South32 - Illawarra Coal

Review of Dendrobium Longwalls 20 and 21 Subsidence Management Plan

Risk Assessment Report

AR2625

Revision 4

29 May 2019

Assessment and report completed by;
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1. Revisions

Rev No	Date	Description
1	09 April 2019	Initial Release
2	23 April 2019	Minor corrects following site review
3	26 April 2019	Additional wording describing ranking process
4	29 May 2019	Further changes / corrections following site review

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2. Participants

Name	Position	Relevant Years' Experience
Cody Brady	South32 - Illawarra Coal Principal Mining Approvals	4 Years
Daniel Pygas	Cardno Principal Aquatic Ecology	12 Years
Stuart Brown	HGEO Principal Hydrogeologist	25 Years
Simon Tweed	Niche Environment and Heritage Senior Ecologist	16 Years
James Barbato	Mine Subsidence Engineering Consultants (MSEC) Subsidence Engineer	15 Years
Gary Brassington	South32 - Approvals Review of report undertaken	25 Years

3. Executive Summary

Illawarra Coal carried out a risk assessment for the Dendrobium Longwalls 20 and 21 Subsidence Management Plan application in accordance with the recommendation from the Independent Expert Panel that Subsidence Management Plan 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.

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.

4. Introduction

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.

The mine is owned and operated by Dendrobium Coal Pty Ltd, 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 Independent Expert Panel for Mining in the Catchment (the Panel) Initial Report on specific mining activities at Metropolitan and Dendrobium Mines was released in December 2018. The report recommended that any Subsidence Management Plan (SMP) application consider the potential implications for water quantity of faulting, basal shear planes and lineaments and that a Risk Assessment be included in applications to extract coal within Catchment Special Areas.

The Department of Planning and Environment have recently provided correspondence to South 32 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 Longwalls 20 and 21 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.

5. Context Summary

5.1 Strategic Context

South32 is committed to ensuring safety and environmental compliance within its operation. When new equipment or processes are implemented, South32 insist that Risk Assessment techniques are used to reduce the risks to people, equipment, environment and operations.

5.2 Corporate Context

As South32 is committed to safety and environmental compliance, when a change to systems or new equipment or systems are introduced into the coal operation, management insist that Risk Assessment techniques are used to identify and minimising exposure to its people and the operations. South32 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 Department of Planning and Environment in relation to advice received from the Panel, the management of South32 have conducted a formal Risk Assessment to address the concerns of mining in the catchment that may be affected by the extraction of Longwalls 20 and 21.

There are a number of considerations during each Risk Assessment, being personal safety, equipment damage, operational loss, reputation or environmental issues. Due to the notification from the regulator, this assessment specifically addressed the risks associated to legal compliance that may result from the extraction of longwall blocks 20 and 21.

6. Objectives and Scope

The objective of this Risk Assessment was to support the Longwalls 20 and 21 SMP application and to address concerns raised by the Panel. This Risk Assessment addressed the risks associated to legal compliance that may result from the extraction of longwall blocks 20 and 21.

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

- Groundwater
- Avon and Cordeaux Reservoirs
- Wongawilli Creek
- Donalds Castle Creek
- Swamps, Tributaries to Wongawilli Creek and Donalds Castle Creek

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

- Surface subsidence
- Sub surface ground movements
- Valley closures
- Lineaments
- Faults
- Dykes
- Groundwater drawdown

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 impact from Longwalls 20 and 21
- Accurate 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.

Related 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

Report from B K Hebblewhite Consulting titled: Dendrobium Mine – Longwalls 14-18 Independent Review – Height of Fracturing (Stage 2) (incorporating all content from March 2018 Stage 1 Report). File Name: 170803.2 (final) (1)

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.

Watershed HydroGeo, 2019. Geographic review of mining effects on Upland Swamps at Dendrobium Mine. r008i5, March 2019.

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" on Page 17.

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:

1. Avoidance – avoid the risk by deciding not to proceed with the activity likely to generate the risk (where this is practicable).
2. Reduction – reduce the likelihood of the event.
3. Reduction – reduce the consequences of the event.
4. 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.

1. Design – to the extent reasonable and practicable ensure that hazards are designed out of the proposal.
2. Remove the hazard or substitute a less hazardous proposal.
3. Adopt a safer process – alter the process, equipment or work practices.
4. Enclose or isolate the hazard – provide barriers or other techniques.
5. 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.
6. Mitigate, rehabilitate or provide offsets for impacts from the proposal.

9. Facilitator Qualifications and Experience

Shane Chiddy holds an Associate Diploma in Engineering (Electrical), is an Officer of the Institution of Engineers (Australia) and is a member of the Maintenance Engineering Society of Australia (MESA) and the Mining Electrical and Mining Mechanical Engineering Society (MEMMES). He has also completed Conveyancing 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 Longwalls 20 and 21 Subsidence Management Plan	A	Groundwater
		B	Avon and Cordeaux Reservoir
		C	Wongawilli Creek
		D	Donalds Castle Creek
		E	Swamps, Tributaries to Wongawilli Creek and Donalds Castle 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.

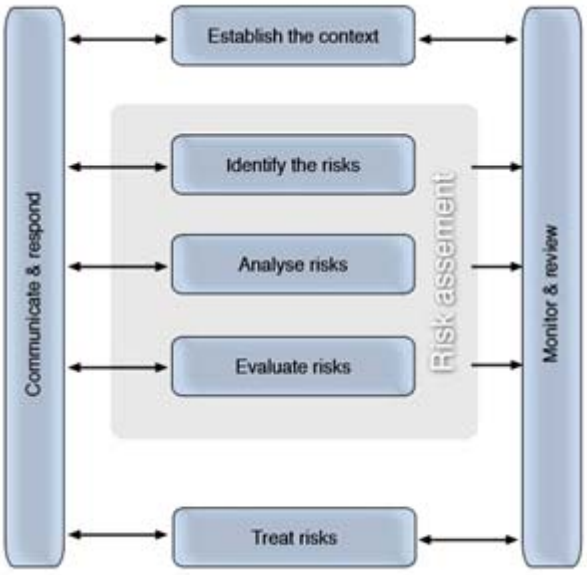
The qualitative approach succeeds by using local expert knowledge and relevant historical data.

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 objectives 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 (identifed 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 should be 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 should be 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 Consultations

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.

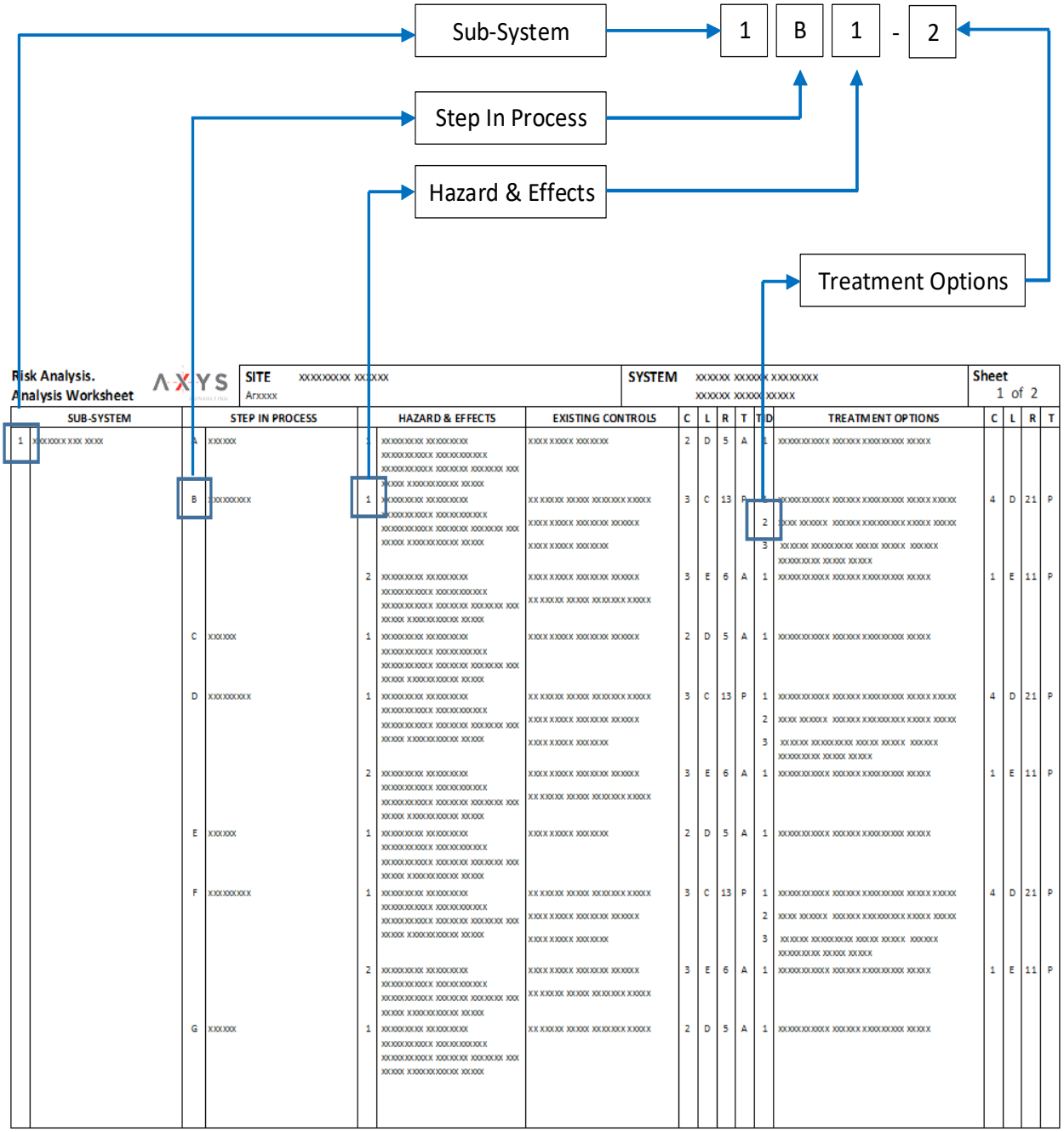
12. Risk Assessment Numbering

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 hosueholds)
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	Review Dendrobium Longwalls 20 and 21 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. These models are used to design mining parameters to ensure compliance with approval conditions and to demonstrate compliance. Mine Design set back from significant Surface Water features Mine Design limiting extraction height to 3.9 metres Calibrated subsidence model is used to design mine setbacks from significant features to limit groundwater impacts/interactions. Subsidence monitoring data is analysed and interrogated against predictions to verify modelling and inform the model. Assessment of Mine Panel alternative geometry Height of Fracturing Investigation	10	0.3	3	L	1	Nil Required

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Review Dendrobium Longwalls 20 and 21 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 The IEP Report has been reviewed with the key recommendations of Section 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. These models are used to design mining parameters to ensure compliance with approval conditions and to demonstrate compliance. Mine Design set back from significant geological features Mine Design limiting extraction height to 3.9 metres Calibrated subsidence model is used to design mine setbacks from significant features to limit groundwater impacts/interactions. Subsidence monitoring is conducted and analysed against predictions to verify modelling.	10	0.1	1	L	1 2 3	Assess any correlation between groundwater fingerprinting (chemistry) and lineaments. Outcomes of this investigation will be considered in future mine design around lineaments. Assess any correlation between piezometers response and lineaments. Outcomes of this investigation may influence future exploration drilling and assessments. Review any impacts of surface subsidence associated with lineaments. Outcomes of this investigation will be included in the knowledge base to support subsidence modelling and assessments.

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Review Dendrobium Longwalls 20 and 21 Subsidence Management Plan	A	Groundwater	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 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. Mine Headings through Dyke under reservoir do not produce groundwater, informing groundwater assessments and mine design. Mine Design avoids major geological structures Extensive exploration program undertaken to identify location of Faults and Dykes	10	0.3	3	L	1	Assess any correlation between mine water chemistry and known geology due to Faults and Dykes. Outcomes of this investigation will be used in assessments of surface and groundwater impacts and mine design around faults and dykes
		B	Avon and Cordeaux Reservoir	1	Surface subsidence and sub-surface ground movements result in impacts in excess of development consent conditions on water quantity.	Longwall Panels are greater than 1500 metres from reservoir full supply level Calibrated subsidence model is used to design mine setbacks from significant features to limit groundwater impacts/interactions. Subsidence monitoring data is analysed and interrogated against predictions to verify modelling and inform the model. 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. Mine Design avoids major geological structures	30	0.1	3	F	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Review Dendrobium Longwalls 20 and 21 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 Calibrated subsidence model is used to design mine setbacks from significant features to limit groundwater impacts/interactions. Longwall Panels are greater than 1500 metres from reservoir full supply level 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. Groundwater model is informed by subsidence modelling (e.g. upsidence and closure in valleys) and is used to design mine setbacks from significant features to achieve compliance with development consent conditions e.g. development does not result in reduction (other than negligible reduction) in the quality or quantity of surface water or groundwater inflows …	30	0.03	0.9	F	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Review Dendrobium Longwalls 20 and 21 Subsidence Management Plan	B	Avon and Cordeaux Reservoir	3	Lineaments result in impacts in excess of development consent conditions on water quantity	Flank inseam Drilling program in advance of development panels Lineaments are mapped and recorded Lineaments are assessed for correlation with know geological conditions Surface Mapping around lineaments to understand if there are any associated geological features Targeted exploration drilling on both surface and underground The IEP Report has been reviewed with the key recommendations of Section 3.6 [Recommendations 1 and 3] implemented to determine mine design constraints to achieve compliance with consent conditions e.g. development does not result in reduction (other than negligible reduction) in the quality or quantity of surface water or groundwater inflows …	30	0.03	0.9	F	1 2 3	Carry out an investigation to compare the impacts on lineaments from mining in the Western Coalfield (Springvale) and the Southern Coalfield. Outcomes of this investigation will inform lineament consideration in mine planning. Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures Review any impacts of surface subsidence associated with lineaments. Outcomes of this investigation will be included in the knowledge base to support subsidence modelling and assessments.

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Review Dendrobium Longwalls 20 and 21 Subsidence Management Plan	B	Avon and Cordeaux Reservoir	4	Faults and dykes result in impacts in excess of development consent conditions on water quantity	Faults and Dykes are mapped and recorded Surface geological mapping around faults and dykes 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. Mine Headings through Dyke under reservoir do not produce groundwater, informing groundwater assessments and mine design. Mine design avoids major geological structures Extensive exploration program undertaken to identify location and characteristics of faults and dykes Drilling program - surface and inseam	30	0.03	0.9	F	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Review Dendrobium Longwalls 20 and 21 Subsidence Management Plan	B	Avon and Cordeaux Reservoir	5	Groundwater drawdown results in impacts in excess of development consent conditions on water quantity	Longwall Panels are greater than 1500 metres from reservoir full supply level Calibrated subsidence model is used to design mine setbacks from significant features to achieve compliance with development consent conditions e.g. development does not result in reduction (other than negligible reduction) in the quality or quantity of surface water or groundwater inflows … Subsidence monitoring data is analysed and interrogated against predictions to verify modelling and inform the model development 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. Mine Design avoids major geological structures Regional and site specific Dendrobium Groundwater models are used to design mine setbacks from significant features to achieve compliance with development consent conditions e.g. development does not result in reduction (other than negligible reduction) in the quality or quantity of surface water or groundwater inflows …	30	0.03	0.9	F	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Review Dendrobium Longwalls 20 and 21 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 Calibrated subsidence model is used to design mine setbacks from significant features to achieve performance measures e.g. Wongawilli Creek. 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. Mine design avoids major geological structures Environmental Monitoring including ecological aspects - (visual inspection) 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	30	1	30	F	1 2	Review Subsidence Management TARPS for Wongawilli Creek Submit the Subsidence Management Plan for Longwalls 20 and 21

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Review Dendrobium Longwalls 20 and 21 Subsidence Management Plan	C	Wongawilli Creek	2	Lineaments, faults and dykes result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	Lineaments are mapped and recorded Lineaments are assessed for correlation with know geological conditions Surface mapping around lineaments to understand if there is a geological feature associated Targeted exploration drilling on both surface and underground The IEP Report has been reviewed with the key recommendations of Section 3.6 [Recommendations 1 and 3] implemented to determine mine design constraints to achieve performance measures e.g. Tributaries to Wongawilli Creek. Subsidence Management Plan - including end of panel reporting and auditing against performance measures Calibrated subsidence model is used to design mine setbacks from significant features to achieve performance measures e.g. 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	30	0.1	3	F	1	Nil Required

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Review Dendrobium Longwalls 20 and 21 Subsidence Management Plan	C	Wongawilli Creek	3	Groundwater drawdown result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	Mine Design Longwall Panel setback from Wongawilli Creek Calibrated subsidence model is used to design mine setbacks from significant features to achieve performance measures for Wongawilli Creek. 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. Mine Design avoids major geological structures Groundwater model is used to design mine setbacks from significant features to achieve compliance with development consent conditions e.g. development does not result in reduction (other than negligible reduction) in the quality or quantity of surface water or groundwater inflows … Wongawilli Creek Pool 43A Assessment Subsidence Management Plan - including end of panel reporting and auditing against performance measures	30	1	30	F	1	Review Subsidence Management TARPS in relation to Wongawilli Creek

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Review Dendrobium Longwalls 20 and 21 Subsidence Management Plan	D	Donalds Castle Creek	1	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Donalds Castle Creek (including no more than minor environmental consequences)	Longwall panels setback from Donalds Castle Creek Calibrated subsidence model is used to design mine setbacks from significant features to achieve performance measures for Donalds Castle Creek. 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. Mine design avoids major geological structures Environmental Monitoring including ecological aspects - (Visual Inspection) Experience with mining next to Donalds Castle 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	30	0.3	10	F	1 2	Review Subsidence Management TARPS for Donalds Castle Creek Submit the Subsidence Management Plan for Longwalls 20 - 21

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Review Dendrobium Longwalls 20 and 21 Subsidence Management Plan	D	Donalds Castle Creek	2	Lineaments, faults and dykes result in impacts in excess of development consent conditions for Donalds Castle Creek (including no more than minor environmental consequences)	Lineaments are mapped and recorded Lineaments are assessed for correlation with know geological conditions Surface mapping around lineaments to understand if there is a geological feature associated Targeted exploration drilling on both surface and underground The IEP Report has been reviewed with the key recommendations of Section 3.6 [Recommendations 1 and 3] implemented to determine mine design constraints to achieve performance measures e.g. Donalds Castle Creek Subsidence Management Plan - including end of panel reporting and auditing against performance measures Calibrated subsidence model is used to design mine setbacks from significant features to achieve performance measures for Donalds Castle 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 Longwall panels setback from Donalds Castle Creek	30	0.03	0.9	F	1	Nil Required

Risk Analysis. Analysis Worksheet

SITE South32 - Illawarra Coal
AR2625

SYSTEM Review of Dendrobium Longwalls 20 and 21 Subsidence Management Plan

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Review Dendrobium Longwalls 20 and 21 Subsidence Management Plan	D	Donalds Castle Creek	3	Groundwater drawdown result in impacts in excess of development consent conditions for Donalds Castle Creek (including no more than minor environmental consequences)	Longwall panels setback from Donalds Castle Creek Calibrated subsidence model is used to design mine setbacks from significant features to achieve performance measures for Donalds Castle Creek. 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. Mine Design avoids major geological structures Groundwater model is used to design mine setbacks from significant features to achieve Performance Measures for Donalds Castle Creek. Subsidence Management Plan - including end of panel reporting and auditing against performance measures	30	0.3	10	F	1	Review Subsidence Management TARPs for Donalds Castle Creek

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Review Dendrobium Longwalls 20 and 21 Subsidence Management Plan	E	Swamps, Tributaries to Wongawilli Creek and Donalds Castle Creek	1	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamps (no more than minor environmental impact without offsets), Tributaries to Wongawilli Creek and Donalds Castle Creek (as per EIS)	Calibrated subsidence model is used to design mine setbacks from significant features 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. Mine Design avoids major geological structures 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., Frog, Dragon Fly and Swamp Research Plans Maddens Plains Environmental Offset	30	0.3	10	F	1	Review and update Subsidence Management TARPS in relation to Swamps, Tributaries to Wongawilli Creek and Donalds Castle Creek

SUB-SYSTEM		STEP IN PROCESS		HAZARD & EFFECTS		EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
1	Review Dendrobium Longwalls 20 and 21 Subsidence Management Plan	E	Swamps, Tributaries to Wongawilli Creek and Donalds Castle Creek	2	Lineaments, faults or dykes result in impacts in excess of development consent conditions for Swamps (no more than minor environmental impact without offsets), Tributaries to Wongawilli Creek and Donalds Castle Creek (as per EIS)	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. Mine Design avoids major geological structures Groundwater model is used to design mine setbacks from significant features to achieve Performance Measures 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) Lineaments 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 The IEP Report has been reviewed with the key recommendations of Section 3.6 [Recommendations 1 and 3] implemented to determine mine design constraints to achieve performance measures e.g. Tributaries to Wongawilli Creek. Calibrated subsidence model is used to design mine setbacks from significant features to achieve performance measures.	30	0.1	3	F	1 2	Carry out an investigation to compare the impacts on lineaments from mining in the Western Coalfield (Springvale) and the Southern Coalfield. Outcomes of this investigation will inform lineament consideration in mine planning. Assess any correlation between piezometers response and lineaments for swamps, tributaries to Wongawilli Creek and Donalds Castle Creek. Outcomes of this investigation may influence future exploration drilling and assessment.

SUB-SYSTEM	STEP IN PROCESS	HAZARD & EFFECTS	EXISTING CONTROLS	C	L	R	T	TID	TREATMENT OPTIONS
			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						

Attachment 2

Assessment Worksheets
(Risk Rank 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	Review Subsidence Management TARPS for Wongawilli Creek
			2	Submit the Subsidence Management Plan for Longwalls 20 and 21
1C3	30	Groundwater drawdown result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	Review Subsidence Management TARPS in relation to Wongawilli Creek
1D1	10	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Donalds Castle Creek (including no more than minor environmental consequences)	1	Review Subsidence Management TARPS for Donalds Castle Creek
			2	Submit the Subsidence Management Plan for Longwalls 20 - 21
1D3	10	Groundwater drawdown result in impacts in excess of development consent conditions for Donalds Castle Creek (including no more than minor environmental consequences)	1	Review Subsidence Management TARPs for Donalds Castle Creek
1E1	10	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamps (no more than minor environmental impact without offsets), Tributaries to Wongawilli Creek and Donalds Castle Creek (as per EIS)	1	Review and update Subsidence Management TARPS in relation to Swamps, Tributaries to Wongawilli Creek and Donalds Castle 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	Nil Required
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	Assess any correlation between mine water chemistry and known geology due to Faults and Dykes. Outcomes of this investigation will be used in assessments of surface and groundwater impacts and mine design around faults and dykes
1B1	3	Surface subsidence and sub-surface ground movements result in impacts in excess of development consent conditions on water quantity.	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures
1C2	3	Lineaments, faults and dykes result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	Nil Required
1E2	3	Lineaments, faults or dykes result in impacts in excess of development consent conditions for Swamps (no more than minor environmental impact without offsets), Tributaries to Wongawilli Creek and Donalds Castle Creek (as per EIS)	1	Carry out an investigation to compare the impacts on lineaments from mining in the Western Coalfield (Springvale) and the Southern Coalfield. Outcomes of this investigation will inform lineament consideration in mine planning.
			2	Assess any correlation between piezometers response and lineaments for swamps, tributaries to Wongawilli Creek and Donalds Castle Creek. Outcomes of this investigation may influence future exploration drilling and assessment.
1A2	1	Lineaments result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference policy, minimal harm criteria) on groundwater quantity	1	Assess any correlation between groundwater fingerprinting (chemistry) and lineaments. Outcomes of this investigation will be considered in future mine design around lineaments.
			2	Assess any correlation between piezometers response and lineaments. Outcomes of this investigation may influence future exploration drilling and assessments.
			3	Review any impacts of surface subsidence associated with lineaments. Outcomes of this investigation will be included in the knowledge base to support subsidence modelling and assessments.
1B2	0.9	Valley Closure (including basal shear) results in impacts in excess of development consent conditions on water quantity	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures

REF	Risk	HAZARD	TID	TREATMENT OPTIONS
1B3	0.9	Lineaments result in impacts in excess of development consent conditions on water quantity	1	Carry out an investigation to compare the impacts on lineaments from mining in the Western Coalfield (Springvale) and the Southern Coalfield. Outcomes of this investigation will inform lineament consideration in mine planning.
			2	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures
			3	Review any impacts of surface subsidence associated with lineaments. Outcomes of this investigation will be included in the knowledge base to support subsidence modelling and assessments.
1B4	0.9	Faults and dykes result in impacts in excess of development consent conditions on water quantity	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures
1B5	0.9	Groundwater drawdown results in impacts in excess of development consent conditions on water quantity	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures
1D2	0.9	Lineaments, faults and dykes result in impacts in excess of development consent conditions for Donalds Castle Creek (including no more than minor environmental consequences)	1	Nil Required

Attachment 3

Assessment Worksheets
(Consequence Order)

REF	Cons	HAZARD	TID	TREATMENT OPTIONS
1B1	30	Surface subsidence and sub-surface ground movements result in impacts in excess of development consent conditions on water quantity.	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures
1B2	30	Valley Closure (including basal shear) results in impacts in excess of development consent conditions on water quantity	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures
1B3	30	Lineaments result in impacts in excess of development consent conditions on water quantity	1	Carry out an investigation to compare the impacts on lineaments from mining in the Western Coalfield (Springvale) and the Southern Coalfield. Outcomes of this investigation will inform lineament consideration in mine planning.
			2	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures
			3	Review any impacts of surface subsidence associated with lineaments. Outcomes of this investigation will be included in the knowledge base to support subsidence modelling and assessments.
1B4	30	Faults and dykes result in impacts in excess of development consent conditions on water quantity	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures
1B5	30	Groundwater drawdown results in impacts in excess of development consent conditions on water quantity	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures
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	Review Subsidence Management TARPS for Wongawilli Creek
			2	Submit the Subsidence Management Plan for Longwalls 20 and 21
1C2	30	Lineaments, faults and dykes result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	Nil Required
1C3	30	Groundwater drawdown result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	Review Subsidence Management TARPS in relation to Wongawilli Creek
1D1	30	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Donalds Castle Creek (including no more than minor environmental consequences)	1	Review Subsidence Management TARPS for Donalds Castle Creek
			2	Submit the Subsidence Management Plan for Longwalls 20 - 21
1D2	30	Lineaments, faults and dykes result in impacts in excess of development consent conditions for Donalds Castle Creek (including no more than minor environmental consequences)	1	Nil Required
1D3	30	Groundwater drawdown result in impacts in excess of development consent conditions for Donalds Castle Creek (including no more than minor environmental consequences)	1	Review Subsidence Management TARPs for Donalds Castle Creek
1E1	30	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamps (no more than minor environmental impact without offsets), Tributaries to Wongawilli Creek and Donalds Castle Creek (as per EIS)	1	Review and update Subsidence Management TARPS in relation to Swamps, Tributaries to Wongawilli Creek and Donalds Castle Creek
1E2	30	Lineaments, faults or dykes result in impacts in excess of development consent conditions for Swamps (no more than minor environmental impact without offsets), Tributaries to Wongawilli Creek and Donalds Castle Creek (as per EIS)	1	Carry out an investigation to compare the impacts on lineaments from mining in the Western Coalfield (Springvale) and the Southern Coalfield. Outcomes of this investigation will inform lineament consideration in mine planning.
			2	Assess any correlation between piezometers response and lineaments for swamps, tributaries to Wongawilli Creek and Donalds Castle Creek. Outcomes of this investigation may influence future exploration drilling and assessment.
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	Nil Required

REF	Cons	HAZARD	TID	TREATMENT OPTIONS
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	Assess any correlation between groundwater fingerprinting (chemistry) and lineaments. Outcomes of this investigation will be considered in future mine design around lineaments.
			2	Assess any correlation between piezometers response and lineaments. Outcomes of this investigation may influence future exploration drilling and assessments.
			3	Review any impacts of surface subsidence associated with lineaments. Outcomes of this investigation will be included in the knowledge base to support subsidence modelling and assessments.
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	Assess any correlation between mine water chemistry and known geology due to Faults and Dykes. Outcomes of this investigation will be used in assessments of surface and groundwater impacts and mine design around faults and dykes

Attachment 4

Risk Treatment Schedule 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	Nil Required				
1A2	Lineaments result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference policy, minimal harm criteria) on groundwater quantity	1	Assess any correlation between groundwater fingerprinting (chemistry) and lineaments. Outcomes of this investigation will be considered in future mine design around lineaments.	Gary BRASSINGTON	Friday, 28 June 2019		
		2	Assess any correlation between piezometers response and lineaments. Outcomes of this investigation may influence future exploration drilling and assessments.	Gary BRASSINGTON	Friday, 28 June 2019		
		3	Review any impacts of surface subsidence associated with lineaments. Outcomes of this investigation will be included in the knowledge base to support subsidence modelling and assessments.	Gary BRASSINGTON	Friday, 28 June 2019		
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	Assess any correlation between mine water chemistry and known geology due to Faults and Dykes. Outcomes of this investigation will be used in assessments of surface and groundwater impacts and mine design around faults and dykes	Gary BRASSINGTON	Friday, 28 June 2019		
1B1	Surface subsidence and sub-surface ground movements result in impacts in excess of development consent conditions on water quantity.	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures	Gary BRASSINGTON	Friday, 28 June 2019		
1B2	Valley Closure (including basal shear) results in impacts in excess of development consent conditions on water quantity	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures	Gary BRASSINGTON	Friday, 28 June 2019		

ID	HAZARD	TID	TREATMENT OPTIONS	RESPONSIBILITY	IMPLEMENTATION	COMMENTS	COMPLETED (Sign Off)
1B3	Lineaments result in impacts in excess of development consent conditions on water quantity	1	Carry out an investigation to compare the impacts on lineaments from mining in the Western Coalfield (Springvale) and the Southern Coalfield. Outcomes of this investigation will inform lineament consideration in mine planning.	Gary BRASSINGTON	Friday, 28 June 2019		
		2	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures	Gary BRASSINGTON	Friday, 28 June 2019		
		3	Review any impacts of surface subsidence associated with lineaments. Outcomes of this investigation will be included in the knowledge base to support subsidence modelling and assessments.	Gary BRASSINGTON	Friday, 28 June 2019		
1B4	Faults and dykes result in impacts in excess of development consent conditions on water quantity	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures	Gary BRASSINGTON	Friday, 28 June 2019		
1B5	Groundwater drawdown results in impacts in excess of development consent conditions on water quantity	1	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures	Gary BRASSINGTON	Friday, 28 June 2019		
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	Review Subsidence Management TARPS for Wongawilli Creek	Gary BRASSINGTON	Wednesday, 31 July 2019		
		2	Submit the Subsidence Management Plan for Longwalls 20 and 21	Gary BRASSINGTON	Monday, 3 June 2019		
1C2	Lineaments, faults and dykes result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	Nil Required				

ID	HAZARD	TID	TREATMENT OPTIONS	RESPONSIBILITY	IMPLEMENTATION	COMMENTS	COMPLETED (Sign Off)
1C3	Groundwater drawdown result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	Review Subsidence Management TARPS in relation to Wongawilli Creek	Gary BRASSINGTON	Wednesday, 31 July 2019		
1D1	Valley Closure (including basal shear) results in impacts in excess of development consent conditions for Donalds Castle Creek (including no more than minor environmental consequences)	1	Review Subsidence Management TARPS for Donalds Castle Creek	Gary BRASSINGTON	Wednesday, 31 July 2019		
		2	Submit the Subsidence Management Plan for Longwalls 20 - 21	Gary BRASSINGTON	Monday, 3 June 2019		
1D2	Lineaments, faults and dykes result in impacts in excess of development consent conditions for Donalds Castle Creek (including no more than minor environmental consequences)	1	Nil Required				
1D3	Groundwater drawdown result in impacts in excess of development consent conditions for Donalds Castle Creek (including no more than minor environmental consequences)	1	Review Subsidence Management TARPs for Donalds Castle Creek	Gary BRASSINGTON	Wednesday, 31 July 2019		
1E1	Surface subsidence, sub-surface movements or valley closure result in impacts in excess of development consent conditions for Swamps (no more than minor environmental impact without offsets), Tributaries to Wongawilli Creek and Donalds Castle Creek (as per EIS)	1	Review and update Subsidence Management TARPS in relation to Swamps, Tributaries to Wongawilli Creek and Donalds Castle Creek	Gary BRASSINGTON	Wednesday, 31 July 2019		
1E2	Lineaments, faults or dykes result in impacts in excess of development consent conditions for Swamps (no more than minor environmental impact without offsets), Tributaries to Wongawilli Creek and Donalds Castle Creek (as per EIS)	1	Carry out an investigation to compare the impacts on lineaments from mining in the Western Coalfield (Springvale) and the Southern Coalfield. Outcomes of this investigation will inform lineament consideration in mine planning.	Gary BRASSINGTON	Friday, 28 June 2019		
		2	Assess any correlation between piezometers response and lineaments for swamps, tributaries to Wongawilli Creek and Donalds Castle Creek. Outcomes of this investigation may influence future exploration drilling and assessment.	Gary BRASSINGTON	Friday, 28 June 2019		

Attachment 5

Risk Rank Order

Associated with Lineaments

REF	Risk	HAZARD	TID	TREATMENT OPTIONS
1C2	3	Lineaments, faults and dykes result in impacts in excess of development consent conditions for Wongawilli Creek (including no more than minor environmental consequences)	1	Nil Required
1E2	3	Lineaments, faults or dykes result in impacts in excess of development consent conditions for Swamps (no more than minor environmental impact without offsets), Tributaries to Wongawilli Creek and Donalds Castle Creek (as per EIS)	1	Carry out an investigation to compare the impacts on lineaments from mining in the Western Coalfield (Springvale) and the Southern Coalfield. Outcomes of this investigation will inform lineament consideration in mine planning.
			2	Assess any correlation between piezometers response and lineaments for swamps, tributaries to Wongawilli Creek and Donalds Castle Creek. Outcomes of this investigation may influence future exploration drilling and assessment.
1A2	1	Lineaments result in impacts in excess of development consent conditions (and Groundwater Licence, Aquifer Interference policy, minimal harm criteria) on groundwater quantity	1	Assess any correlation between groundwater fingerprinting (chemistry) and lineaments. Outcomes of this investigation will be considered in future mine design around lineaments.
			2	Assess any correlation between piezometers response and lineaments. Outcomes of this investigation may influence future exploration drilling and assessments.
			3	Review any impacts of surface subsidence associated with lineaments. Outcomes of this investigation will be included in the knowledge base to support subsidence modelling and assessments.
1B3	0.9	Lineaments result in impacts in excess of development consent conditions on water quantity	1	Carry out an investigation to compare the impacts on lineaments from mining in the Western Coalfield (Springvale) and the Southern Coalfield. Outcomes of this investigation will inform lineament consideration in mine planning.
			2	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment. Outcomes of this discussion paper will be used to define future monitoring and management procedures
			3	Review any impacts of surface subsidence associated with lineaments. Outcomes of this investigation will be included in the knowledge base to support subsidence modelling and assessments.
1D2	0.9	Lineaments, faults and dykes result in impacts in excess of development consent conditions for Donalds Castle Creek (including no more than minor environmental consequences)	1	Nil Required

Attachment 6

Summary of Actions and Outcomes

ID	Treatment Options	Outcome	Action
1A2 1A3	Assess any correlation between groundwater fingerprinting (chemistry) and lineaments. Assess any correlation between mine water chemistry and known geology due to Faults and Dykes.	Commission an investigation that assesses any correlation between mine water chemistry and known or inferred geological features. Outcomes from the investigation to be incorporated into various technical models, drilling exploration plans, mine design considerations.	1
1A2 1E2	Assess any correlation between piezometers response and lineaments. Assess any correlation between piezometers response and lineaments for Swamps, Tributaries to Wongawilli Creek and Donalds Castle Creek.	Commission an investigation that assesses any correlation between piezometers response and lineaments (inlcuding Swamps, Tributaries to Wongawilli Creek and Donalds Castel Creek). Outcomes of the investigation to be incorporated into various technical models, drilling exploration plans, mine design considerations.	2
1B1, 1B2, 1B3, 1B4, 1B5	Complete a discussion paper on "Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment.	Complete a discussion paper on "total Catchment Water Budget and Processes" relevant to the aspects identified in this Risk Assessment.	3
1B3, 1E2	Carry out an investigation to compare the impacts on lineaments from mining in the Western Coalfield (Springvale) and the Southern Coalfield.	Commission an investigation which aims to compare the impacts on lineaments from mining in the Western Coalfield (Springvale) and the Southern Coalfield, including Dendrobium Mine.	4
1A2, 1B3	Review any impact of surface subsidence associated with lineaments.	Commission an investigation to review any impact of surface subsidence associated with lineaments. Outcomes of the investigation to be incorporated into various technical models, drilling exploration plans, mine design considerations.	5
1C1, 1C3, 1D1, 1D3, 1E1	Review Subsidence Management TARPS for Wongawilli Creek. Review Subsidence Management TARPS for Donalds Castle Creek. Review and update Subsidence Management TARPS in relation to Swamps, Tributaries to Wongawilli Creek and Donalds Castle Creek.	Review Subsidence Management TARPS for Dendrobium Area 3B (inlcuding Wongawilli Creek, Donalds Castler Creek, Swamps and Tributaries).	6
1C1, 1D1	Submit the Subsidence Management Plan for Longwalls 20 - 21.	Submit the Subsidence Management Plan for Longwalls 20 and 21.	7