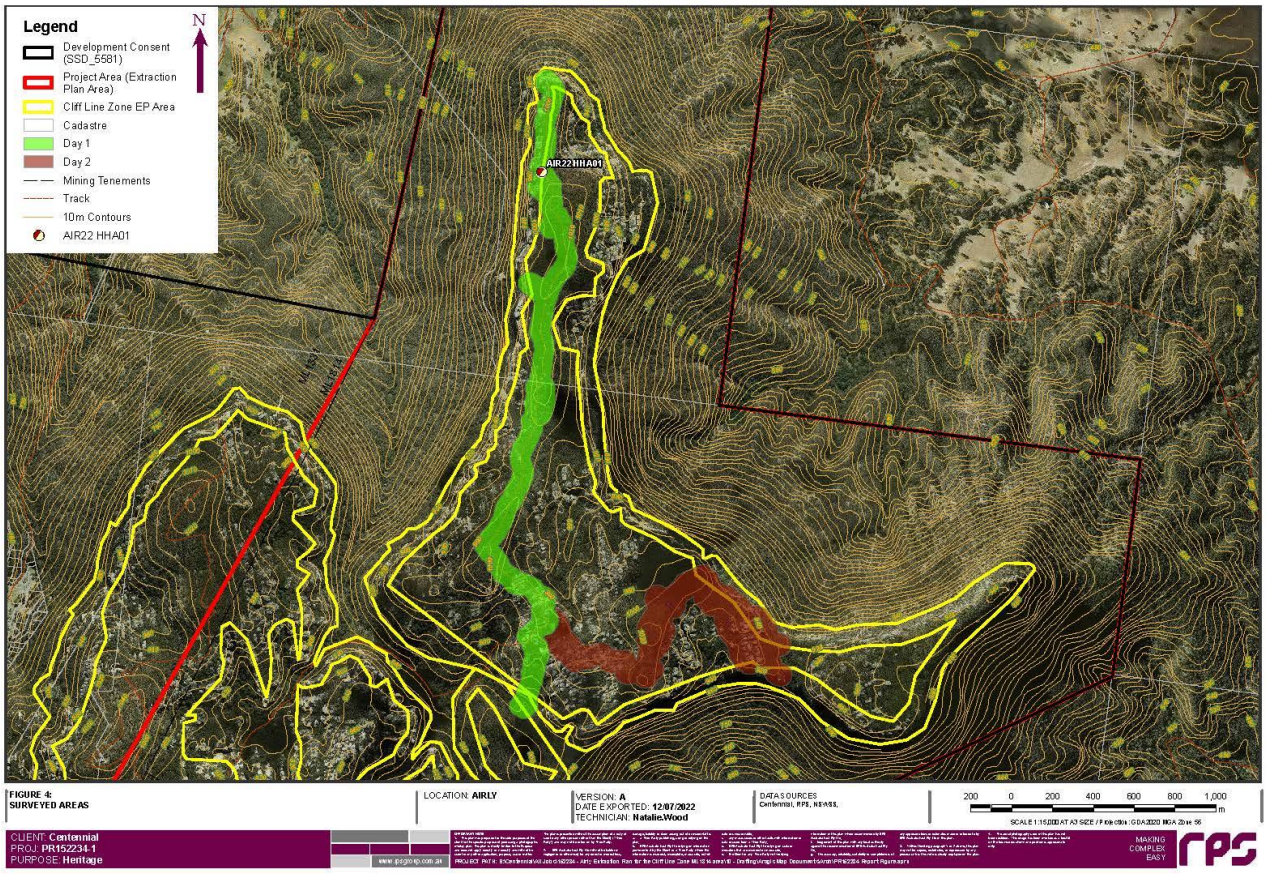


**Figure 5-1: Areas surveyed during day one (green) and day two (brown)**

### 5.3.1 Sites located

One potential historical heritage site was identified:

| **AIR22 HAA01** | |
|---|---|
| **Date** | 21/06/22 |
| **Time:** | 12:12pm |
| **Coordinates** | -33.085644°/ 150.071748° |
| **General location** | On Genowlan Plateau just before the break of slope down towards Genowlan Point in a small clearing. |
| **Description** | Large oval shaped depression orientated approximately north south. 8.5m long, 5.5m wide with shallow gradual sloping sides and a flat base (Figure 5-2, Figure 5-3). At the northern end is a 1.2m long, 5m wide pile of rubble (Figure 5-4). Rubble a mix of orange and grey 250-350mm subangular stones with smaller 25-50mm subangular stones. Similar stones found in smaller quantities cross the depression. No artefacts or objects of any kind found. Area covered in scrubby grass but more cleared than elsewhere. |

| AIR22 HAA01 | |
|---|---|
| **Interpretation** | Possible attempted or abandoned mine shaft site. Based on location and lack of disturbance likely to have been hand dug and so not related to 19th century shale mining. Likely related to diamond mining in 20th century. |
| **Assessment** | No further potential or investigation required. Unlikely to be of significance. |

**Figure 5-2: Shallow oval depression located at AIR22, HAA01, view to the north, scale =2m**

**Figure 5-3: Shallow oval depression located at AIR22, HAA01, view to the south, scale =2m**

**Figure 5-4: Rubble pile at northern end of shallow oval depression located at AIR22, HAA01, view to the north, scale =2m**

# 6 CONCLUSIONS & RECOMMENDATIONS

This Baseline assessment focuses only on historical heritage contained within the MW17-19 Extraction Plan area and the Cliff Line Zone Extraction Plan area in ML1814. The conclusions and recommendations here are applicable to the management of historical heritage in both areas which collectively for the study area.

Assessment of the study area indicated that there was low potential for it to contain locally significant archaeological resources related to historical shale mining in the area. Gap Analysis did not provide an indication of any areas that may contain an archaeological resource of significance but did provide a general overview of what types of archaeological evidence may remain in the study area. Analysis of all statutory and non-statutory lists show that at present there are no listed heritage sites or archaeological areas within the study area, however the study area includes part one item currently under assessment for inclusion on the NHL. Field survey of two areas was undertaken in order to confirm the findings of the Gap Analysis and interrogate the assessment of potential. During this survey one potential historical heritage site was found. This site is likely 20th century and does not relate to shale mining activities and does not meet the threshold of significance on its own merit. Therefore, it does not require further monitoring.

This assessment has undertaken historical research, databases searches, and a field survey and has identified no actual or potential sites of historical heritage that would meet the threshold of significance. As such, the management of historical heritage in the MW17-19 Extraction Plan area and the Cliff Line Zone Extraction Plan area in ML1814 can be undertaken as an extension of the existing management documents. In particular the unexpected finds protocol, contained in Section 6.4 of the existing Wester region HHMP which applies to the entire area.

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Unit 2A, 45 Fitzroy Street
Carrington NSW 2294
T +61 2 4940 4200

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Date: 19 December 2022

Sam Price
Environment and Community Coordinator
319 Glen Davis Road,
Capertee NSW 2846

Dear Sam,

**Desktop review of ML 1814 area and MW17-19 EP Area for Aboriginal Cultural Heritage**

## Background

RPS have been assisting Centennial Coal with the heritage management of the Airly Mine since 2013 and during this time have produced numerous documents regarding Aboriginal and Historical heritage and archaeology. This included the production of an overarching Aboriginal Cultural Heritage Management Plan (ACHMP) for the Western Region, first issued in 2014 and last updated in September 2021.

The purpose of the ACHMP is to provide Centennial with a consistent approach to consultation with the local Aboriginal communities regarding Aboriginal cultural heritage matters as well as identifying consistent minimum standards and processes for Aboriginal cultural heritage identification, monitoring, and management across all of Centennial's western operations.

In 2022 Centennial began planning for an extension to the Airly Mine to incorporate Cliff Line Zone ML1814, and the MW17-19 Extraction Plan. As stated in section 1.3 of the ACHMP, location specific Extraction Plans are required for each mining area under the Mining Act 1992. This desktop review has been written to ascertain what work, if any, will be required to inform the Extraction Plan for the project site and provide a suggested methodology for any potential works.

## Archaeological Context

### Cliff Line Zone ML1814

There is one known Aboriginal site recorded on the AHIMS database within the Cliff Line Zone ML 1814 site. The Western Region ACHMP (RPS 2021) includes an assessment of the cultural and scientific significance of sites. The ACHMP classifies that site within this area is a Rockshelter with Deposit (AHIMS 45-1-0167). It is assessed as having extremely high cultural significance, high local scientific significance, and high regional scientific significance.

### MW17-19 Extraction Plan

There are no AHIMS registered sites within the MW17-19 Extraction Plan area.

As per the monitoring protocols laid out in the ACHMP baseline recording is required for this site prior to any works that may cause an impact.

## Relevant Previous Work

### Airly Mine Extension Project, Cultural Heritage Impact Assessment, 2014

This comprehensive assessment included extensive survey of the entire Airly Mine area which identified 22 new AHIMS sites during the survey component, although none within the either the Cliff Line Zone ML1814 or MW17-19 Extraction Plan area. One previously recorded site was identified within the Cliff Line Zone ML1814 – 45-1-0167.

### AHIMS Site Card 45-1-0167

The AHIMS site card for 45-1-0167 was lodged on the 17th of February 1992. It records the site as:

*Genowlan Creek 1 – Shelter with Archaeological Deposit*

*Location:*

*The shelter is situated on the eastern side of a steeply inclined valley with cliffline on both sides. It is about 500 metres upstream of a junction of Genowlan Creek. Vegetation in the valley is dominated by tree ferns, bracken and tall eucalypts. Above a vehicle track, the shelter is about 30 metres from the Creek above a 30% gradient.*

*Description*

*Facing southwest, this is a large shelter, the main body of the overhang being 41 metres long more than six metres deep and six metres high. The floor is fairly level and most of it is dry. The deposit consists of pale grey and yellow sandy soil with some roof fall. Behind an area of roof fall the deposit appears potentially deep. Part of the drip line is covered in bracken and ferns.*

*Six artefacts were recorded at the northwestern end of the shelter where the deposit appeared to be of restricted depth overlying, rockfall. Here as well as behind the roof fall deposit is <10cm deep.*

### Point Hatteras, Airly Heritage Baseline Assessment, 2021

This desktop baseline assessment included AHIMS 45-1-0167. At the time there was no plan to undermine the site and it was located beyond the 26.5 degree Angle of Draw area. As such there was no predicted impact to the site. Nevertheless, it was recommended that it should be monitored and managed in accordance with the most recent ACHMP. No site recording was undertaken.

## Conclusions

### Cliff Line Zone ML1814

There is one AHIMS sites within the project site which has extremely high cultural significance. As per Section 6.5 of the Western Region ACHMP, the sites should have 3-phase site monitoring prior to the commencement of mining. To date the site has not had Baseline (Phase 1) monitoring. The detail contained in the AHIMS listing should provide sufficient detail for the completion of the site specific EP-ACHMP for the project area.

### MW17-19 Extraction Plan

There are no AHIMS registered sites within the MW17-19 Extraction Plan area. The Aboriginal Cultural Heritage management protocols contained within the Western Region ACHMP are sufficient for this area.

## Recommendations

- Development and production of a new Extraction Plan Aboriginal Cultural Heritage Management Plan (EP-ACHMP) that covers the areas of ML1814.

  - The existing EP-ACHMP is approaching five years old and is specifically tailored to the ML1331 area. It explicitly excludes any other area.

- Undertake Baseline (Phase 1) survey of the AHIMS site prior to the commencement of mining. Representatives of the registered Aboriginal Parties should be invited to participate in the Baseline (Phase 1) recording. RPS advises that:
  - As per the policies of the Western Region ACHMP, baseline (Phase 1) recording must include:
    - Detailed archaeological recording, to be undertaken by a suitably qualified and experienced Heritage Consultant and to include photographs of the site, and observation of the rock morphology.
    - Archival-quality photos to be taken in accordance with Heritage NSW guidelines. A 3D terrestrial scan may be considered.
    - The designation of a minimum of six (6) control points to be established by a suitably qualified surveyor using a total station or better equipment if available, selected in consultation with the heritage consultant. These are to be used for monitoring.

RPS are happy to provide a fee proposal for the above work. Please get in touch should you wish us to do so.

Yours sincerely,
for RPS AAP Consulting Pty Ltd

**Dr Gary P. Marriner**
Senior Heritage Consultant
gary.marriner@rpsgroup.com.au
+61 2 4940 4231

cc: Susan Kennedy, RPS
Anthony Reid, Catalyst Environmental Management