South32 - Illawarra Metallurgical Coal

Review of Dendrobium Longwall 19A Subsidence Management Plan

Risk Assessment Report

AR3536

Revision 2

Monday, 10 October 2022

Assessment and report completed by;
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1. Revisions

Rev No	Date	Description
1	9 September 2022	Initial Release
2	10 October 2022	Updates following document review by Professor Bruce Hebblewhite "Report No. 2209/01.1 - Review of Dendrobium Longwall 19A Subsidence Management Plan Risk Assessment"

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2. Participants

Name	Position	Relevant Years' Experience
Daniel Pygas	Cardno Principal Aquatic Ecology	14 Years
Will Minchin	Watershed HydroGeo Hydrogeologist	16 Years
Kai Whitaker	Niche Environment and Heritage Environmental Approvals	6 Years
Dr Stuart Brown	HydroGeo Principal Hydrogeologist	25 Years
James Barbato	Mine Subsidence Engineering Consultants (MSEC) Subsidence Engineer	16 Years
Hugo Kaag	South32 Principal Geologist	26 Years
Cody Brady	South32 Principal Approvals	7 Years

The following participants were not in attendance at the risk assessment though have reviewed this risk assessment report and provided feedback which has been incorporated. Professor Bruce Hebblewhite was engaged by Illawarra Metallurgical Coal (IMC) to provide a peer review of the document. Professor Hebblewhite reviewed Revision 1 of the document. Revision 2 has been updated to incorporate the feedback of the peer review.

Name	Position	Relevant Years' Experience
Prof. Bruce Hebblewhite	B K Hebblewhite Consulting Peer Reviewer	45+ Years

3. Introduction

IMC carried out a risk assessment for the Dendrobium Longwall 19A Subsidence Management Plan (SMP) application in accordance with the recommendation from the Independent Expert Panel (Panel) that SMP applications consider the potential implications of mining within a risk assessment context, and in particular any implications for water quantity as a result of faulting, basal shear planes and lineaments.

Upon receiving feedback from the Panel regarding risk assessments undertaken to support recent SMP applications, this risk assessment has incorporated the feedback where appropriate.

The risk assessment identifies the existing controls associated with mining operations at Dendrobium. Several recommendations and actions for further controls have been identified through the risk assessment process.

IMC conducts extensive exploration programs, including surface drilling and 2D seismic surveys, to understand in detail the geological environment of the Dendrobium Mine resource. Several exploration and long term monitoring bores are located in the vicinity of Longwall 19A which are a key input into the current interpretation of the geology in and around proposed mining area. In addition to the surface exploration, IMC also conducts extensive underground drilling programs that also assist to characterise and define geological structures. The Longwall 19A Geology Report is a key document underpinning some assumptions and controls which are stated in the risk assessment.

4. System Description

Dendrobium Mine is an underground coal mine which commenced construction in January 2002 following approval from the Minister of the then Department of Urban Affairs and Planning on 20 November 2001. Longwall mining commenced at Dendrobium in April 2005 with Longwall 19 currently being extracted in Area 3A.

The mine is owned and operated by IMC, a wholly owned subsidiary of South32 Ltd. The mine operates on a continuous basis, 24 hours a day and 7 days a week. The mine operates one longwall production panel and development units.

The Panel Report Part 1 (2019) on specific mining activities at Metropolitan and Dendrobium Mines recommended *that "all applications to extract coal within Special Areas should be supported by independently facilitated and robust risk assessments that conform to ISO 31000 (the international standard for risk management subscribed to Australia)"*. The Panel also recommended that the potential implications for water quantity of faulting, bedding plane shears and lineaments need to be very carefully considered and risk assessed at all mining operations in the Special Areas.

The Department of Planning and Environment (DPE) have previously provided correspondence to IMC that the Panel have raised concerns regarding mining operations near or under lineaments in special areas of the catchment of the Southern Coalfield. The Panel stated, "*specific regard to the potential impacts on surface water features, including swamps and waterfalls, of mining near and under lineaments".*

Therefore, this risk assessment has been carried out to identify the existing controls associated with mining operations of Dendrobium's Longwall 19A in Special Areas of the catchment and to make recommendations for further controls where appropriate.

The main consideration is for compliance with the Dendrobium mine Development Consent, however safety, business interruption, community concerns, reputational damage and environmental issues have been considered where relevant.

The assessment uses the "Workplace Risk Assessment and Control" (WRAC) format as it provides for a more detailed description of any perceived hazards and their identified controls. It was considered that this assessment type provides for easier reading by non-technical persons.

4.1 Longwall 19A - Background

IMC has completed the mining of Longwalls 6 to 8 in Area 3A at Dendrobium Mine with Longwall 8 finishing in December 2012, and approval for the mining of Longwall 19. IMC proposes to extract Longwall 19A within the Wongawilli Seam. The longwall will be extracted towards the main headings (i.e. retreat mining from the east towards the west) within the Wongawilli Seam. Longwall 19A will be extracted following the completion of Longwall 19.

The Study Area (Drawing 1234-02 MSEC2022 [Attachment 6]) has been defined, as a minimum, as the surface area enclosed by the: 35° angle of draw line from the extent Longwall 19A; and the predicted incremental 20 mm subsidence contour due to the extraction of the proposed longwall. The natural features located within 600 m of the extent of the longwall mining area have also been included in the assessments, in accordance with Condition 8(d), Schedule 3, of the Development Consent (DA 60-03-2001); and features that are expected to experience either far-field horizontal movements, or valley related effects, and which could be sensitive to these movements. Specialist assessments submitted as part of the Longwall 19A SMP application should be read in conjunction with this risk assessment.

Natural and built features considered in the risk assessment:

- Wongawilli Creek is located west of Longwall 19A. The thalweg (i.e. base or centreline) of Wongawilli Creek is located at a minimum distance of 390 m west of the finishing end of Longwall 19A, at its closest point. Wongawilli Creek is located outside the Study Area based on the 35° angle of draw line and predicted 20 mm subsidence contour. The total length of creek within the Study Area based on the 600 m boundary is approximately 1.1 km. Wongawilli Creek is predicted to experience less than 20 mm vertical subsidence due to the mining of Longwall 19A only.
- The drainage lines located within the Study Area based on the 600 m boundary are SC10, SC10C, WC13(A) and WC14. The upper reaches of WC13(A) and WC14 are partially located above the proposed Longwall 19A and SC10, SC10C and WC14 are partially located above Longwall 19. The drainage lines in the western part of the Study Area flow into Wongawilli Creek and the drainage lines in the eastern part of the Study Area flow into Sandy Creek.
- There are four swamps (Refs. Den15a, Den15b, Den34 and Den148) that have been identified partially or wholly within the Study Area based on the 35° angle of draw line and predicted 20 mm subsidence contour. There are two additional swamps (Refs. Den12 and Den96) that are partly or wholly located within the Study Area based on the 600 m boundary.
- The Cordeaux Reservoir, also known as Lake Cordeaux, is located 1.4 km north-east of the proposed Longwall 19A, at its closest point. The Cordeaux Dam Wall is located more than 5 km north of this longwall. The Upper Cordeaux No. 1 and No. 2 Dams are located more than 3 km south-east of the proposed Longwall 19A.
- The Avon Reservoir, also known as Lake Avon, is located more than 3 km west of the proposed Longwall 19A. The existing longwalls in Area 3B are located between Longwall 19A and the reservoir. The Avon Dam Wall is located more than 5 km north-west of the proposed Longwall 19A. The Avon Reservoir is located more than 3 km from the proposed longwalls.
- Geological features at both inseam and surface levels were considered as part of the risk assessment and are shown on (Drawing MSEC1234-07 MSEC202 [Attachment 6]).

5. Context Summary

5.1 Strategic Context

IMC is committed to ensuring safety and environmental compliance within its operation. When new equipment or processes are implemented, IMC insist that risk assessment techniques are used to reduce the risks to people, equipment, environment and operations.

5.2 Corporate Context

As IMC is committed to safety and environmental compliance, when a change to systems or new equipment or systems are introduced into the operation, management insist that risk assessment techniques are used to identify and minimising exposure to its people and the operations. IMC is also committed to implementing risk assessment techniques to identify risk when required by external sources.

5.3 Risk Management Context

Due to correspondence received from the DPE in relation to advice received from the Panel, the management of IMC have conducted a formal risk assessment to address the concerns of mining in the catchment that may be affected by the extraction of Longwall 19A.

There are a number of considerations during each risk assessment, being personal safety, equipment damage, operational loss, reputation or environmental issues. This assessment specifically addressed the risks associated to legal compliance that may result from the extraction of Longwall 19A.

6. Objectives and Scope

The objective of this risk assessment was to support the Longwall 19A SMP application and to address recommendations raised by the Panel. This risk assessment addressed the risks associated to legal compliance that may result from the extraction of Longwall 19A.

A scoping session was carried out with the assessment team and the following items were agreed to be assessed:

- Groundwater
- Avon and Cordeaux Reservoir
- Wongawilli Creek
- Sandy Creek
- Sandy Creek Waterfall (SC-WF1)
- Swamp Den15A
- Swamps, Tributaries to Wongawilli Creek and Sandy Creek

For each of the items above the following concerns (where relevant) were reviewed and assessed:

- Surface subsidence
- Sub-surface ground movements
- Valley closure and upsidence
- Lineaments
- Faults
- Dykes
- Groundwater drawdown

The presence of the Dendrobium Nepheline Syenite sill was discussed in the scoping section of the Risk Assessment. Given that the sill is not expected to alter the subsidence response it was considered to be outside the scope of the risk assessment with regards to subsidence impacts.

Exploratory drilling operations, including horizontal inseam drilling, have provided detailed data on the extent of the sill, enabling operational plans to account and anticipate the sill within the schedule.

7. Assumptions and Constraints

The following assumptions and limitations were applied to this risk assessment:

- iPick Document Kiosks and the South32 web site are available and provide access to site documentation
- South32 have a team addressing mining approvals and compliance
- Detailed subsidence predictions and other analysis have been developed to understand the potential impact from Longwall 19A
- Reliable subsidence measurement is available and used
- A detailed understanding of prior experience from mining under the catchment areas and the effect on those areas in the Southern Coalfield are well documented and understood
- Extensive monitoring will be conducted both electronically and physically to identify any adverse impact to areas prior, during and after mining activities associated with the current extraction application
- IMC have undertaken several risk assessments of this kind to support SMP applications. A number of investigations and technical studies which were “Treatment Options” of previous risk assessment have now been completed. These studies e.g. SRK 2020, provide valuable information and understanding of the hazards being assessed. Whilst these investigations are not strict controls in themselves, they are included as they inform the hazard and related controls.
- Where studies and reports are listed as existing controls in the analysis worksheets, it is noted that they do not strictly constitute controls. However, the information and assessment included in each report provides relevant information which underpins the understanding of the risk being assessed.

Related and referenced documents include:

- AS NZS ISO 31000-2009: Risk Management - Principles and guidelines
- MDG1010 - Risk Management Handbook for the Mining Industry
- MDG1014 - Guide to Reviewing a Risk Assessment of Mine Equipment and Operations
- *Work Health and Safety Act 2011*
- Work Health and Safety Regulation 2011
- *Work Health and Safety (Mines and Petroleum Sites) Act 2013*
- Work Health and Safety (Mines and Petroleum Sites) Regulation 2014
- Doyle J, 2007. Review of Permeability of Geological Structures in the Dendrobium Area.
- HGEO, 2020. Dendrobium Mine Spatial analysis of mine inflow chemistry, Dendrobium Areas 1, 2 and 3. April 2020. Report D20357.
- HGEO, 2021. Dendrobium Mine Reporting trends in water quality and metal loads in streams. May 2021. Report D21143.
- HGEO, 2020. Dendrobium Mine Spatial analysis of piezometric responses to mining, Dendrobium Area 3A and 3B. December 2020. Report D20373.
- HGEO, 2020. Dendrobium Mine Effects of Longwall 16 extraction on overlying strata and groundwater conditions, Dendrobium Area 3B. November 2020. Report D20374.
- HGEO, 2022. Dendrobium Mine Assessment of surface water flow and quality effects of proposed Dendrobium Longwall 19A. September 2022. Report D22175.
- Independent Expert Panel for Mining in the Catchment (IEPMC), 2019, Independent Expert Panel for Mining in the Catchment Report: Part 1. Coal Mining Impacts in the Special Areas of the Greater Sydney Water Catchment, Prepared for the NSW Department of Planning, Industry and Environment
- B K Hebblewhite Consulting, 2020. Dendrobium Mine – Longwalls 14-18 Independent Review – Height of Fracturing (Stage 4). File Name: 2010/01.1. 5 November. November 2020.
- Letter from Department of Planning and Environment titled: Independent Expert Panel for Mining in the Catchment, Advice Regarding Lineaments
  File Name: 20190219_ltr to South32 Re: lineaments.
- Letter form Emeritus Professor Jim Galvin titled Re: IEPMC advice to Department of Planning and Environment Emerging knowledge regarding lineaments. File Name: IEPMC advice to DPE re-emerging knowledge lineaments.
- Mine Subsidence Engineering Consulting, 2022. Subsidence Predictions and Impact Assessments for the Natural and Built Features due to the Extraction of the Proposed Longwall 19A in Area 3A at Dendrobium Mine. Report No. MSEC1234, Rev A. dated 10 June 2022.
- SCT, 2020. Review of HGEO Report D19341: Investigation Into the Height of Fracturing above extracted longwalls in Area 3, Dendrobium. DEN4968A.
- SRK Consulting, 2020. Geological Structure Comparison Investigation. STH055.
- Tonkin, C., & Timms, W. 2015). Geological Structures and Fault infill in the Southern Coalfields and Implications for Groundwater Flow. Journal of Research Projects Review, 4, 49 - 58.
- Watershed HydroGeo, 2019. Dendrobium Area 3B Discussion of Surface Water Flow TARPs. December 2019.
- Watershed HydroGeo, 2021. Avon Reservoir catchment - catchment and reservoir water balance. January 2021. Report R012i4.
- Watershed HydroGeo, 2022. Dendrobium Area 3A: Longwall 19A Groundwater Assessment. September 2022.
- IMC Technical Services, 2022. Geology of Longwall 19A. March 2022

8. Risk Treatment

The group was introduced to the risk assessment process at the commencement of the session by the facilitator. The various steps were explained, and the group reviewed the likelihood, consequence and risk ranking matrix.

The risk ranking was undertaken with consideration to existing controls being in place.

Risk ranking was undertaken by the risk assessment team with consideration to the consequence of an event occurring and the likelihood of that hazard (event) occurring that leads to the level of consequence identified. The consequence ranking may be one of six identified types i.e. Health and Safety, Natural Environment, Community, Reputation, Legal and Financial. The scales for these consequences are shown in Section 13 "Risk Rank Method".

It is noted that different types of consequences may/will have a different likelihood of occurrence, this equates to a different risk ranking being realised. For example, the 'Natural Environment' consequence of an event occurring may be low but with a high likelihood. However, a 'Legal' consequence of an event occurring may be high, but with a low likelihood. For any event, the combination of consequence and likelihood which results in the highest risk is documented.

During this assessment the group considered, as far as practicable, all consequences shown in Section 13, however, to reduce the complexity and volume of reporting, only the worst case 'risk ranking' for each hazard is documented in the risk assessment. Using this process some consequences that are high may have an overall low 'risk rank' because the probability of the event (leading to the consequence level identified) is very low, whereby a consequence may have a high 'risk rank' because the probability of the event (leading to the consequence level identified) is higher.

Controls were developed using the following forms:

- Avoidance – avoid the risk by deciding not to proceed with the activity likely to generate the risk (where this is practicable).
- Reduction – reduce the likelihood of the event.
- Reduction – reduce the consequences of the event.
- Accept – accept the risk within the organisation and establish an appropriate plan to manage the consequences of these risk if they are to occur.

The above risk control options were applied by reference to the following control methodologies in a hierarchical sequence.

- Design – to the extent reasonable and practicable ensure that hazards are designed out of the proposal.
- Remove the hazard or substitute a less hazardous proposal.
- Adopt a safer process – alter the process, equipment or work practices.
- Enclose or isolate the hazard – provide barriers or other techniques.
- Establish appropriate administrative procedures. Set up, document and implement new procedures that provide for:
    - Scheduling of the proposal to reduce exposure.
    - Routine maintenance and housekeeping procedures
    - Training on hazards associated with the proposal.
- Mitigate, rehabilitate or provide offsets for impacts from the proposal.

9. Facilitator

Shane Chiddy holds an Associate Diploma in Engineering (Electrical), is an Officer of the Institution of Engineers (Australia) and is a member of the Asset Management Council of Australia (AMC) and the Mining Electrical and Mining Mechanical Engineering Society (MEMMES). He has also completed Contract Law through Macquarie University, G2 and Establish the Risk Management Systems (Mine 7033 - G3) through Queensland University and is certified as a Functional Safety Engineer by TÜV Rheinland for both Safety Instrumented Systems and Machine Safety.

Prior to commencing his consulting career, Shane Chiddy qualified as an electrician and worked underground for 15 years. He then occupied a number of engineering roles within Rio Tinto, including such roles as electrical supervisor, development engineer and senior production engineer. This latest role was responsible for the longwall, underground diesel equipment and conveyors.

Additionally, Shane Chiddy has been trained and accredited by John Moubray in the UK as a certified RCM II practitioner, and has conducted a number of extensive Reliability-centred Maintenance II analyses including underground and surface equipment such as longwalls, continuous miners and conveying systems. He has facilitated RCM II analysis and delivered training in the mining, defence and telecommunications industries.

His consulting experience includes the application of Reliability-centred Maintenance II and extensive risk management and project management assignments.

10. Sub-Systems Considered in the Assessment

Sub-System		STEP IN PROCESS	
1	Review Dendrobium Longwall 19A Subsidence Management Plan	A	Groundwater
		B	Avon and Cordeaux Reservoir
		C	Wongawilli Creek
		D	Sandy Creek
		E	Sandy Creek Waterfall (SC-WF1)
		F	Swamp Den15A
		G	Swamps, Tributaries to Wongawilli Creek and Sandy Creek

11. Risk Assessment Methodology

11.1 Qualitative Risk Analysis

This risk assessment has been performed using Qualitative Risk Analysis techniques and has been performed to align with the principles of the Australian Standard AS31000 - Risk Management Principles and Guidelines and the Department of Mineral Resource Guideline MDG1010.

The risk assessment has followed the WRAC (Workplace Risk Assessment and Control) principles as outlined in the guideline.

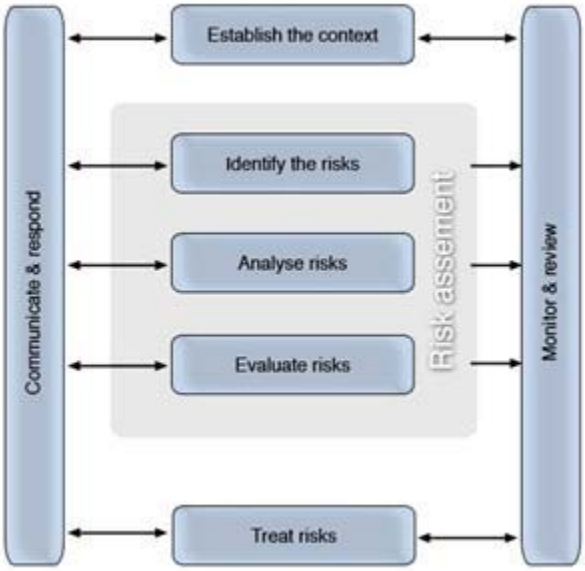
The qualitative approach succeeds by using local expert knowledge and relevant historical data.

This system of analysis uses a participative approach which is very powerful for identifying potential hazard scenarios.

The following steps outline the systematic identification of hazards, ranking of risks, and identification of new and/or improved controls that were used in the risk assessment session:

1. Introduce team to the risk assessment process and the context of the risk assessment. This includes the scope and method of the risk assessment
2. Identify discrete components, or elements, of the Project
3. Identify and add potential deviation steps
4. Review each sub-system and identify loss scenarios - (Potential Incidents and Accidents)
5. For those hazards evaluate the risk using the risk rank method by determining the probability, consequence, and risk rank of each loss scenario
6. Identify existing controls for each hazard
7. Specify additional controls required to control the hazard(s)
8. Close the risk assessment
9. Document and distribute to the team for proof reading
10. Undertake verification of the assessment by a nominated person

The available Standards on Risk Management (including MDG1010) define the Risk Management process as that shown below.



11.2 Establish the Context

This risk analysis has been performed using Qualitative Risk Analysis techniques and is performed in compliance with the Department of Mineral Resources (now the Resources Regulator) Guideline MDG1010.

11.3 Identify Hazards

This step involves identification of all the hazards to be managed. To correctly apply this step a well-structured systematic process must be used, because controls may not be able to be implemented to reduce or eliminate any hazards missed at this point in the analysis.

For each hazard, the team identifies:

1. What Can Happen; and
2. How and Why it Can Happen

Checklists, Flowcharts and Brainstorming are used to identify hazards.

11.4 Analyse Risks

The main objective of an analysis is to separate minor risks from major risks and to provide data to assist in the evaluation and treatment of hazards.

Risk Analysis involves considering the following:

1. Likelihood of the hazard occurring (identified as 'L' within the worksheets)
2. Consequences if the hazard does occur (identified as 'C' in the worksheets)
3. Determining any existing controls

The combination of the likelihood and the consequence determines the level of the risk involved. The likelihood and consequence categories used are outlined in Section 13.

During the assessment the consequences are categorised as either hazards to personnel, the environment or to the site operations. Reputation, legal compliance and community are also considered where appropriate.

The consequence category is identified on the Analysis Worksheets in the Column labelled 'T' for Type.

11.5 Evaluate Risks

Evaluation involves comparing the level of risk found during the analysis with previously established risk criteria. The output of this part of the process is a list of prioritised hazards for further action.

If the resulting hazards fall into the low or tolerable risk categories, they may be accepted with minimal further treatment. Although, low and tolerable hazards should be monitored and periodically reviewed to ensure that they remain tolerable.

If hazards do not fall into the low or tolerable risk category, then they should be treated using other options.

11.6 Treat Risks

Risk treatment involves identifying the range of options for treating risks, assessing the options and preparing risk treatment plans and implementing them.

Risk treatment may be in one of the following forms:

1. Risk avoidance. Decide not to proceed with the activity
2. Reduce likelihood. Reduce the chance of the risk occurring
3. Reduce the risk consequences. Reduce the consequence if the risk occurs
4. Retain (or accept) the risk. Plans should be put in place to mitigate the consequences of these risks in the event that they occur

Risk treatment options are assessed on the extent of any additional benefits or opportunities created. A number of options may be considered and applied either individually or in a combination.

Risk treatment plans are developed to identify responsibilities, schedules, budgets and performance measures and the review process that is to be established.

11.7 Monitor and Review

It is essential to monitor the effectiveness of the risk management system and the risk treatment implementation.

Risks and the effectiveness of control measures need to be monitored to ensure that the changing environments do not alter risk priorities. Few risks remain static.

Factors affecting likelihood and/or consequence change as do factors regarding suitability of controls.

11.8 Communications and Consultation

Communication and consultation are important during the entire risk management process. It is important to develop a communication plan for both internal and external stakeholders.

This should be a two-way consultation not a one-way flow of information.

Effectiveness of internal and external communications is important to ensure that those responsible for implementing risk management understand the basis on which all decisions have been made, and why particular actions are required.

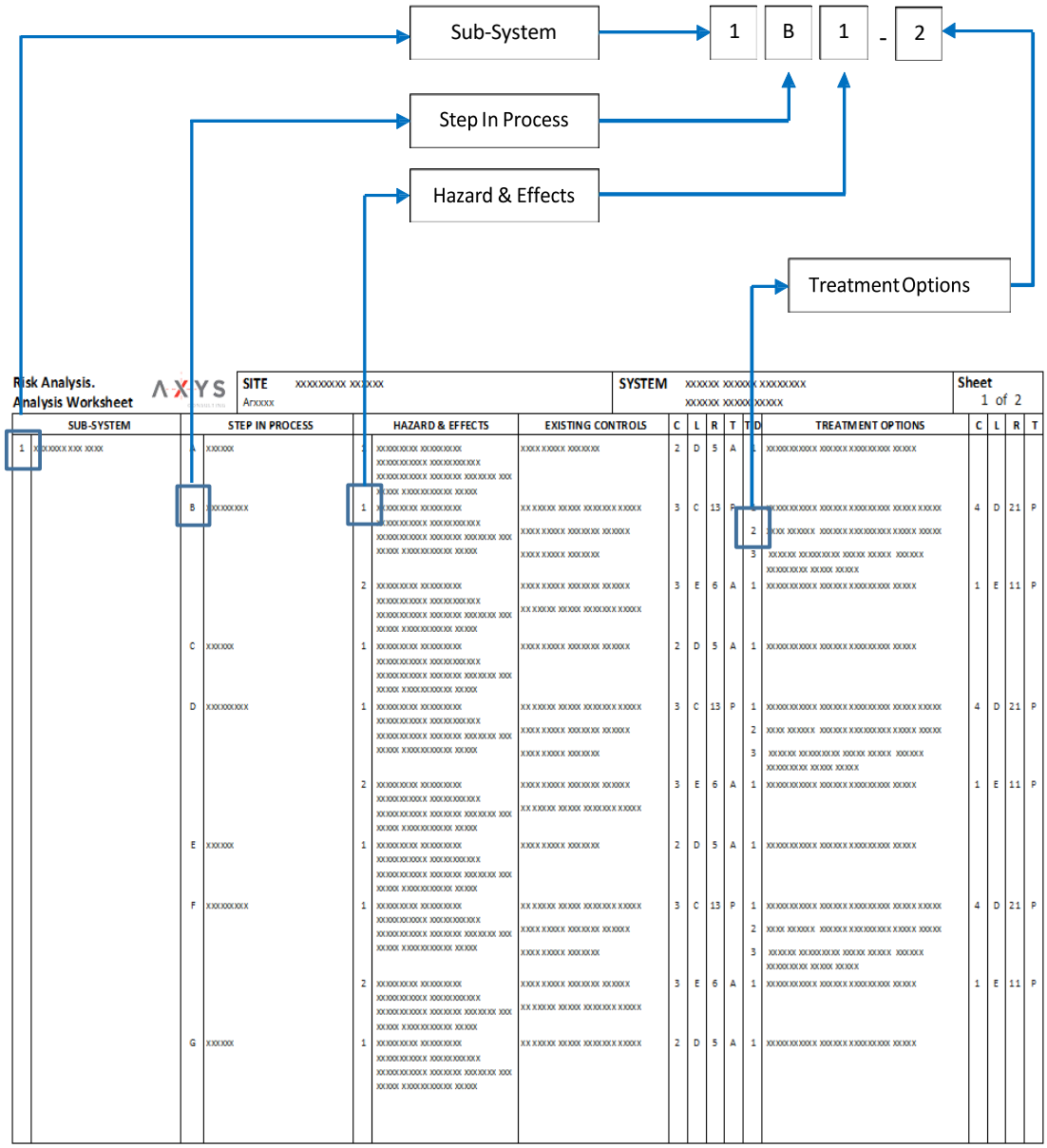
12. Risk Assessment Numbering

The assessment uses an alphanumeric numbering system to differentiate each component, the step in the process, the hazard and the treatment options.

The sub system number is found in the first column of the worksheets, the step is identified as a letter and is found in the third column, the hazard number in the fifth column and the treatment options in the TID (Treatment ID) column.

Using this method each hazard and treatment option throughout the analysis has a distinct identifier. This identifier then flows through all of the worksheets and can be referenced back to the Analysis Worksheets.

The example below shows the distinct identifier for the hazard is 1B1, the treatment option identified below would be identified as 1B1-2.



13. Risk Rank Method

For each event, the Likelihood and Consequence is determined and selected. If an event affects more than one area of consequence (e.g. affects people and operations), the highest rank number is always selected.

Risk Matrix							
Likelihood		Consequence					
		Low 1	Minor 3	Moderate 10	Significant 30	Major 100	Catastrophic 300
10 Almost Certain	Could be expected to occur more than once during the study or project. Could occur once per year.	10	30	100	300	1000	3000
3 Likely	Could easily be incurred and has generally occurred in similar studies or projects Could be incurred 1 - 2 Years	3	9	30	90	300	900
1 Possible	Incurred in a minority of similar studies or projects. Could be incurred within a 5-year strategic budget period	1	3	10	30	100	300
0.3 Unlikely	Known to happen, but only rarely. Could be incurred within a 5 -20-year time frame	0.3	0.9	3	9	30	90
0.1 Rare	Has not occurred in similar studies or projects, but could Could be incurred 20 – 50 years	0.1	0.3	1	3	10	30
0,03 Very Rare	Conceivable, but only in extreme circumstances. Has not happened in industry in the last 50 years	0.03	0.09	0.3	0.9	3	9

Area of Effect	Estimated Level of Consequence					
	1	3	10	30	100	300
Harm to People (P)	Low level short term subjective symptoms or inconvenience. No medical treatment	Objective but reversible impairment. Medical treatment injury or illness	Permanent impairment <30% of body to one or more persons	Single fatality. Permanent impairment >30% of body to one or more persons	2-20 fatalities Permanent impairment >3-% of body more than 10 persons	>20 fatalities. Permanent impairment >30% of body to more than 100 persons
Environmental (E)	Low level impact to land, biodiversity, ecosystem services, water resources or air	Minor Impacts (<3 months) to land, biodiversity, ecosystem services, water resources or air	Moderate impacts. (<1 year) to land, biodiversity, ecosystem services, water resources or air	Major impacts (<5 years) to land, biodiversity, ecosystem services, water resources or air	Serious or extensive impacts (<20 years) to land, biodiversity, ecosystem services, water resources or air	Severe impacts (>20 years) to land, biodiversity, ecosystem services, water resources or air
Community (C)	Single low-level community health, safety or security impact, low level inconvenience <2 weeks, minor, low level disturbance to a single house or structure.	Minor community health, safety or security impacts (<10 households) or human rights infringements, inconvenience to livelihoods <6 months, moderate damage to <50 houses or community infrastructure	Moderate community health, safety or security impacts (<50 households). Single allegation of human rights violations, moderate disruption to people's lives (<50 households)	Serious community health, safety or security impacts (<50 households). Multiple allegations of human rights violations, extended disruption to people's lives (>50 households)	Serious community health, safety or security impacts (>50 households) or human rights violation, extended disruption to people's lives (>200 households)	Extensive community health, safety or security impacts (>200 households) or human rights violations, extended serious disruption to people's lives (>1000 households)
Reputation (R)	Public concern restricted to local complaints. Low level interest from local media and/or regulator	Adverse local public or media attention and complaints. Heightened scrutiny from regulator. Asset reputation is adversely affected with a small number of people	Attention from regional media and/or heightened concern by local community. Criticism by community, NGOs or activists. Asset reputation adversely affected.	Adverse national media attention. General public and NGO adverse reaction with interest from regulators with no material outcome. Structured campaigning from employees.	Serious national and international negative media attention. General public and NGO adverse reaction with interest from regulators (<3 months). Structured campaigning from employees.	Crisis event or publication of confidential material information resulting in international media, government, regulator, NGO campaigning and employee condemnation of the company (<6 months)
Legal (L)	Low level legal issue	Minor legal issues and non- compliance with commitments	Breach of regulation. Lack of valid exploration title	Significant civil litigation	Prosecutions for criminal breaches resulting in gaol terms for employees or agents or defendant to major civil litigation	Lack of valid operating title, forced closure of an operation, competition, anti-corruption, international trade law or tax breach
Financial (F)	<US$500,000	US$5,000,000 to >US$500,000	US$25,000,000 to >US$5,000,000	US$100,000,000 to >US$25,000,000	US$250,000,000 to >US$100,000,000	>$250,000,000

Attachment 1

Analysis Worksheets

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	A	Groundwater	1	Surface subsidence and sub-surface ground movements result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy and associated Minimal Harm Criteria) on groundwater quantity	Groundwater Licence with sufficient Groundwater allocation Ground and Surface Water Monitoring (Piezometers, Mine water balance and water chemistry) data is analysed in independent studies, results inform surface and groundwater models and analysis. These models are used to ensure compliance with approval conditions and to demonstrate compliance. Mine Design set back from Wongawilli Creek, Sandy Creek and water supply reservoirs Mine Design limiting extraction height to 3.9 metres Calibrated subsidence model is used to design mine setbacks from Wongawilli Creek to limit groundwater impacts/interactions. Subsidence monitoring data is analysed and interrogated against predictions to verify modelling and inform the model. Height of Fracturing Investigation (HGEO 2021 and Hebblewhite Report 2020)	10	0.3	3	L	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals. If impacts occur in excess of development consent conditions, conduct widescale review of future mining plans for all of Dendrobium Area 3.

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	A	Groundwater	2	Lineaments result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	Lineaments are mapped and recorded Lineaments are assessed for correlation with know geological conditions Surface Mapping around lineaments to understand if there is an associated geological feature Drilling on both surface and underground targeting known and inferred geology completed and ongoing The IEP Part 1 Report has been reviewed with the key recommendations of Sectior 3.6 [Recommendations 1 and 3] implemented to determine mine design constraints to achieve compliance with consent conditions Groundwater Licence with sufficient Groundwater allocation Ground and Surface Water Monitoring (Piezometers, Mine water balance and water chemistry) data is analysed in independent studies, results inform surface and groundwater models and analysis. These models are used to ensure compliance with approval conditions and to demonstrate compliance. Mine Design limiting extraction height to 3.9 metres Calibrated subsidence model is used to design mine setbacks from Wongawilli Creek to limit groundwater impacts/interactions. Subsidence monitoring data is analysed and interrogated against predictions to verify modelling and inform the model. Measured subsidence has been reviewed in locations of mapped lineaments and other geological structures (MSEC Report MSEC1034 - 2019 and SRK Report STH055 - 2020) No correlation has been found between mine inflow chemistry and lineaments (HGEO Report D20357 2020) No correlation between piezometers response and lineaments has been observed (HGEO Report D20373 2020)	10	0.3	3	L	1 2 3	Review Reporting of Geological Features relevant to Longwall 19A to determine if further investigatory actions such as inseam and or surface drilling are required to define geological features Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals. If impacts occur in excess of development consent conditions, conduct widescale review of future mining plans for all of Dendrobium Area 3. In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
						Report regarding impacts of surface subsidence associated with lineaments. Outcomes have been included in the knowledge base to support subsidence modelling and assessments. (SRK STH055 2020)						
1		A		3	Faults and Dykes result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	Faults and Dykes are mapped and recorded Surface geological mapping around Faults and Dykes Drilling on both surface and underground targeting known and inferred geology completed and ongoing Extensive exploration program undertaken to identify location of Faults and Dykes Review of Permeability of Geological Structures in the Dendrobium Area J DOYLE 2007 Tonkin, C., & Timms, W. (2015). Geological Structures and Fault-infill in the Southern Coalfields and Implications for Groundwater Flow. Journal of Research Projects Review, 4, 49 -58. No correlation between piezometers response and lineaments has been observed (HGEO Report D20373 2020) No correlation has been found between mine inflow chemistry and lineaments (HGEO Report D20357 2020)	10	0.3	3	L	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals. If impacts occur in excess of development consent conditions, conduct widescale review of future mining plans for all of Dendrobium Area 3.
											2	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	A	Groundwater	4	Shear planes (including basal shear planes) transmits groundwater in excess of Development Consent Conditions (no more than negligible impacts as defined by the regional groundwater model) and/or Dams Safety NSW conditions (policy of no more than 1ML per day cumulative leakage from Cordeaux and Avon Reservoirs) in addition to Groundwater Licence, Aquifer Interference Policy and minimal harm criteria.	Shear planes (including basal shear planes) have been extensively drilled and characterised (including extent, depth and permeability) (SCT Reports 2015-2019) Mining is located more than 1500 metres from Cordeaux Reservoir and 3000 metres from Avon Reservoir Extensive geological and hydrogeological testing of surface boreholes through the basal shear horizons including lithology, defect logging, geophysical logging, Lugeon testing and geotechnical analysis The IEP Part 1 Report has been reviewed with the key recommendations of Sectior 3.6 [Recommendation 1] implemented to determine mine design constraints to achieve compliance with consent conditions Groundwater licence with sufficient groundwater allocation Ground and surface water monitoring (e.g. piezometers, mine water balance and water chemistry) data are analysed ir independent studies, results inform surface and groundwater models and analysis. These models are used to ensure compliance with approval conditions and to demonstrate compliance.	10	0.3	3	L	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals. If impacts occur in excess of development consent conditions, conduct widescale review of future mining plans for all of Dendrobium Area 3.

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	B	Avon and Cordeaux Reservoir	1	Surface subsidence and sub-surface ground movements result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy and associated Minimal Harm Criteria) on groundwater quantity	Groundwater Licence with sufficient Groundwater allocation Ground and Surface Water Monitoring (Piezometers, Mine water balance and water chemistry) data is analysed in independent studies, results inform surface and groundwater models and analysis. These models are used to ensure compliance with approval conditions and to demonstrate compliance. Mining is located more than 1500 metres from Cordeaux Reservoir and 3000 metres from Avon Reservoir Mine Design limiting extraction height to 3.9 metres Height of Fracturing Investigation (HGEO 2021 and Hebblewhite Report 2020) Discussion paper on "Catchment Water Budget and Processes" completed (Watershed Hydrogeo Report R012i4 - 2021)	10	0.3	3	L	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals. If impacts occur in excess of development consent conditions, conduct widescale review of future mining plans for all of Dendrobium Area 3.

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	B	Avon and Cordeaux Reservoir	2	Valley Closure (including basal shear) results in impacts in excess of development consent conditions on water quantity	Subsidence Monitoring - (Closure Lines, Vertical Subsidence, 3D Far-Field, ALS, Visual Inspection) data is analysed in independent studies, results inform the calibrated subsidence model and mine planning decisions Longwall Panel is a minimum of 1500 metres from Cordeaux Reservoir full supply level Longwall Panel is greater than 3000 metres from Avon Reservoir full supply level Longwall Panel is outside the Dams Safety NSW notification areas for Cordeaux and Avon Reservoirs Ground and Surface Water Monitoring (piezometers, mine water balance and water chemistry) data is analysed in independent studies, results inform surface and groundwater models and analysis. These models are used to ensure compliance with approval conditions and to demonstrate compliance. Groundwater models are informed by recent and ongoing investigations into changes to permeability (including basal shear) along the Avon Reservoir shoreline in order to assess possible reduction in quantity of surface water available for water supply. Height of Fracturing Investigation (HGEO 2021 and Hebblewhite Report 2020)	30	0.03	0.9	F	1	None Identified

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	B	Avon and Cordeaux Reservoir	3	Lineaments result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	Lineaments are mapped and recorded Lineaments are assessed for correlation with know geological conditions Surface Mapping around lineaments to understand if there is an associated geological feature Drilling on both surface and underground targeting known and inferred geology completed and ongoing The IEP Part 1 Report has been reviewed with the key recommendations of Sectior 3.6 [Recommendations 1 and 3] implemented to determine mine design constraints to achieve compliance with consent conditions Groundwater Licence with sufficient Groundwater allocation Ground and Surface Water Monitoring (piezometers, mine water balance and water chemistry) data is analysed in independent studies, results inform surface and groundwater models and analysis. These models are used to ensure compliance with approval conditions and to demonstrate compliance. Mine Design limiting extraction height to 3.9 metres Measured subsidence has been reviewed in locations of mapped lineaments and other geological structures (MSEC Report MSEC1034 - 2019 and SRK Report STH055 - 2020) No correlation has been found between mine inflow chemistry and lineaments (HGEO Report D20357 2020) No correlation between piezometers response and lineaments has been observed (HGEO Report D20373 2020) Report regarding impacts of surface subsidence associated with lineaments. Outcomes have been included in the knowledge base to support subsidence modelling and assessments. (SRK STH055 2020)	10	0.3	3	L	1 2 3	Review Reporting of Geological Features relevant to Longwall 19A to determine if further investigatory actions such as inseam and or surface drilling are required to define geological features Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals. If impacts occur in excess of development consent conditions, conduct widescale review of future mining plans for all of Dendrobium Area 3. In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	B	Avon and Cordeaux Reservoir	4	Faults and Dykes result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	Extensive exploration program undertaken to identify location and characteristics of Faults, Dykes and Intrusions Underground Faults, Dykes and Intrusions are mapped and recorded Surface geological mapping around Faults, Dykes and Intrusions Targeted geological drilling from the surface and underground Investigation and Reporting of Geological Features Review of Permeability of Geological Structures in the Dendrobium Area J DOYLE 2007 Tonkin, C., & Timms, W. (2015). Geological Structures and Fault-infill in the Southern Coalfields and Implications for Groundwater Flow. Journal of Research Projects Review, 4, 49 -58.	30	0.03	0.9	B	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1		B		5	Groundwater drawdown results in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	Longwall Panel is a minimum of 1500 metres from Cordeaux Reservoir full supply level Longwall Panel is greater than 3000 metres from Avon Reservoir full supply level Longwall Panel is outside the Dams Safety NSW notification areas for Cordeaux and Avon Reservoirs Ground and Surface Water Monitoring (piezometers, mine water balance and water chemistry) data is analysed in independent studies, results inform surface and groundwater models. These models are used to design mining parameters to ensure compliance with approval conditions and to demonstrate compliance. Regional and site specific Dendrobium Groundwater models are informed by recent and ongoing investigations into changes to permeability (including basal shear) along the Avon Reservoir shoreline in order to assess possible reduction in quantity of surface water available for water supply.	30	0.03	0.9	F	1	None Identified

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	C	Wongawilli Creek	1	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	Longwall panels setback from Wongawilli Creek considering cumulative movements from Areas 3A and 3B Calibrated subsidence model is used to assess longwall setback options from Wongawilli Creek to achieve performance measures. Subsidence monitoring data is analysed and interrogated against predictions to verify modelling. Ground and Surface Water Monitoring (piezometers, mine water balance and water chemistry) data is analysed in independent studies, results inform surface and groundwater models. These models are used to design mining parameters to ensure compliance with approval conditions and to demonstrate compliance. Environmental Monitoring including visual inspections and aquatic ecology monitoring Experience with mining next to Wongawilli Creek for Longwall Area 3A and 3B. Impact levels from these activities influence setbacks. Impacts to date have been in-line with modelling Subsidence Management Plan - including End of Panel reporting and auditing against performance measures Revised WIMMCP including surface water flow TARPS for Wongawilli Creek (Watershed Hydrogeo 2019) (IMC 2022)	30	1	30	F	1	Submit the Subsidence Management Plan for Longwall 19A

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	C	Wongawilli Creek	2	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	Lineaments, faults, dykes and intrusions are mapped and recorded Lineaments are assessed for correlation with known geological conditions Surface mapping around lineaments to understand if there is a geological feature associated Targeted exploration drilling on both surface and underground Subsidence Management Plan - including end of panel reporting and auditing against performance measures Calibrated subsidence model is used to design mine setbacks from Wongawilli Creek. Subsidence Monitoring - (Closure Lines, Vertical Subsidence, 3D Far-Field, ALS, Visual Inspection) data is analysed in independent studies, results inform the calibrated subsidence model and mine planning decisions Review of Permeability of Geological Structures in the Dendrobium Area J DOYLE 2007	30	0.1	3	F	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1		C		3	Groundwater drawdown result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	Longwall panels setback from Wongawilli Creek considering cumulative movements from Areas 3A and 3B Ground and Surface Water Monitoring (piezometers, mine water balance and water chemistry) data is analysed in independent studies, results inform surface and groundwater models. These models are used to design mining parameters to ensure compliance with approval conditions and to demonstrate compliance. Revised surface water flow TARPS (Watershed Hydrogeo 2019) (IMC 2020) have been developed in consultation with DPIE and WaterNSW using the findings of the Wongawilli Creek Pool 50 Assessment to assess mining related changes in flow conditions along Wongawilli Creek Subsidence Management Plan - including end of panel reporting and auditing against performance measures	10	1	10	F	1	None Identified

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	D	Sandy Creek	1	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Sandy Creek (including no more than minor environmental consequences)	Longwall 19A is setback from Sandy Creel by 1200 metres Ground and Surface Water Monitoring (piezometers, mine water balance and water chemistry) data is analysed in independent studies, results inform surface and groundwater models. These models are used to design mining parameters to ensure compliance with approval conditions and to demonstrate compliance. Environmental Monitoring including visual inspections and aquatic ecology monitoring Experience with mining next to Sandy Creek for Longwalls 6 to 8 which informs future monitoring and TARPs Subsidence Management Plan - including end of panel reporting and auditing against performance measures	30	0.1	3	B	1	Submit the Subsidence Management Plan for Longwall 19A
1		D		2	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Sandy Creek (including no more than minor environmental consequences)	Longwall 19A is setback from Sandy Creel by 1200 metres Lineaments are mapped and recorded Lineaments are assessed for correlation with known geological conditions Surface mapping around lineaments to understand if there is a geological feature associated Targeted exploration drilling on both surface and underground Subsidence Management Plan - including end of panel reporting and auditing against performance measures Subsidence Monitoring - (Closure Lines, Vertical Subsidence, 3D Far-Field, ALS, Visual Inspection) data is analysed in independent studies, results inform the calibrated subsidence model and mine planning decisions Review of Permeability of Geological Structures in the Dendrobium Area J DOYLE 2007	30	0.03	0.9	F	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	D	Sandy Creek	3	Groundwater drawdown result in impacts in excess of development consent conditions for Sandy Creek (including no more than minor environmental consequences)	Longwall 19A is setback from Sandy Creel by 1200 metres Ground and Surface Water Monitoring (piezometers, mine water balance and water chemistry) data is analysed in independent studies, results inform surface and groundwater models. These models are used to design mining parameters to ensure compliance with approval conditions and to demonstrate compliance. Subsidence Management Plan - including end of panel reporting and auditing against performance measures	30	0.3	10	F	1	None Identified
1		E	Sandy Creek Waterfall (SC-WF1)	1	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Sandy Creek Waterfall (SC-WF1)	Longwall 19A is setback from Sandy Creel Waterfall by 1400 metres Surface Water Monitoring data is analysed in independent studies, results inform surface data analysis and TARPs. These are used to ensure compliance with approval conditions and to demonstrate compliance. Environmental Monitoring - (Visual Inspection) Experience with mining next to Sandy Creek Waterfall for Longwalls 6 to 8 and 19 Subsidence Management Plan - including end of panel reporting and auditing against performance measures Closure Monitoring including high resolution closure lines data is reviewed and assessed against the TARP and consent conditions	30	0.1	3	B	1	Review the Sandy Creek Waterfall TARP for Longwall 19A

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	E	Sandy Creek Waterfall (SC-WF1)	2	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Sandy Creek Waterfall (SC-WF1)	Longwall 19A is setback from Sandy Creel Waterfall by 1400 metres Lineaments, faults, dykes and intrusions are mapped and recorded Lineaments are assessed for correlation with known geological conditions Surface mapping around lineaments to understand if there is a geological feature associated Targeted exploration drilling on both surface and underground Subsidence Management Plan - including end of panel reporting and auditing against performance measures Subsidence Monitoring - (Closure Lines, Vertical Subsidence, 3D Far-Field, ALS, Visual Inspection) data is analysed in independent studies, results inform the calibrated subsidence model and mine planning decisions No identified geological structures coincident with the Sandy Creek Waterfal (SC-WF1) Experience with mining next to Sandy Creek Waterfall for Longwalls 6 to 8 and 19	30	0.03	0.9	F	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1		F	Swamp Den15A	1	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to changes in swamp hydrology) Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	Ground and Surface Water Monitoring, including Piezometers and Soil Moisture Probes. Data is analysed in independent studies and reported as part of TARP and end of panel process to assess impacts. Environmental Monitoring including terrestrial and aquatic ecology monitoring programs - (LiDAR or other methods for the mapping of swamp boundaries, floristic monitoring of swamps) Longwall 19A is setback from Swamp Den15A by approximately 60 metres	10	1	10	F	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	F	Swamp Den15A	2	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to swamp scour and erosion) Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	Ground and Surface Water Monitoring, including Piezometers and Soil Moisture Probes. Data is analysed in independent studies and reported as part of TARP and end of panel process to assess impacts. Environmental Monitoring including terrestrial and aquatic ecology monitoring programs - (LiDAR or other methods for the mapping of swamp boundaries, floristic monitoring of swamps) Longwall 19A is setback from Swamp Den15A by approximately 60 metres	10	0.03	0.3	L	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp
1		F		3	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to changes in ecosystem functionality i.e. changes in species richness and composition). Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	Ground and Surface Water Monitoring, including Piezometers and Soil Moisture Probes. Data is analysed in independent studies and reported as part of TARP and end of panel process to assess impacts. Environmental Monitoring including terrestrial and aquatic ecology monitoring programs - (LiDAR or other methods for the mapping of swamp boundaries, floristic monitoring of swamps) Longwall 19A is setback from Swamp Den15A by approximately 60 metres	300	0.03	9	E	1 2	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp Complete annual review of the Dendrobium Areas 3A and 3B - Terrestrial Ecology Monitoring Program
1		F		4	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to changes in hydrology, erosion of the surface or ecosystem functionality i.e. changes in species richness and composition). Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	Lineaments, faults, dykes and intrusions are mapped and recorded Lineaments are assessed for correlation with know geological conditions Surface mapping around lineaments to understand if there is any geological feature Environmental Monitoring including terrestrial and aquatic ecology monitoring programs - (LiDAR or other methods for the mapping of swamp boundaries, floristic monitoring of swamps) Ground and Surface Water Monitoring, including Piezometers and Soil Moisture Probes. Data is analysed in independent studies and reported as part of TARP and end of panel process to assess impacts.	300	0.03	9	E	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	F	Swamp Den15A	5	Valley Closure (including basal shear) results in changes to the structural integrity of the Controlling Rockbar (SC10-RB14) in Swamp Den15A	Longwall 19A is setback approximately 700 metres from Controlling Rockbar (SC10-RB14) Experience with mining next to Controlling Rockbar (SC10-RB14) for Longwall 8 which mined within 110 metres and Longwall 19 which mined within 300 metres of the Rockbar Experience with mining near to (not directly beneath) Rockbars in Area 3B Calibrated subsidence model is used to inform of predicted movements Swamp Impact Monitoring Management and Contingency Plan (SIMMCP) includes mitigation and rehabilitation actions	3	0.1	0.3	F	1	None Identified
1		G	Swamps, Tributaries to Wongawilli Creek and Sandy Creek	1	Surface subsidence, sub-surface movements or valley closure result in impacts to Swamps, Tributaries to Wongawilli Creek and Sandy Creek. Ranking has considered the loss of an individual small swamp. The effect is considered low due to the abundant comparable habitat available in the Cordeaux Catchment area.	Subsidence monitoring data is analysed and interrogated against predictions to verify modelling. Ground and Surface Water Monitoring (Piezometers, Mine water balance and water chemistry) data is analysed in independent studies, results inform surface and groundwater models. The analysis is used to assess impacts and demonstrate compliance. Subsidence Management Plan - including end of panel reporting and auditing against performance measures Environmental Monitoring including terrestrial and aquatic ecology monitoring programs - (LiDAR or other methods for the mapping of swamp boundaries, floristic monitoring of swamps) Research Programs e.g. Littlejohns Tree Frog, Giant Dragon Fly and Swamp Research Plans Maddens Plains Environmental Offset	3	3	9	E	1	Review and update Subsidence Management TARPS in relation to Swamps, Tributaries to Wongawilli Creek and Sandy Creek

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	G	Swamps, Tributaries to Wongawilli Creek and Sandy Creek	2	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Swamps, Tributaries to Wongawilli Creek and Sandy Creek. Ranking has considered the loss of an individual small swamp. The effect is considered low due to the abundant comparable habitat available in the Cordeaux Catchment area.	Lineaments, faults, dykes and intrusions are mapped and recorded Lineaments are assessed for correlation with know geological conditions Surface mapping around lineaments to understand if there is any geological feature Targeted exploration drilling on both surface and underground Ground and Surface Water Monitoring (Piezometers, flow observations and water chemistry) data is analysed in independent studies, results inform surface and groundwater models. The analysis is used to assess impacts and demonstrate compliance. Subsidence Management Plan - including end of panel reporting and auditing against performance measures Environmental Monitoring including terrestrial and aquatic ecology monitoring programs - (LiDAR or other methods for the mapping of swamp boundaries, floristic monitoring of swamps) Subsidence Monitoring - (Closure Lines, Vertical Subsidence, 3D Far-Field, ALS, Visual Inspection) data is analysed in independent studies, results inform the calibrated subsidence model and mine planning decisions No correlation between piezometers response and lineaments has been observed (HGEO Report D20373 2020)	3	0.3	0.9	E	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1		G		3	Cumulative impacts, including the impacts of cracking of first and second order watercourses. Leading to changes to water supply	Surface Water Monitoring data is analysed in independent studies, results inform surface data analysis and TARPs. These are used to ensure compliance with approval conditions and to demonstrate compliance.	10	0.1	1	R	1	None Identified

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Dendrobium Longwall 19A Subsidence Management Plan	G	Swamps, Tributaries to Wongawilli Creek and Sandy Creek	4	Cumulative impacts, including the impacts of cracking of first and second order watercourses. Leading to effects on aquatic and terrestrial ecology.	Surface Water Monitoring data is analysed in independent studies, results inform surface data analysis and TARPs. These are used to ensure compliance with approval conditions and to demonstrate compliance. Environmental Monitoring including terrestrial and aquatic ecology monitoring programs - (e.g. Littlejohns Tree Frog Monitoring Programme and other aquatic flora and fauna monitoring) Set-back of the longwalls from Wongawilli Creek [and to a lesser extent, SC10] Existing monitoring at numerous sites on Wongawilli Creek and its tributaries and Sandy Creek and its tributaries.	30	1	30	E	1	None Identified

Attachment 2

Assessment Worksheets
(Risk Rank Order)

Risk Analysis Risk Order

REF	Risk	HAZARD	TID	TREATMENT OPTIONS
1C1	30	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	Submit the Subsidence Management Plan for Longwall 19A
1C3	10	Groundwater drawdown result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	None Identified
1F1	10	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to changes in swamp hydrology) Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp
1F3	9	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to changes in ecosystem functionality i.e. changes in species richness and composition). Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp
			2	Complete annual review of the Dendrobium Areas 3A and 3B - Terrestrial Ecology Monitoring Program
1F4	9	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to changes in hydrology, erosion of the surface or ecosystem functionality i.e. changes in species richness and composition). Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp
1G1	9	Surface subsidence, sub-surface movements or valley closure result in impacts to Swamps, Tributaries to Wongawilli Creek and Sandy Creek. Ranking has considered the loss of an individual small swamp. The effect is considered low due to the abundant comparable habitat available in the Cordeaux Catchment area.	1	Review and update Subsidence Management TARPS in relation to Swamps, Tributaries to Wongawilli Creek and Sandy Creek
1A1	3	Surface subsidence and sub-surface ground movements result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy and associated Minimal Harm Criteria) on groundwater quantity	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals
1A2	3	Lineaments result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	Review Reporting of Geological Features relevant to Longwall 19A to determine if further investigatory actions such as inseam and or surface drilling are required to define geological features
			2	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals
			3	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure

REF	Risk	HAZARD	TID	TREATMENT OPTIONS
1A3	3	Faults and Dykes result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals
			2	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1A4	3	Shear planes (including basal shear planes) transmits groundwater in excess of Development Consent Conditions (no more than negligible impacts as defined by the regional groundwater model) and/or Dams Safety NSW conditions (policy of no more than 1ML per day cumulative leakage from Cordeaux and Avon Reservoirs) in addition to Groundwater Licence, Aquifer Interference Policy and minimal harm criteria.	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals
1B1	3	Surface subsidence and sub-surface ground movements result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy and associated Minimal Harm Criteria) on groundwater quantity	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals
1B3	3	Lineaments result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	Review Reporting of Geological Features relevant to Longwall 19A to determine if further investigatory actions such as inseam and or surface drilling are required to define geological features
			2	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals
			3	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1C2	3	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1D1	3	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Sandy Creek (including no more than minor environmental consequences)	1	Submit the Subsidence Management Plan for Longwall 19A
1E1	3	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Sandy Creek Waterfall (SC-WF1)	1	Review the Sandy Creek Waterfall TARP for Longwall 19A
1G3	1	Cumulative impacts, including the impacts of cracking of first and second order watercourses. Leading to changes to water supply quality	1	None Identified
1B2	0.9	Valley Closure (including basal shear) results in impacts in excess of development consent conditions on water quantity	1	None Identified
1B4	0.9	Faults and Dykes result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1B5	0.9	Groundwater drawdown results in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	None Identified

REF	Risk	HAZARD	TID	TREATMENT OPTIONS
1D2	0.9	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Sandy Creek (including no more than minor environmental consequences)	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1E2	0.9	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Sandy Creek Waterfall (SC-WF1)	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1G2	0.9	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Swamps, Tributaries to Wongawilli Creek and Sandy Creek. Ranking has considered the loss of an individual small swamp. The effect is considered low due to the abundant comparable habitat available in the Cordeaux Catchment area.	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1F2	0.3	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to swamp scour and erosion) Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp
1F5	0.3	Valley Closure (including basal shear) results in changes to the structural integrity of the Controlling Rockbar (SC10-RB14) in Swamp Den15A	1	None Identified

Attachment 3

Assessment Worksheets
(Consequence Order)

Risk Analysis Consequence Order

REF	Con	HAZARD	TID	TREATMENT OPTIONS
1F3	300	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to changes in ecosystem functionality i.e. changes in species richness and composition). Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp
			2	Complete annual review of the Dendrobium Areas 3A and 3B - Terrestrial Ecology Monitoring Program
1F4	300	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to changes in hydrology, erosion of the surface or ecosystem functionality i.e. changes in species richness and composition). Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp
1B2	30	Valley Closure (including basal shear) results in impacts in excess of development consent conditions on water quantity	1	None Identified
1B4	30	Faults and Dykes result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1B5	30	Groundwater drawdown results in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	None Identified
1C1	30	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	Submit the Subsidence Management Plan for Longwall 19A
1C2	30	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1D1	30	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Sandy Creek (including no more than minor environmental consequences)	1	Submit the Subsidence Management Plan for Longwall 19A
1D2	30	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Sandy Creek (including no more than minor environmental consequences)	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1E1	30	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Sandy Creek Waterfall (SC-WF1)	1	Review the Sandy Creek Waterfall TARP for Longwall 19A

REF	Con	HAZARD	TID	TREATMENT OPTIONS
1E2	30	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Sandy Creek Waterfall (SC-WF1)	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1A1	10	Surface subsidence and sub-surface ground movements result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy and associated Minimal Harm Criteria) on groundwater quantity	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals
1A2	10	Lineaments result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	Review Reporting of Geological Features relevant to Longwall 19A to determine if further investigatory actions such as inseam and or surface drilling are required to define geological features
			2	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals
			3	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1A3	10	Faults and Dykes result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals
			2	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1A4	10	Shear planes (including basal shear planes) transmits groundwater in excess of Development Consent Conditions (no more than negligible impacts as defined by the regional groundwater model) and/or Dams Safety NSW conditions (policy of no more than 1ML per day cumulative leakage from Cordeaux and Avon Reservoirs) in addition to Groundwater Licence, Aquifer Interference Policy and minimal harm criteria.	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals
1B1	10	Surface subsidence and sub-surface ground movements result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy and associated Minimal Harm Criteria) on groundwater quantity	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals
1B3	10	Lineaments result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	Review Reporting of Geological Features relevant to Longwall 19A to determine if further investigatory actions such as inseam and or surface drilling are required to define geological features
			2	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals
			3	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1C3	10	Groundwater drawdown result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	None Identified

REF	Con	HAZARD	TID	TREATMENT OPTIONS
1F1	10	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to changes in swamp hydrology) Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp
1F2	10	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to swamp scour and erosion) Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp
1G3	10	Cumulative impacts, including the impacts of cracking of first and second order watercourses. Leading to changes to water supply quality	1	None Identified
1F5	3	Valley Closure (including basal shear) results in changes to the structural integrity of the Controlling Rockbar (SC10-RB14) in Swamp Den15A	1	None Identified
1G1	3	Surface subsidence, sub-surface movements or valley closure result in impacts to Swamps, Tributaries to Wongawilli Creek and Sandy Creek. Ranking has considered the loss of an individual small swamp. The effect is considered low due to the abundant comparable habitat available in the Cordeaux Catchment area.	1	Review and update Subsidence Management TARPS in relation to Swamps, Tributaries to Wongawilli Creek and Sandy Creek
1G2	3	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Swamps, Tributaries to Wongawilli Creek and Sandy Creek. Ranking has considered the loss of an individual small swamp. The effect is considered low due to the abundant comparable habitat available in the Cordeaux Catchment area.	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure

Attachment 4

Risk Treatment Schedule and Action Plan

ID	HAZARD	TID	TREATMENT OPTIONS	RESPONSIBILITY	IMPLEMENTATION	COMMENTS	COMPLETED (Sign Off)
1A1	Surface subsidence and sub-surface ground movements result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy and associated Minimal Harm Criteria) on groundwater quantity	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals. If impacts occur in excess of development consent conditions, conduct widescale review of future mining plans for all of Dendrobium Area 3.	Cody Brady (Assessment by Watershed Hydrogeo)	Friday, 30 June 2023		
1A2	Lineaments result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	Review Reporting of Geological Features relevant to Longwall 19A to determine if further investigatory actions such as inseam and or surface drilling are required to define geological features	Hugo Kaag	Prior to commencement of Longwall 19A		
		2	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals. If impacts occur in excess of development consent conditions, conduct widescale review of future mining plans for all of Dendrobium Area 3.	Cody Brady (Assessment by Watershed Hydrogeo)	Calibration conducted after periodic review (generally on a yearly basis).		
		3	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure	Hugo Kaag	Friday, 30 June 2023		

ID	HAZARD	TID	TREATMENT OPTIONS	RESPONSIBILITY	IMPLEMENTATION	COMMENTS	COMPLETED (Sign Off)
1A3	Faults and Dykes result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals. If impacts occur in excess of development consent conditions, conduct widescale review of future mining plans for all of Dendrobium Area 3.	Cody Brady (Assessment by Watershed Hydrogeo)	Friday, 30 June 2023		
		2	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure	Hugo Kaag	Friday, 30 June 2023		
1A4	Shear planes (including basal shear planes) transmits groundwater in excess of Development Consent Conditions (no more than negligible impacts as defined by the regional groundwater model) and/or Dams Safety NSW conditions (policy of no more than 1ML per day cumulative leakage from Cordeaux and Avon Reservoirs) in addition to Groundwater Licence, Aquifer Interference Policy and minimal harm criteria.	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals. If impacts occur in excess of development consent conditions, conduct widescale review of future mining plans for all of Dendrobium Area 3.	Cody Brady (Assessment by Watershed Hydrogeo)	Friday, 30 June 2023		
1B1	Surface subsidence and sub-surface ground movements result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy and associated Minimal Harm Criteria) on groundwater quantity	1	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals. If impacts occur in excess of development consent conditions, conduct widescale review of future mining plans for all of Dendrobium Area 3.	Cody Brady (Assessment by Watershed Hydrogeo)	Friday, 30 June 2023		
1B2	Valley Closure (including basal shear) results in impacts in excess of development consent conditions on water quantity	1	None Identified				

ID	HAZARD	TID	TREATMENT OPTIONS	RESPONSIBILITY	IMPLEMENTATION	COMMENTS	COMPLETED (Sign Off)
1B3	Lineaments result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	Review Reporting of Geological Features relevant to Longwall 19A to determine if further investigatory actions such as inseam and or surface drilling are required to define geological features	Hugo Kaag	Friday, 31 March 2023		
		2	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals. If impacts occur in excess of development consent conditions, conduct widescale review of future mining plans for all of Dendrobium Area 3.	Cody Brady (Assessment by Watershed Hydrogeo)	Friday, 30 June 2023		
		3	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure	Hugo Kaag	Friday, 30 June 2023		
1B4	Faults and Dykes result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure	Hugo Kaag	Friday, 30 June 2023		
1B5	Groundwater drawdown results in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	None Identified				
1C1	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	Submit the Subsidence Management Plan for Longwall 19A	Cody Brady	Friday, 28 October 2022		

ID	HAZARD	TID	TREATMENT OPTIONS	RESPONSIBILITY	IMPLEMENTATION	COMMENTS	COMPLETED (Sign Off)
1C2	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure	Hugo Kaag	Friday, 30 June 2023		
1C3	Groundwater drawdown result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	None Identified				
1D1	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Sandy Creek (including no more than minor environmental consequences)	1	Submit the Subsidence Management Plan for Longwall 19A	Cody Brady	Friday, 28 October 2022		
1D2	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Sandy Creek (including no more than minor environmental consequences)	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure	Hugo Kaag	Friday, 30 June 2023		
1D3	Groundwater drawdown result in impacts in excess of development consent conditions for Sandy Creek (including no more than minor environmental consequences)	1	None Identified				
1E1	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Sandy Creek Waterfall (SC-WF1)	1	Review the Sandy Creek Waterfall TARP for Longwall 19A	Cody Brady	Friday, 30 June 2023		

ID	HAZARD	TID	TREATMENT OPTIONS	RESPONSIBILITY	IMPLEMENTATION	COMMENTS	COMPLETED (Sign Off)
1E2	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Sandy Creek Waterfall (SC-WF1)	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure	Hugo Kaag	Friday, 30 June 2023		
1F1	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to changes in swamp hydrology) Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp	Cody Brady	Friday, 30 June 2023		
1F2	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to swamp scour and erosion) Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp	Cody Brady	Friday, 30 June 2023		
1F3	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to changes in ecosystem functionality i.e. changes in species richness and composition). Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp	Cody Brady	Friday, 30 June 2023		
		2	Complete annual review of the Dendrobium Areas 3A and 3B - Terrestrial Ecology Monitoring Program	Cody Brady	Friday, 30 June 2023		

ID	HAZARD	TID	TREATMENT OPTIONS	RESPONSIBILITY	IMPLEMENTATION	COMMENTS	COMPLETED (Sign Off)
1F4	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to changes in hydrology, erosion of the surface or ecosystem functionality i.e. changes in species richness and composition). Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp	Cody Brady	Friday, 30 June 2023		
1F5	Valley Closure (including basal shear) results in changes to the structural integrity of the Controlling Rockbar (SC10-RB14) in Swamp Den15A	1	None Identified				
1G1	Surface subsidence, sub-surface movements or valley closure result in impacts to Swamps, Tributaries to Wongawilli Creek and Sandy Creek. Ranking has considered the loss of an individual small swamp. The effect is considered low due to the abundant comparable habitat available in the Cordeaux Catchment area.	1	Review and update Subsidence Management TARPS in relation to Swamps, Tributaries to Wongawilli Creek and Sandy Creek	Cody Brady	Friday, 30 June 2023		
1G2	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Swamps, Tributaries to Wongawilli Creek and Sandy Creek. Ranking has considered the loss of an individual small swamp. The effect is considered low due to the abundant comparable habitat available in the Cordeaux Catchment area.	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure	Hugo Kaag	Friday, 30 June 2023		
1G3	Cumulative impacts, including the impacts of cracking of first and second order watercourses. Leading to changes to water supply quality	1	None Identified				
1G4	Cumulative impacts, including the impacts of cracking of first and second order watercourses. Leading to effects on aquatic and terrestrial ecology.	1	None Identified				

Attachment 5

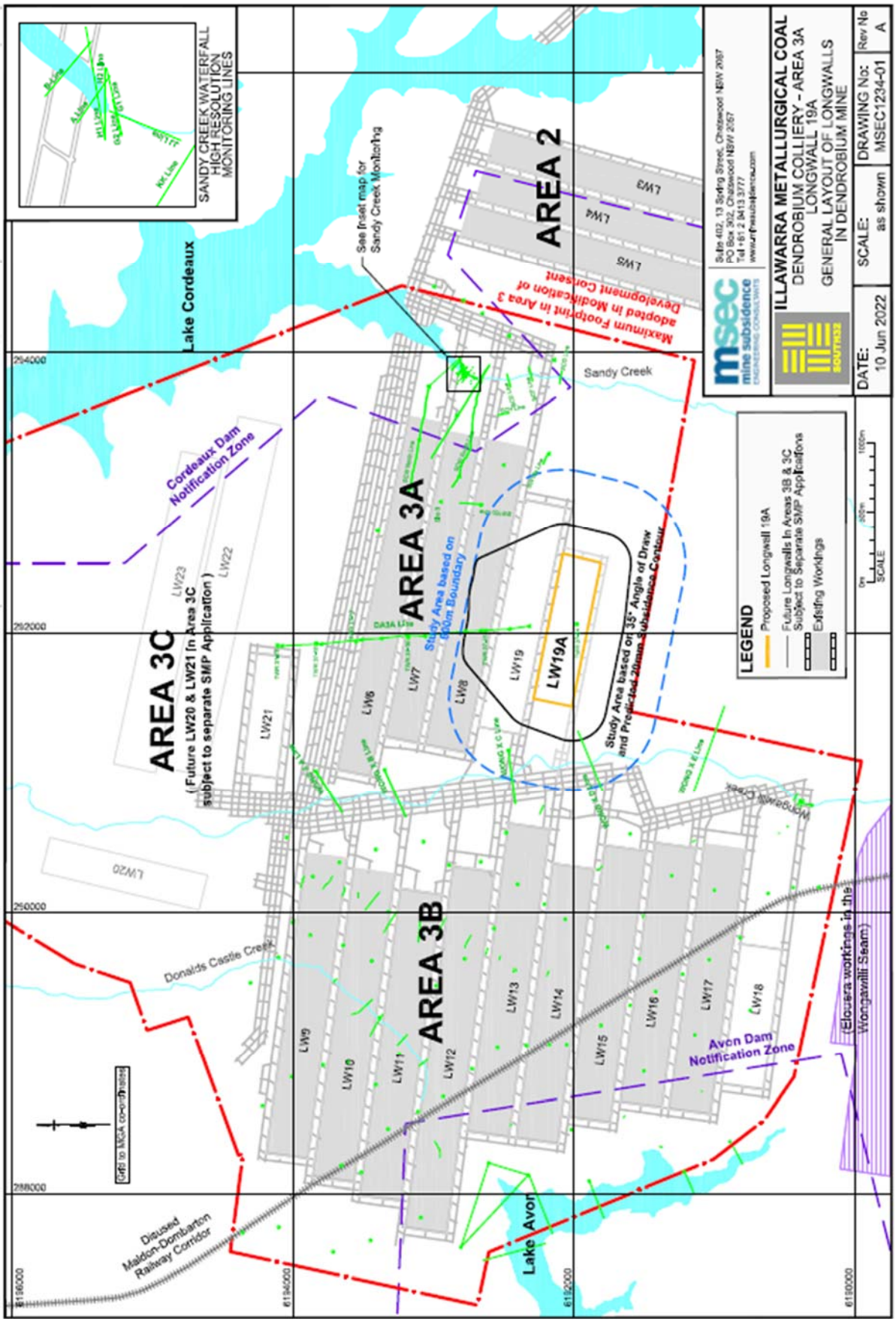
Risk Rank Order
Associated with Lineaments

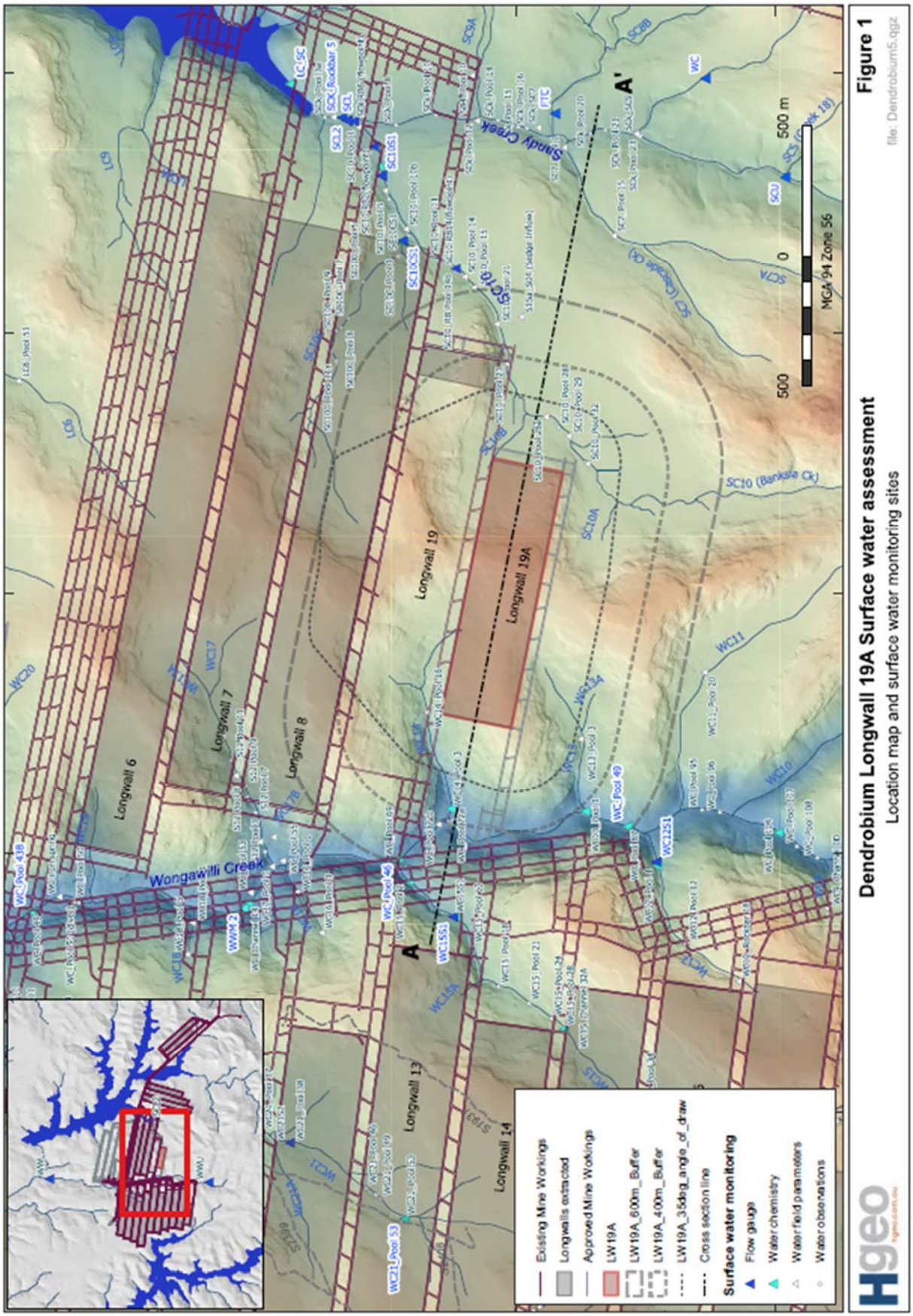
Risk Analysis Risk Order (Associated with Lineaments)

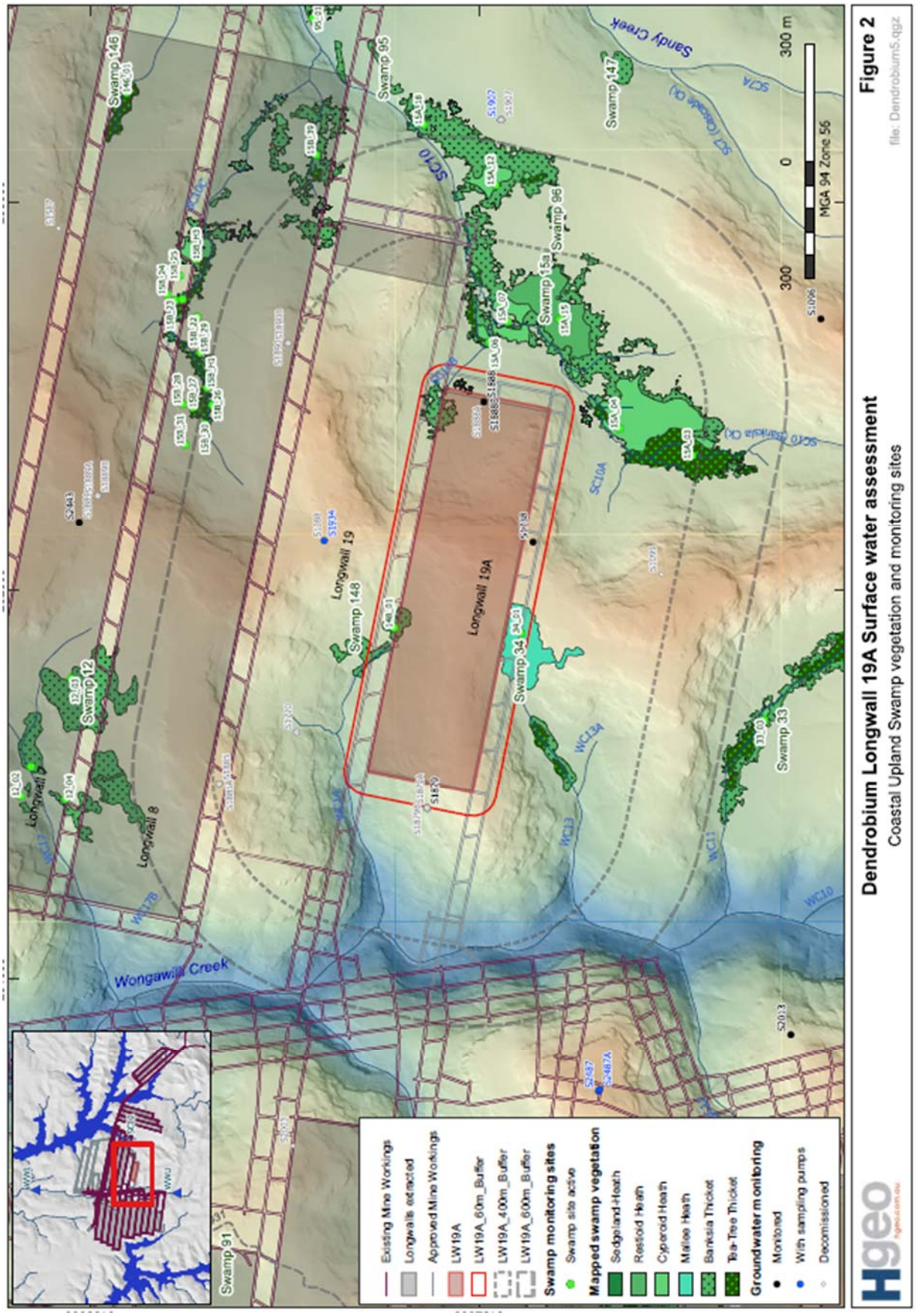
REF	Risk	HAZARD	TID	TREATMENT OPTIONS
1F4	9	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Swamp Den15A (subsidence leading to changes in hydrology, erosion of the surface or ecosystem functionality i.e. changes in species richness and composition). Ranking has considered the loss of the entire swamp affecting the ecosystem functionality	1	Review the location of piezometers and soil moisture monitoring with automatic loggers within Swamp Den15A to confirm adequate monitoring of the swamp
1A2	3	Lineaments result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	Review Reporting of Geological Features relevant to Longwall 19A to determine if further investigatory actions such as inseam and or surface drilling are required to define geological features
			2	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals
			3	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1B3	3	Lineaments result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference Policy, minimal harm criteria) on groundwater quantity	1	Review Reporting of Geological Features relevant to Longwall 19A to determine if further investigatory actions such as inseam and or surface drilling are required to define geological features
			2	Continue to periodically review and calibrate the groundwater model against monitoring results including Peer Review at appropriate intervals
			3	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1C2	3	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1D2	0.9	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Sandy Creek (including no more than minor environmental consequences)	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1E2	0.9	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Sandy Creek Waterfall (SC-WF1)	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure
1G2	0.9	Lineaments, faults, dykes and intrusions result in impacts in excess of development consent conditions for Swamps, Tributaries to Wongawilli Creek and Sandy Creek. Ranking has considered the loss of an individual small swamp. The effect is considered low due to the abundant comparable habitat available in the Cordeaux Catchment area.	1	In the event that an anomalous, unmapped geological structure is encountered: 1. Assess the significance of the structure to increase understanding 2. If necessary, conduct surveys and testing e.g. radio imaging method, seismic, inseam and/or surface drilling 3. If the structure is deemed significant, revise mine plan accordingly to avoid/manage the geological structure

Attachment 6

Area Plans – Longwall 19A


SANDY CREEK WATERFALL
HIGH RESOLUTION
MONITORING LINES
Lake Cordeaux
See Inset map for Sandy Creek Monitoring
AREA 2
AREA 3A
AREA 3B
AREA 3C
(Future LW20 & LW21 in Area 3C subject to separate SMP Application)
Maximum Footprint in Area 3 adopted in Modification of Development Consent
Sandy Creek
Cordeaux Dam Notification Zone
Study Area based on 40m Boundary
Study Area based on 35° Angle of Draw and Predicted 20mm Subsidence Contour
LW19A
Donalds Castle Creek
Avon Dam Notification Zone
Disused Maldon-Dombarton Railway Corridor
Lake Avon
(Elouera workings in the Wongawilli Seam)
LEGEND
Proposed Longwall 19A
Future Longwalls In Areas 3B & 3C Subject to Separate SMP Applications
Existing Workings
SCALE
ILLAWARRA METALLURGICAL COAL
DENDROBIUM COLLIERY - AREA 3A
LONGWALL 19A
GENERAL LAYOUT OF LONGWALLS IN DENDROBIUM MINE
msec mine subsidence
DATE: 10 Jun 2022
SCALE: as shown
DRAWING No: MSEC1234-01
Rev No A


Dendrobium Longwall 19A Surface water assessment
Location map and surface water monitoring sites
Figure 1
file: Dendrobium5.ggz
Hgeo
Existing Mine Workings
Longwalls extracted
Approved Mine Workings
LW19A
LW19A_600m_Buffer
LW19A_400m_Buffer
LW19A_35deg_angle_of_draw
Cross section line
Surface water monitoring
Flow gauge
Water chemistry
Waterfield parameters
Water observations
Longwall 19
Longwall 19A
Longwall 6
Longwall 7
Longwall 8
Longwall 13
Longwall 14
Wongawilli Creek
Sandy Creek
SC10 (Banksia Ck)
SC (Cascade Ck)
A
A'
500 m
0
500
MGA 94 Zone 56


Dendrobium Longwall 19A Surface water assessment
Coastal Upland Swamp vegetation and monitoring sites
Figure 2
file: Dendrobium5.qgz
Hgeo
MGA 94 Zone 56
300 m
0
300
Sandy Creek
Wongawilli Creek
Longwall 19A
Longwall 19
Longwall 148
Longwall 12
Longwall 8
Swamp 146
Swamp 95
Swamp 147
Swamp 96
Swamp 15a
Swamp 34
Swamp 33
Swamp 12
Swamp 91
SC10
SC10A
SC7A
WC13A
WC13
WC11
WC10
WC17B
Existing Mine Workings
Longwalls extracted
Approved Mine Workings
LW19A
LW19A_60m_Buffer
LW19A_400m_Buffer
LW19A_600m_Buffer
Swamp monitoring sites
Swamp site active
Mapped swamp vegetation
Sedgeland-Heath
Restiod Heath
Cyperoid Heath
Mallee Heath
Banksia Thicket
Tea-Tree Thicket
Groundwater monitoring
Monitored
With sampling pumps
Decommissioned