

Appendix O

Environmental Risk
Assessment



Narrabri Underground Mine Stage 3 Extension Project

Environmental Impact Statement



Operational Risk Mentoring
Practical Solutions for Operational Risk Management

Narrabri Underground Mine Stage 3 Extension Project

Environmental Risk Assessment

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Date of Team Review: 20th September 2019

Job Number: ORMJ1803

Version: 3

Date: 8/10/20

**Narrabri Underground Mine Stage 3 Extension Project
Environmental Risk Assessment**

DOCUMENT CONTROL AND DISTRIBUTION

Document No.	ORMJ1803
Title	Narrabri Underground Mine Stage 3 Extension Project – Environmental Risk Assessment
General Description	Report on the team-based risk assessment.
Key Supporting Documentation	<ul style="list-style-type: none">• AS/NZ ISO 31000:2018 <i>Risk management – Guidelines</i> (Standards Australia, 2018);• HB 203:2012 <i>Managing environment-related risk</i> (Standards Australia, 2012);• MDG1010 <i>Minerals Industry Safety and Health Risk Management Guideline</i> (Department of Trade and Investment, 2011);• <i>Secretary's Environmental Assessment Requirements for the Narrabri Underground Stage 3 Extension Project</i>; and• <i>Whitehaven Coal Standard - Risk Management</i> (Whitehaven Coal Limited, 2019).

Version

Version	Date	Description	Created By	Reviewed
3	8/10/2020	Final report issued.	PNS	

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1 INTRODUCTION

The Narrabri Mine is located approximately 25 kilometres (km) south-east of Narrabri and approximately 60 km north-west of Gunnedah within the Narrabri Shire Council Local Government Area of New South Wales (NSW) (Figure 1). The Narrabri Mine is operated by Narrabri Coal Operations Pty Limited (NCOPL).

NCOPL is seeking a new Development Consent under the State Significant Development provisions of Part 4 of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) for the Narrabri Underground Mine Stage 3 Extension Project (the Project). This risk assessment forms part of the Environmental Impact Statement (EIS) which has been prepared to accompany the Development Application for the Project. The Secretary's Environmental Assessment Requirements (SEARs) for the Project were issued on 20 November 2019. This Environmental Risk Assessment (ERA) addresses the requirements in the SEARs relating to risk assessment, which states:

The Environmental Impact Statement (EIS) for the development must comply with the requirements in Clauses 6 and 7 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000. In particular, the EIS must include:

...

- *a risk assessment of the potential environmental impacts of the development, identifying key assessment issues;*

1.1 AIM AND OBJECTIVES

A workshop was held in September 2019 with various personnel from NCOPL and other organisations. The aim of the workshop/team session was:

To conduct a risk assessment of the potential impacts of the Project, identifying the key issues for further assessment.

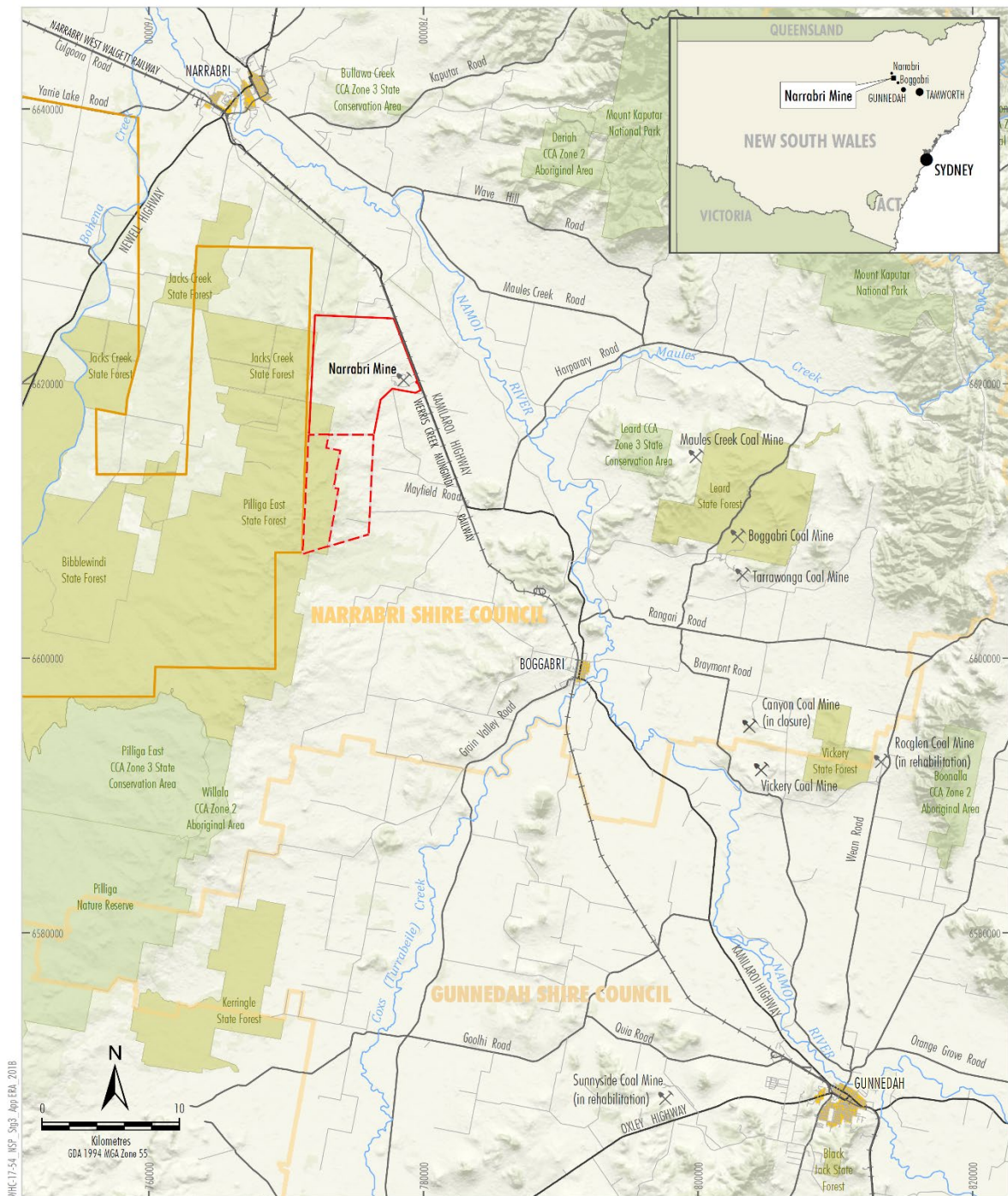
The ERA team identified that the desired outcomes of the workshop and subsequent reporting was to:

1. identify key issues to be addressed in the EIS;
2. identify potential controls and consider whether these controls would be adequate; and
3. develop a document suitable for inclusion in the Project EIS and prepared in accordance with Australian Standard/New Zealand Standard International Standards Organisation (AS/NZS ISO) 31000:2018 *Risk management – Guidelines* (AS/NZS ISO 31000:2018).

A list of terms, acronyms and abbreviations and their definitions is provided in Attachment A.

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Figure 1 – Regional Location



WHE17-54, NSP3, Sep 3, Apr EIA, 2018

- LEGEND**
- Mine Site
 - Mining Lease (ML 1609)
 - Provisional Mining Lease Application Area
 - Local Government Boundary
 - State Forest
 - State Conservation Area, Aboriginal Area
 - Narrabri Gas Project (Santos NSW [Eastern] Pty Ltd)

Source: Geoscience Australia (2011); NSW Spatial Services (2019)

WHITEHAVEN COAL
NARRABRI STAGE 3 PROJECT
Regional Location

Figure 1

Narrabri Underground Mine Stage 3 Extension Project Environmental Risk Assessment

1.2 CLIENT

The client for the ERA is NCOPL.

1.3 SCOPE

The scope of the ERA was to conduct a risk assessment of the potential environmental impacts of the Project, identifying the key issues for further assessment.

Section 1.7 outlines the methodology and key steps adopted for the ERA process.

1.4 CLARIFYING POINTS AND ASSUMPTIONS

The following clarifying points and assumptions regarding the scope were made:

- Regulatory requirements and/or approval risks, technical assessment issues, safety issues and business aspects were not within the scope of the workshop (these non-environmental matters are considered by NCOPL in other risk management forums and activities).
- The geographical extent of the Project was understood to include the Project area, which is described in Section 2 of the EIS.
- The risk assessment was intended to cover all environmental aspects of the Project, including the key issues outlined in the SEARs for the Project (excluding issues relating to community consultation/engagement, which are risk-assessed as part of the Project Social Impact Assessment).
- Cumulative impacts of past, present and reasonably foreseeable actions should be considered.
- Existing and currently planned controls would continue to be undertaken for the Project.

1.5 RISK ASSESSMENT PROCESS

The risk assessment process was based on the framework provided on Figure 2 (based on AS/NZS ISO 31000:2018, MDG1010 *Minerals Industry Safety and Health Risk Management Guideline* [NSW Department of Trade and Investment, 2011] and HB 203:2012 *Managing environment-related risk* [HB 203:2012]).

This ERA draws upon the outcomes of a team workshop in September 2019.

1.6 RESOURCING, SCHEDULE AND ACCOUNTABILITIES

The following resources were allocated in order to effectively conduct the ERA:

- a team of personnel with suitable experience and knowledge of the Narrabri Mine, coal mining operations generally and environmental issues associated with the Project;
- a team of subject matter experts available to review the online version of the modified report;
- external facilitators for the risk assessment and write-up of results; and
- aerial photographs, drawings, the SEARs for the Project and other supporting information.

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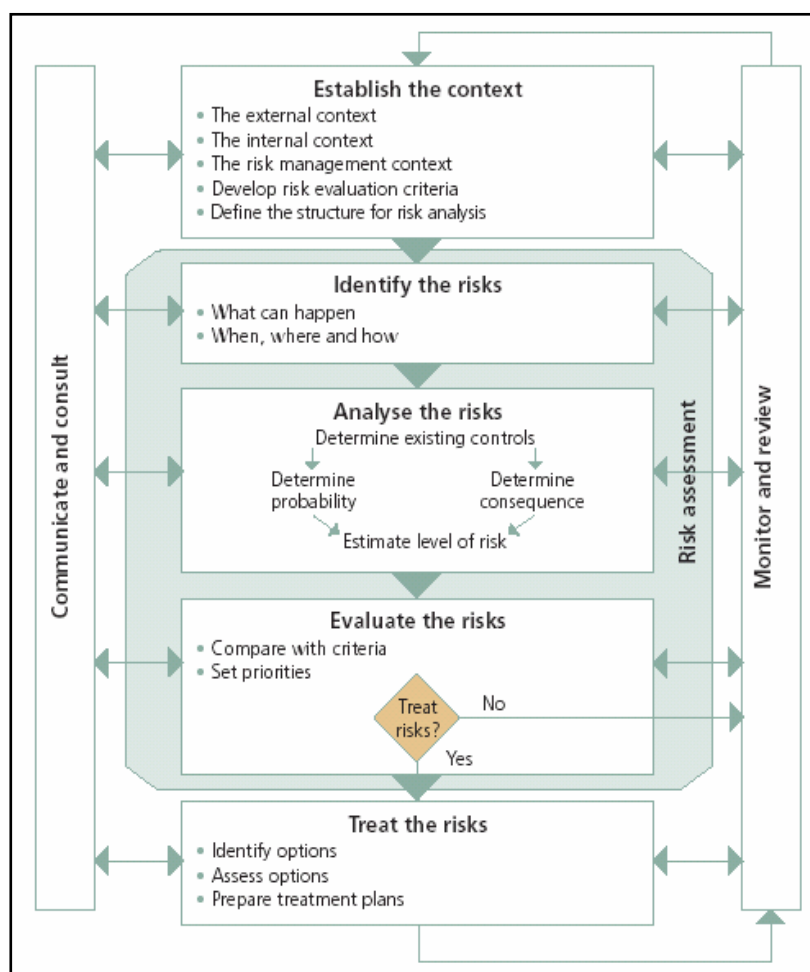
It was understood by the team that the outcomes of the ERA and associated accountabilities would be integrated into the EIS and, upon Project approval, into the overall NCOPL management systems so that they are effectively reviewed, implemented and monitored.

1.7 METHODOLOGY

1.7.1 Framework

Figure 2 outlines the overall framework utilised for the ERA. This framework is further discussed in Section 1.7.2 with respect to the Project area.

Figure 2 – Risk Management Process (AS/NZS ISO 31000:2018)



Source: After AS/NZS ISO 31000:2018.

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1.7.2 Key Steps

The key steps in the process undertaken at the September 2019 workshop and in associated desktop analyses included:

1. confirming the scope of the ERA;
2. listing the key assumptions and clarifying points (if made/identified) on which the ERA is based;
3. reviewing available data on the Project including reports, plans, maps and aerial photos (both prior to, and during, the workshop);
4. conducting a team-based risk assessment that:
 - a) provided detailed descriptions of the tasks to be undertaken and the proposed method;
 - b) identified hazards and assessed the level of risk; and
 - c) developed a list of recommended controls to treat the risk (through prevention, monitoring, management and rehabilitation strategies);
5. preparing a draft report in accordance with AS/NZS ISO 31000:2018 and MDG1010 *Minerals Industry Safety and Health Risk Management Guideline* (Department of Trade and Investment, 2011) for review by NCOPL personnel, subject matter experts and ERA team members;
6. incorporating comments from reviewers; and
7. finalising the report and issue as controlled copy for ongoing use.

With respect to the overall framework (Figure 2), steps 1 to 3 above represent the ‘establish the context’ phase and steps 4 and 5 represents the “identify risks”, “analyse risks”, “evaluate risks” and “treat risks” phases.

As described in Section 1.6 above, the outcomes of the ERA and associated accountabilities will be integrated into the EIS and, upon Project approval, into the overall NCOPL management systems so that they are effectively reviewed, implemented and monitored.

1.7.3 External Facilitation

The team was facilitated through the process by **Operational Risk Mentoring** – a company specialising in Risk Assessment and risk management programmes. The facilitator, Dr Peter Standish, is experienced with underground coal mining and many aspects of environmental monitoring and rehabilitation.

The team was encouraged and challenged to identify a wide range of environmental impacts or hazards.

It is important to understand that the outcomes of this ERA:

- are process-driven;
- challenge current thinking and may not necessarily appear appropriate or reflect pre-conceived ideas; and
- are the result of the team assembled to review the topic and not the result of any one individual or organisation.

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2 ESTABLISH THE CONTEXT

2.1 PROJECT SUMMARY

The Project involves an extension to the south of the approved underground mining area to gain access to additional coal reserves within Mining Lease Applications (MLAs) 1 and 2 (Figure 3), an extension of the mine life to 2044 and development of supporting surface infrastructure. Run-of-mine coal production would occur at a rate of up to 11 million tonnes per annum, consistent with the currently approved limit.

A detailed description of the Project is provided in Section 2 in the Main Report of the EIS.

This ERA forms part of the EIS that has been prepared to accompany the development application made for the Project under Part 4 of the EP&A Act.

2.2 RISK MANAGEMENT CONTEXT

This ERA has been conducted in accordance with the SEARs for the Project (Section 1).

In addition, the ERA was prepared cognisant of the following documents:

- AS/NZ ISO 31000:2018;
- HB 203:2012;
- MDG1010 *Minerals Industry Safety and Health Risk Management Guideline* (Department of Trade and Investment, 2011); and
- *Whitehaven Coal Standard - Risk Management* (Whitehaven Coal Limited [Whitehaven], 2019).

In addition, the key potential environmental issues identified in the *Narrabri Underground Mine Stage 3 Extension Project – Scoping Report* were also considered in this ERA (NCOPL, 2019).

2.3 RISK CRITERIA

The risk criteria utilised is to reduce the risk to 'as low as reasonably practicable' (ALARP) or lower. Figure 4 schematically shows the three risk management zones viz. intolerable, ALARP and tolerable. The middle zone is referred to as the ALARP zone.

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Figure 3 – Approved and Project General Arrangement

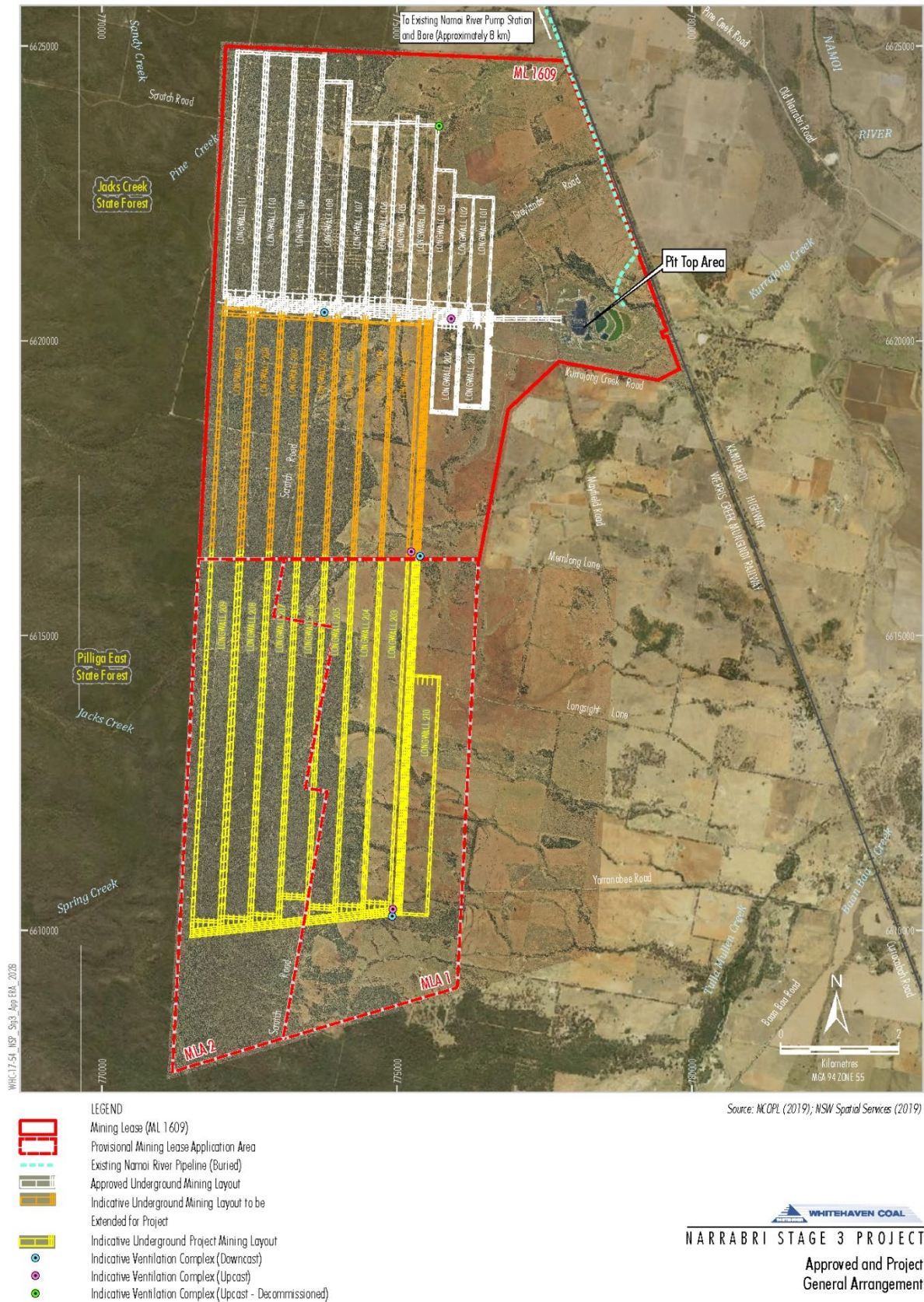
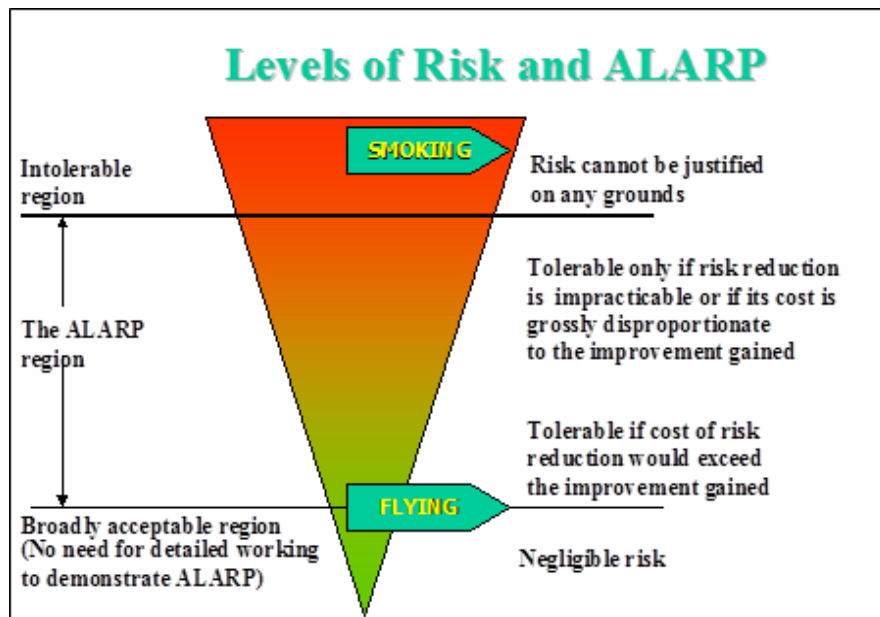


Figure 3

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Figure 4 – Risk Criteria "ALARP"



Flying is an example of a risk considered by most people to be a tolerable risk; whilst smoking is generally considered to be an activity which cannot be justified from a risk perspective. This is shown graphically in Figure 4. Intolerable items, such as smoking, are at the top of the pyramid, while much lower risks, such as flying, sit at the lower end of the ALARP zone (close to tolerable).

The risk ranking matrices used during the ERA workshop are presented in Section 4.

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3 IDENTIFY RISKS

3.1 OVERVIEW

The identification of risks involved the use of risk assessment tools appropriate for identifying potential loss scenarios associated with the Project. The tools used were:

- Introduction – before the potential issues were identified it was important that the whole team had a good understanding of the Project, and this was confirmed by the facilitator.
- Brain-writing – this was used to draw out the main issues using the understanding, relevant experience and knowledge of the team. This session also used prompt words to build on the experience base of the team and identify any potential environmental issues and potential loss scenarios.
- Modified hazard and operability (HAZOP) analysis – this involved the review of key words (drawn from the SEARs for the Project) and aerial photographs, and the consequent identification of potential environmental issues at each location during each phase of operation.
- Online issues collection – with team members participating in a process similar to the Modified HAZOP process, but using an online technique allowing for real-time and sequential input to the study.

3.2 ENVIRONMENTAL RISK ASSESSMENT TEAM

The review team met for the ERA workshop in Brisbane on 20 September 2019. A team-based approach was utilised in order to have an appropriate mix of skills and experience to identify the potential environmental issues and potential loss scenarios. Details of the team members and their relevant qualifications and experience are included in Table 1.

3.3 RISK IDENTIFICATION

3.3.1 *Brain-writing*

The brain-writing process is intended to allow for the generation of relatively unstructured, free-flowing series of issues and ideas. It is enhanced through the use of key word association processes based on work by Edward de Bono and is intended to generate a wide range of data on losses, controls and general issues related to the Project area. Team members submitted their written issues via email prior to the commencement of the team session, and these were added to in an initial, unstructured, ideation session at the start of the risk identification phase of the analysis.

No filtering of the data is allowed during the process – and the reader should be conscious of the intent of not missing a potential left field issue/loss scenario when reading through the material.

Issues identified during the sessions are presented in the consolidated listing of issues identified in Attachment B.

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Table 1 – ERA Team

Name	Affiliation	Skills and Experience
David Ellwood	Director - Narrabri Coal Operations Stage 3 Project, Whitehaven	Formal surveying and mining qualifications and over 15 years of industry experience.
Mark Vile	Environmental Coordinator – Narrabri Coal Operations Stage 3 Project, Whitehaven	BEnvSc (Hons), 18 years of experience in environmental impact assessment in mining and infrastructure development.
Brent Baker	Environmental Superintendent, Whitehaven	BEnvMgt, 11 years environmental experience in the resource industry.
Keith Philipson	Principal Consultant and Senior Groundwater Modeller/Hydrogeologist, AGE	MSc, Hydrogeology, consulting and government experience in groundwater and over 20 years of industry experience.
Peter Khor	Senior Hydrogeologist, AGE	MSc, Hydrogeology, consulting and government experience in groundwater and over 10 years of industry experience.
Greg Roads	Director and Senior Principal Engineer, WRM	BEng (Civil) (Hons), 26 years of experience in the water industry and environmental planning.
Steve Ditton	Director and Principal Geotechnical Engineer, Ditton Geotechnical Services	BEng (Geotechnical and Structural) (hons) and over 25 years of industry experience.
Matthew Whincop	Director, Whincop Archaeology	PhD (Archaeology), over 20 years of experience with archaeological research and cultural heritage in mining and infrastructure projects.
Bronwyn Cameron	Principal Consultant, 2rog	PhD, B Rural Science (Hons), government background and over 20 years of experience in natural resource management.
Peter Cribb	Director and Principal, Resource Strategies	BAGSc (Land Resource Management), over 20 years of experience in environmental management and approvals of resource projects.
Clive Berry	Senior Environmental Project Manager, Resource Strategies	BEng (Environmental), over 17 years of experience in environmental management and project approvals in the resource industry.
Jamie Gleeson	Senior Environmental Project Manager and Senior Ecologist, Resource Strategies	BSc (Hons), over 17 years of experience in environmental management and project approvals in the resource industry.
Alessandro Kennedy	Environmental Project Manager, Resource Strategies	BEng (Civil and Environmental) (Hons), over 5 years of experience in environmental management and project approvals in the resource industry.
Sophie Cannon	Environmental Project Manager, Resource Strategies	BEnvMgt (Hons) and over 12 months of environmental consulting experience in the resource industry.
Peter Standish	Director and Principal Consultant, OpRM	PhD (Mining Engineering), over 30 years of experience in the resource sector including multiple risk analyses on environmental matters.

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3.3.2 Modified HAZOP

The next tool applied with the team was that of a modified HAZOP. In this process the aerial photographs of the site were referred to along with a consideration of the phases of operation and the potential impacts that could arise.

The generic key words used in the HAZOP process representing environmental issue subject areas (generally based on the headings in the SEARs for the Project) were:

- Built Features.
- Water.
- Land and Agriculture.
- Noise.
- Air Quality.
- Biodiversity.
- Heritage.
- Visual.
- Road Transport.
- Social.
- Economic.

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4 ANALYSE AND EVALUATE RISKS

4.1 PRIORITISATION

The key potential environmental issues were identified through a prioritising process where team members were assigned an amount of funds¹ to allocate across the available issues. Key issues are those that attracted the most funds.

The results are shown in Table 2 in descending priority. This provided a method to identify and sort initial concerns at an early stage.

Table 2 – Key Potential Environmental Issues

Ref.	Description of Issue	Aspect Type	Priority Indicator
IS034/ IS030	Impacts on biodiversity as a result of progressive clearing for surface infrastructure development.	Biodiversity	1680
IS040	Groundwater impacts (as a result of drawdown/depressurisation) including consideration of the Namoi Alluvium Zone 5 extraction bore.	Water	1210
IS010	Impacts to groundwater bores not owned by NCOPL as a result of drawdown/depressurisation.	Water	1055
IS070	Noise impacts from ventilation and other surface infrastructure.	Noise	1005
IS002	Groundwater impacts, in particular on Biophysical Strategic Agricultural Land (BSAL), as a result of hydraulic connectivity.	Water	610
IS071/ IS007/ IS036/ IS077	Impacts on springs and groundwater dependent ecosystems as a result of groundwater drawdown or subsidence effects.	Water	575
IS033	Impacts to overland ephemeral surface water flow due to changes in surface topography resulting from subsidence.	Water	535
IS026/ IS076	Impacts to groundwater quality as a result of the management and/or use of brine post-closure.	Water	525
IS068	Cumulative groundwater impacts of the Project, including the Narrabri Gas Project.	Water	510
IS021/ IS004/ IS029	Degradation (e.g. erosion, ponding) of drainage and/or creek lines as a result of subsidence effects.	Water	235
IS064	Scope 1, 2 and 3 Greenhouse Gas emissions resulting from construction and operation of the Project.	Air Quality	150
IS014	Disturbance and/or harm to Aboriginal cultural heritage sites and objects as a result of installation of surface infrastructure.	Heritage	120

¹ This is based on work documented by Robert Cialdini and separately Annie Duke in their respective texts, *Influence* and *Thinking in Bets*. Psychological and neurological studies support the increased level of attention paid to a subject when there is money on the line.

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Ref.	Description of Issue	Aspect Type	Priority Indicator
IS008	Reduction in baseflow to Namoi River and tributaries due to reverse of groundwater gradient resulting from depressurisation.	Water	110
IS022/ IS018	Reduced agricultural productivity on NCOPL-owned land due to impacts from mine infrastructure (reduction in available area, increased erosion) and subsidence effects.	Land and Agriculture	100
IS003	Impacts to dry sclerophyll forest and woodland/forest as a result of subsidence-related ponding.	Biodiversity	80
IS039	Impacts to dispersive soils due to subsidence effects including ponding and loss of soils into surface cracks.	Land and Agriculture	55
IS001	Potential subsidence-related surface cracking in inaccessible woodland/forest that is too significant to self-remediate.	Land and Agriculture	50
IS035	Impacts on future land use as a result of ongoing surface movement due to subsidence.	Land and Agriculture	50

The key issues identified in the ERA (Table 2) are addressed in in Section 6 of the EIS and the assessments prepared by specialists included as appendices to the EIS.

4.2 PROBABILITY AND MAXIMUM REASONABLE CONSEQUENCE

Potential loss scenarios (primarily based on the identified key potential environmental issues) were ranked for risk by the ERA team. A tabular analysis was used for this risk ranking process, based on the probability and consequence of a loss scenario occurring as decided by the ERA team.

The following definition of risk was used:

- the combination of the probability of an unwanted event occurring; and
- the maximum reasonable consequences (MRCs) should the event occur.

Tables 3 to 5 present the ERA matrix tools that were utilised for ranking risks.

Table 3 – Measures of Probability

Event	Likelihood	Description	Quantification
A	Almost Certain	The event is expected to occur in most circumstances	Typically occurs once per day to one week
B	Likely	The event will probably occur in most circumstances	Typically occurs once per week to one month
C	Occasional	The event should occur at some time	Typically occurs once per month to one year
D	Unlikely	The event could occur at some time	Typically occurs once in one to five years
E	Rare	The event may only occur in exceptional circumstances	Typically occurs once in five to ten years

Source: Whitehaven (2019).

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Table 4 – Measures of Maximum Reasonable Consequence

Level	Description	Environment	Economics
5	Catastrophic	Unconfined detrimental impact requiring long term recovery leaving major residual damage (typically years)	>\$50M
4	Major	Unconfined detrimental impact requiring medium term recovery leaving residual damage (typically months)	\$10M - \$50M
3	Medium	Near source confined detrimental impact requiring medium term recovery (typically months) Unconfined detrimental impact requiring short term recovery (typically weeks)	\$2M - \$10M
2	Minor	Near source confined reversible impact requiring short term recovery (typically a week)	\$100K - \$2M
1	Insignificant	Near source confined negligible or temporary impact (typically a shift)	<\$100K

Source: Whitehaven (2019).

Table 5 – Risk Ranking Matrix

Likelihood	Consequence level					
		Insignificant (1)	Minor (2)	Medium (3)	Major (4)	Catastrophic (5)
	Almost Certain (A)	Moderate	High	High	Critical	Critical
	Likely (B)	Moderate	Moderate	High	High	Critical
	Occasional (C)	Low	Moderate	High	High	High
	Unlikely (D)	Low	Low	Moderate	Moderate	High
	Rare (E)	Low	Low	Moderate	Moderate	High

Legend – Risk Levels:

Risk	Critical	Risks that significantly exceed the risk acceptance threshold. Immediate attention needed, stop the job.
	High	Risks that exceed the risk acceptance threshold. Additional risk control measures required. If further risk control measures are not practicable the responsible Manager must sign off.
	Moderate	Risks acceptance threshold. Additional control measures could be implemented to control risks further. Active monitoring of risk control measures required.
	Low	Risks that are below the risk acceptance threshold. No additional control measures required. Monitoring of risks may be needed.

Source: Whitehaven (2019).

4.3 RISK RANKING

Risk ranking was undertaken by the team on loss scenarios based on the key potential environmental issues, as provided in Table 6. The risk descriptions presented in Table 6 correlate with the issues identified in Table 2.

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Table 6 – Risk Ranking Results

Aspect Type	Risk Description	Ranking Basis/Loss Scenarios	P ¹	C ²	R ³
Water	Impacts to Namoi Alluvium resulting from dewatering of mine and extraction from the Namoi Zone 5 groundwater bore.	<i>Risk ranking basis:</i> Near source drawdown anticipated, with no material impacts to the Namoi Alluvium. Minor loss of the resource. <i>Planned controls:</i> Integrated ⁴ groundwater and surface water assessment; acquisition of sufficient water licences; and groundwater and surface water monitoring programmes.	A	1	Moderate
Water	Dewatering of porous rock aquifers adjacent to coal seam.	<i>Risk ranking basis:</i> Significant depressurisation to porous rock aquifers expected. Impacts on springs and groundwater dependent ecosystems are not expected due to porous rock impacts. <i>Planned controls:</i> Integrated ⁴ groundwater and surface water assessment; acquisition of sufficient water licences; and groundwater and surface water monitoring programmes.	A	1	Moderate
Water	Impacts to springs and groundwater dependent ecosystems due to groundwater drawdown.	<i>Risk ranking basis:</i> Potential terrestrial groundwater dependent ecosystems have been mapped in the Project area and some potential springs occur in the Project area and nearby. Groundwater modelling indicates that groundwater depressurisation in the vicinity of these features is generally limited. <i>Planned controls:</i> Characterisation of potentially impacted groundwater dependent ecosystems and springs; integrated ⁴ groundwater and surface water assessment; validation of groundwater model and groundwater and surface water monitoring programmes.	D	5	Low
Biodiversity	Loss of habitat due to vegetation clearance.	<i>Risk ranking basis:</i> Near source and confined reversible impact anticipated as loss of habitat will occur where clearing for surface infrastructure development is required. Loss of tree hollows and fragmentation of habitat for fauna. <i>Planned controls:</i> Impact avoidance, through relocation of surface infrastructure, where possible, mitigation (rehabilitation) and implementation of biodiversity offsets. Salvage and relocation of habitat resources in accordance with the Vegetation Clearance Protocol.	B	2	Moderate
Biodiversity	Loss of flora and/or fauna due to vegetation clearance.	<i>Risk ranking basis:</i> Minor and near source impact on threatened fauna and flora. <i>Planned controls:</i> Vegetation Clearance Protocol and implementation of biodiversity offsets.	A	1	Moderate

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Aspect Type	Risk Description	Ranking Basis/Loss Scenarios	P ¹	C ²	R ³
Noise	Noise impacts on local landholders from ventilation shafts, gas drainage, drilling and other surface construction requirements.	<i>Risk ranking basis:</i> Planned controls including siting of noisy infrastructure would limit potential for noise exceedances. <i>Planned controls:</i> Noise control measures, mitigation at receptors and land acquisition.	E	1	Low
Water	Water management system failure resulting in release of brine to the environment.	<i>Risk ranking basis:</i> Release of brine considered to be unlikely due to planned controls. <i>Planned controls:</i> Site water balance for development of site water management system, including brine management strategy. Design and construction of brine storage to appropriate standards.	D	1	Low
Water	Ponding of drainage and/or creek lines due to subsidence effects.	<i>Risk ranking basis:</i> Minor ponding impacts are predicted (primarily 1 st and 2 nd order streams). Potential for minor, short-term loss of vegetation. Subsidence predictions have proven reliable. <i>Planned controls:</i> Integrated ⁴ subsidence and surface water impact assessment and subsidence monitoring and remediation of ponding.	B	1	Moderate
Air Quality	Scope 1, 2 and 3 Greenhouse Gas emissions resulting from construction and operation of the Project.	<i>Risk ranking basis:</i> Certain to be scope 1, 2 and 3 greenhouse gas emissions resulting from the Project - very minor proportion of global emissions. <i>Planned controls:</i> Active and adaptive management of scope 1 and 2 emissions through selection and use of energy efficient plant.	A	1	Moderate
Heritage	Impacts to Aboriginal cultural heritage items due to surface infrastructure development and/or subsidence effects.	<i>Risk ranking basis:</i> Potential for harm to Aboriginal cultural heritage sites arising from surface clearing activities. Surface artefact scatters can withstand impacts associated with subsidence. <i>Planned controls:</i> Aboriginal cultural heritage surveys; Aboriginal Cultural Heritage Assessment report prepared in consultation with Registered Aboriginal Parties (RAPs); and implementation of Aboriginal cultural heritage management measures during construction and operation (including salvage, chance finds protocol and RAP consultation).	C	1	Low
Land and Agriculture	Reduced agricultural productivity due to subsidence effects (cracking, ponding).	<i>Risk ranking basis:</i> Near source impacts on agricultural land are very likely. <i>Planned controls:</i> Integrated ⁴ subsidence, surface water and agricultural impact assessment and subsidence monitoring and remediation.	A	1	Moderate

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Aspect Type	Risk Description	Ranking Basis/Loss Scenarios	P ¹	C ²	R ³
Agricultural Productivity	Loss of BSAL as a result of subsidence-related groundwater impacts.	<i>Risk ranking basis:</i> Minor impact on BSAL present in Project area. Mapped BSAL does not support irrigated cropping. <i>Planned controls:</i> Integrated ⁴ subsidence, surface water and agricultural impact assessment and subsidence monitoring and remediation. Rehabilitation of disturbance areas.	D	1	Low
Land and Agriculture	Increased footprint of Rejects Emplacement Area due to Project rejects and emplacement of drill cuttings from drilling programmes.	<i>Risk ranking basis:</i> Potential for increased footprint with consideration of stability issues. <i>Planned controls:</i> Geochemistry assessment will characterise materials emplaced to confirm they are manageable. Geotechnical/stability review to be conducted.	A	1	Moderate
Air Quality	Fumes or other emissions resulting from spontaneous combustion of coal, particulate matter from stockpiles or other sources relating to Project operations.	<i>Risk ranking basis:</i> Material particulate matter and odour emissions unlikely based on planned controls. <i>Planned controls:</i> Trigger Action Response Plan in place for stockpile dust suppression and active management of fume/dust-generating activities on site. Air quality modelling to identify predicted performance; implementation of air quality mitigation measures; and air quality monitoring programmes.	B	1	Moderate
Subsidence	Impacts on rocky outcrops/features due to subsidence effects.	<i>Risk ranking basis:</i> Potential for rockfalls, excessive cracking and instability of rocky features such as Bulga Hill. <i>Planned controls:</i> Mitigated by NCOPL decision to reduce the southern extent of longwall mining in LWs 205 and 206, reducing subsidence effects to low levels. Subsidence monitoring and remediation of rock falls and subsidence cracks as required by the Land Management Plan (Eco Logical Australia, 2017) (or the latest approved version).	D	1	Low

¹ Refer to Table 3.

² Refer to Table 4.

³ Refer to Table 5.

⁴ Related aspects are addressed consistently between assessments.

5 MONITOR AND REVIEW

5.1 NOMINATED COORDINATOR

The nominated client review facilitator is David Ellwood, Director Narrabri Coal Operations Stage 3 Project, Whitehaven.

It is understood the nominee will coordinate the inclusion of the key potential environmental issues into the various studies undertaken as part of the EIS and the overall NCOPL management systems.

5.2 COMMUNICATION AND CONSULTATION

Consultation, involvement of personnel (NCOPL and their specialists) and communication of the process and outcomes of the ERA are intended to be achieved by the inclusion of this report and the relevant specialist assessments addressing the key potential environmental issues in the EIS, and consideration of the report's outcomes in the overall NCOPL management systems.

5.3 CONCLUDING REMARKS

The risk assessment process conducted by the team was aligned with AS/NZS ISO 31000:2018 and MDG1010 *Minerals Industry Safety and Health Risk Management Guideline* (Department of Trade and Investment, 2011), with the intention of identifying the key potential environmental issues for the Project.

The risk rankings indicate that the loss scenarios ranked were within the Moderate or the Low range.

OpRM would like to thank all the personnel who contributed to the risk assessment, in particular those personnel from NCOPL and Resource Strategies who prepared source material for the team session.

Peter Standish, August, 2020

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6 REFERENCES

Department of Trade and Investment (2011) *MDG1010 Minerals Industry Safety and Health Risk Management Guideline*.

Eco Logical Australia (2017) *Narrabri Mine Land Management Plan (LW107 to LW 110)*.

Narrabri Coal Operations Pty Limited (2019) *Narrabri Underground Mine Stage 3 Extension Project – Scoping Report*.

Standards Australia (2018) *Australian Standard/New Zealand Standard International Standards Organisation 31000:2018 Risk management – Guidelines*.

Standards Australia (2012) *HB 203:2012 Managing environment-related risk*.

Whitehaven Coal Limited (2019) *Whitehaven Coal Standard - Risk Management*.

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ATTACHMENT A – DEFINITIONS

Table A1 – Definitions

Term	Explanation
ALARP	“As Low As Reasonably Practicable”. The level of risk between tolerable and intolerable levels that can be achieved without expenditure of a disproportionate cost in relation to the benefit gained.
AS/NSZ ISO 31000:2018	Australian Standard/New Zealand Standard on Risk Management (see references in Section 6).
Cause	A source of harm.
Control	An intervention by the proponent intended to either prevent a cause from becoming an incident or to reduce the outcome should an incident occur.
SEARs	Secretary’s Environmental Assessment Requirements.
ERA	Environmental Risk Assessment.
MDG1010	Department of Primary Industries guideline on risk management (see references in Section 6).
MRC	Maximum Reasonable Consequence
NCOPL	Narrabri Coal Operations Pty Limited
OpRM	Abbreviation - Operational Risk Mentoring (a trading name of Salbury Pty Ltd).
Outcome	The end result following the occurrence of an incident. Outcomes are analogous to impacts and have a risk ranking attached to them.
Personnel	Includes all people working in and around the site (e.g. all contractors, sub-contractors, visitors, consultants, project managers, etc.).
Practicable	The extent to which actions are technically feasible, in view of cost, current knowledge and best practices in existence and under operating circumstances of the time.
Review	An examination of the effectiveness, suitability and efficiency of a system and its components.
Risk	The combination of the potential consequences arising from a specified hazard, together with the likelihood of the hazard actually resulting in an unwanted event.

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ATTACHMENT B - ISSUE IDENTIFICATION RESULTS

The output from the team's analyses are presented, in decreasing priority order, below. The priority indicator column in the table below was determined as the sum of amounts allocated by team members during the session of September 2019.

Table B1 – Issues Register

Ref.	Aspect Type	Description of Issue	Priority Indicator
IS034 IS030	Biodiversity	Impacts on biodiversity as a result of progressive clearing for surface infrastructure development.	1680
IS040	Water	Groundwater impacts (as a result of drawdown/depressurisation) including consideration of the Namoi Alluvium Zone 5 extraction bore.	1210
IS010	Water	Impacts to groundwater bores not owned by NCOPL as a result of drawdown/depressurisation.	1055
IS070	Noise	Noise impacts from ventilation and other surface infrastructure.	1005
IS002	Water	Groundwater impacts, in particular on BSAL, as a result of hydraulic connectivity.	610
IS071 IS007 IS036 IS077	Water	Impacts on springs and groundwater dependent ecosystems as a result of groundwater drawdown or subsidence effects.	575
IS033	Water	Impacts to overland ephemeral surface water flow due to changes in surface topography resulting from subsidence.	535
IS026 IS076	Water	Impacts to groundwater quality as a result of the management and/or use of brine post-closure.	525
IS068	Water	Cumulative groundwater impacts of the Project, including the Narrabri Gas Project.	510
IS021 IS004 IS029	Water	Degradation (e.g. erosion, ponding) of drainage and/or creek lines as a result of subsidence effects.	235
IS064	Air Quality	Scope 1, 2 and 3 Greenhouse Gas emissions resulting from construction and operation of the Project.	150
IS014	Heritage	Disturbance and/or harm to Aboriginal cultural heritage sites and objects as a result of installation of surface infrastructure.	120
IS008	Water	Reduction in baseflow to the Namoi River and tributaries due to reverse of groundwater gradient resulting from depressurisation.	110
IS022 IS018	Land and Agriculture	Reduced agricultural productivity on NCOPL-owned land due to impacts from mine infrastructure (reduction in available area, increased erosion) and subsidence effects.	100
IS003	Biodiversity	Impacts to dry sclerophyll forest and woodland/forest as a result of subsidence-related ponding.	80

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Ref.	Aspect Type	Description of Issue	Priority Indicator
IS039	Land and Agriculture	Impacts to dispersive soils due to subsidence effects including ponding and loss of soils into surface cracks.	55
IS001	Land and Agriculture	Potential subsidence-related surface cracking in inaccessible woodland/forest that is too significant to self-remediate.	50
IS035	Land and Agriculture	Impacts on future land use as a result of ongoing surface movement due to subsidence.	50
IS044 IS078	Land and Agriculture	General issues with regrowth of vegetation in rehabilitation areas.	35
IS019	Land and Agriculture	Loss of agricultural land as a result of subsidence-related ponding.	30
IS060	Land and Agriculture	Increase in Rejects Emplacement Area requirements due to emplacement of drill cuttings from drilling programmes.	20
IS062	Air Quality	Air quality impacts resulting from the upcast ventilation shafts.	20
IS025	Water	Surface water quality impacts as a result of brine storage dam failure or breach.	5
IS072	Heritage	Impacts to the aesthetic significance of an Aboriginal cultural heritage site or place, as a result of the development of surface infrastructure.	5
IS017	Biodiversity	Impacts on native flora and fauna resulting from use of the site access roads and services corridors.	-
IS066	Biodiversity	Impacts on the lower Darling aquatic community due to changes in impacts on groundwater and surface water quantity/quality.	-
IS042	Biodiversity	Tree impacts resulting from subsidence effects (shearing of roots).	-
IS056	Biodiversity	Additional surface disturbance required in Stage 2 footprint as a result of Stage 3 requirements (e.g. additional gas drainage).	-
IS013	Heritage	Impacts to Aboriginal grinding groove sites situated on rocky outcrops as a result of landform subsidence.	-
IS055	Heritage	Disturbance to, and/or loss of, unknown heritage items as a result of mine infrastructure development.	-
IS073	Heritage	Erosion impacts on Aboriginal cultural heritage/historic heritage sites resulting from surface and underground mine infrastructure development.	-
IS005	Land and Agriculture	Potential pothole or piping failures of clay-rich soils into shallow bedrock joints and cracks caused by subsidence. Drought conditions may mean impact recovery/re-seeding vegetation will take longer and allow continued deterioration.	-
IS006	Land and Agriculture	Unsuccessful rehabilitation of previously mined areas to agricultural land, due to drought conditions preventing re-seeding.	-

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Ref.	Aspect Type	Description of Issue	Priority Indicator
IS020	Built Features	Degraded agricultural infrastructure (e.g. roads, fences, dams, contour banks, bores, etc.) as a result of subsidence effects.	-
IS023	Land and Agriculture	Increased soil erosion as a result of mine infrastructure development.	-
IS024 IS074	Land and Agriculture	Loss of BSAL as a result of surface infrastructure development subsidence effects.	-
IS032	Land and Agriculture	Land contamination as a result of improper waste management/disposal of hazardous items.	-
IS065	Land and Agriculture	Issues with the ongoing management and long-term stability of the Rejects Emplacement Area resulting from the potential increased footprint.	-
IS075	Land and Agriculture	Exclusion of areas from grazing for livestock resulting from operation of the Project.	-
IS050	Air Quality	Dust generation resulting from construction of access tracks and traffic movements.	-
IS051	Air Quality	Dust generation resulting from construction of mine infrastructure.	-
IS052	Air Quality	Dust generation resulting from improper management of existing stockpiles.	-
IS053	Air Quality	Off-site odour or other amenity impacts resulting from spontaneous combustion event in the underground workings.	-
IS061	Noise	Noise impacts on neighbouring landholders as a result of additional ventilation shafts and gas drainage activities.	-
IS048	Road	Traffic interactions resulting from employee use of intersection to Kamilaroi Highway.	-
IS009	Social/Economic	Changes in community value of the Namoi River due to surface water flow changes from extraction or discharge from the mine site.	-
IS063	Social/Economic	Odour resulting from spontaneous combustion of coal, bacteria in brine, diesel or other source relating to Project operations.	-
IS059	Visual	Visual impacts as a result of installation of new ventilation shafts.	-
IS037	Visual	Temporary amenity and visual impacts to landscape during operations.	-
IS011	Water	Induced flow or loss between groundwater sources due to depressurisation.	-
IS012	Water	Loss of surface water flows into the mine workings and/or cross-formation flow between aquifers, as a result of interconnected fractures caused by subsidence.	-
IS027 IS041	Water	Water quality impacts resulting from release of excess groundwater generated on-site into the Namoi River.	-

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Ref.	Aspect Type	Description of Issue	Priority Indicator
IS028	Water	Exceedance of water quality limits resulting from release of surface water runoff from mine infrastructure area dams.	-
IS047	Water	Transmission of groundwater resulting from the construction of gas wells and shafts.	-
IS049	Water	Disturbance of existing land contamination (e.g. old sheep dips) as a result of subsidence.	-
IS058	Water	Insufficient size/number of brine ponds as a result of inaccurate salinity predictions (i.e. higher value than was expected).	-
IS079	Water	Water quality impacts as a result of water releases (other than brine).	-

¹ Issues raised multiple times have been grouped and their votes added together.

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